A Framework for Information Management in E-Agriculture

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DECLARATION

I, Emmanuel Mugejjera, do hereby declare that this study is original and has not been submitted for any other degree award to any other University before.

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DEDICATION

This dissertation is dedicated to my late father Aloysious Kintu and my late mother Tereza Namugga Kintu. The confidence that you instilled in me and the preeminence that you put on academic excellence have made me move on up to today. You always told me that I can excel, I will continue to listen to your voice even when you are dead!

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LIST OF ACRONYMS

CBS	Central Broadcasting Service
CKW	Community Knowledge Workers
CSFs	Critical Success Factors
E-agriculture	Electronic Agriculture
EFA	Exploratory factor analysis
FAO	Food and Agricultural Organization
FFS	Farm Field Schools
FMAAI	Framework for Supporting Management of Agricultural Advisory Information
GDP	Gross Domestic Product
GIS	Geographical Information System
ICT	Information and Communications Technology
IM	Information Management
NGO	Non-Governmental Organization
PMAAI	Platform for Supporting Management of Agricultural Advisory Information
RCEs	Resource Constrained Environments
SEM	Structural Equation Modeling
SMS	Short Messaging System
UNECA	United Nations Economic Commission for Africa
UNCTAD	United Nations Conference on Trade and Development
WSIS	World Summit on the Information Society

DEFINITION OF KEY TERMS

This section defines key terms and concepts as used in the context of this study. This has been done to provide a unified understanding of terms and concepts between the researcher and the readers of this thesis.

E-agriculture is defined as using information and communication technologies (ICTs) to enhance agricultural and rural development (Namisiko and Aballo, 2013; Chauhan and Abugho, 2013; Chauhan, 2015). This research is on the use of ICTs mainly for acquisition, storage, dissemination, and use of information needed by stakeholders in agricultural advisory information management in e-agriculture.

Information is processed data that pertains to a given entity. In this context, focus is placed on information that has value or potential value to the stakeholders in e-agriculture.

E-agriculture Information is the information required by stakeholders in e-agriculture.

Information Management is the control, organization, and evaluation of the collection, storage, dissemination, archiving, and destruction of information required in a given context (ECM, 2021; Larson, 2005; Treasury Board of Canada, 2005). The sole aim of information management is to provide the right information to the right people at the right place and time (Robertson, 2005; Ravi, 2011).

E-agriculture Information Management is the control, organization and evaluation of the collection, storage, dissemination, archiving and destruction of information required by stakeholders in e-agriculture.

Framework is a structure/skeleton (real or conceptual) that supports or guides the realization of a defined result/goal (Edwin, 2014).

E-agriculture Information Management Framework is a skeleton that guides the coordination and organization of the collection, storage, dissemination, processing and destruction of information needed by stakeholders in E-agriculture.

Resource-constrained Environments (RCEs) are environments or circumstances or countries characterized with material and societal limitations (Anderson and Kolko, 2012). Material limitations include, but are not limited to, limited electricity, poor infrastructure, low technical capacity, low income, low bandwidth, and expensive network connectivity. Societal limitations include population with low literacy, social constraints like cultures where people are unfamiliar with or afraid of technology.

Information and Communications Technologies (ICTs) refers to all tools used to capture, store, process, disseminate and manage information (Aker, 2011). This research focuses on computers, mobile phones, radios, and televisions.

ABSTRACT

Agriculture is a vital sector in a developing economy like Uganda's. ICTs have been used in this sector to avail information and to support different information based agricultural processes in what is called electronic agriculture. Despite the use of ICTs, access to agricultural advisory information in a developing economy like Uganda's remains problematic. This state of affairs is attributed to inadequate management of agricultural advisory information in e-agriculture. Therefore, this study aimed to develop a framework for supporting management of agricultural advisory information for small scale farmers engaged in growing of crops aided by ICTs in Uganda's developing economy. The Design Science research method was used to guide the development of this framework. The framework presented in this work was based on a field study using 386 respondents from Uganda's districts of Gulu, Lira, Mbale, Namayingo, Masaka, Wakiso, Mbarara and Ntungamo. Structural equation modeling was used in the design of the framework.

The results show that the critical success factors for management of agricultural advisory information are: People and Technology; Funding, Processes, and Regulations; and Information use outcomes and continuity. The framework is composed of the above factors with People and Technology; Funding, Processes, and Regulations; influencing Information use outcomes and continuity. The framework was evaluated by seeking expert opinion and using a prototype in form of a web-based platform.

In conclusion, the findings indicate that the framework is suitable for supporting the management of agricultural advisory information based on the parameters of goal, environment, structure, activity and evolution. It is suggested that the framework be used based on practical suggestions provided on each sub factor of the framework to aid policy makers in information management in e-agriculture support the agricultural advisory information management practices. Overall, the framework can be used to inform the management of agricultural advisory information. The prototype developed is a foundation for automation of selected tasks in the management of information in e-agriculture in Uganda's context.

CHAPTER ONE
INTRODUCTION

1.1. Background to the Study

Agriculture is so vital worldwide today for its role in providing food for the growing world population, as well as being a source of livelihood for a third of the world population (FAO, 2013). Globally, agriculture contributes 30% of the total Gross Domestic Product (GDP) (FAO, 2013). It employs 90% of the people in rural areas (UNECA, 2007), and 60% of the total workforce (both rural and urban) are employed by the agricultural sector (McKinsey Quarterly, 2011). Agriculture contributes 40% of the total export earnings, provides 50% of the household needs and contributes 50% of the household income (McKinsey Quarterly, 2011).

In developing economies especially in Africa and Uganda in particular, agriculture is the backbone of the economy (Chavula, 2014). It is the backbone of livelihoods and employment for most Africans. It accounts for about 25 percent of the African continent's GDP and supports the livelihoods of 90 percent of the population in Africa, in addition to employing 65 to 70 percent of African population (OECD and FAO, 2016; World Bank, 2016). More critical in Sub Saharan Africa is that agricultural growth is quite effective in reducing poverty and growth more than any other sector. Agriculture is thus instrumental in improving the quality and standard of life of the African people, making it important to enhance the performance of the agricultural sector (AFDB, 2017). For this case, the agricultural sector has a spinal/cardinal role in the life of African people. Nevertheless, this sector has potential that is not yet adequately tapped and it lags behind in productivity, mechanization, access to credit and in advisory and extension services compared to the performance of the agricultural sector in other continents (AFDB, 2017).

Agriculture in Uganda

Agriculture in Uganda is a foundational sector that contributes to the reduction in poverty and hunger (Bernstein and Wiesmann, 2019). The agricultural sector employs sixty-eight percent of the people with a contribution of 25 percent of Uganda's GDP (World Bank, 2019). This is coupled with Uganda's high levels of biodiversity and rich volcanic soils that favor agriculture (Bernstein and Wiesmann, 2019). In addition, there are many fresh water lakes in Uganda that provide potential for irrigation in dry seasons. Uganda has also two rainy seasons per year that are used by farmers for supporting agriculture (Bernstein and Wiesmann, 2019).

Nonetheless, the global climatic change has led to volatility in the agricultural sector with Uganda experiencing periodic droughts with adverse effects on agricultural productivity and food security (OPM GOU, 2012). The drastic changes that have been caused by droughts and famine require the country to raise agricultural productivity and improve food security. This can be done through boosting extension services (agricultural advisory services), farmer's use of inputs and reduce post-harvest losses (World Bank, 2018). Enhancing agricultural advisory services demands for conducting research and generating information that is part of the agricultural advisory services and proposing strategies in managing (coordinating and controlling) this information.

Adoption of Electronic Agriculture

Electronic agriculture (e-agriculture), which is the use of information and communication technologies (ICTs) in agriculture (Namisiko and Aballo, 2013; Chauhan and Abugho, 2013; Chauhan, 2015), has been credited for increasing agricultural and rural development. E-agriculture positively transforms agriculture through enhancing the acquisition, processing, and dissemination of agricultural information, especially agricultural advisory information, thus availing such information to stakeholders in agriculture (Narmilan, 2017; Valentia-Garcia *et al.*, 2019). The use of ICTs in agriculture results into massive information availability. Since information is an asset, there is need to manage this information in order to get value out of it by controlling and coordinating it (Evans *et al.,* 2011; Hunter *et al.*, 2011; Eroglu and Cakmak, 2020).

In developing economies, different farmers have adopted ICTs to support their agricultural activities in different ways. Farmers have adopted the use of mobile-based applications and web-based technologies to support and boost agricultural practices (ITU-T, 2012). Mobile phones have services like SMS, WhatsApp, mobile money services, Internet and web-based services that enable marketing, workshops and training, transfer of money and other services (Aker, 2011). Many mobile-based services developed for agriculture in developing economies target sharing of information in order to increase awareness and thus boost agricultural productivity (FAO, 2012). However, mobile-based services have not greatly benefitted agricultural advisory services particularly in disseminating or sharing agricultural advisory information amongst those using mobile phones and other ICTs.

Existing Efforts to Advance E-agriculture in Uganda

There are several efforts to enhance e-agriculture in Uganda. Organs working under the Ministry of Agriculture Animal Industry and Fisheries (MAAIF) have been institutionalized to further e-agriculture. Among the organs that target research in agriculture and provision of agricultural advisory services to farmers are: National Agricultural Advisory Services (NAADS), national agriculture research centers, National Agriculture Crop Research Institutes and other agriculture research centers distributed in different regions in Uganda. Different universities like Makerere University and Uganda Martyrs University Nkozi have departments and colleges purely dedicated to the improvement of agriculture in general and e-agriculture in particular. Such institutions generate research output especially in form of agriculture advisory information available for farmers to access using ICTs in order to improve agricultural productivity (Umeh and Chukwu, 2015). Each district in Uganda has a district production office (DPO) with dedicated officers intended to promote agriculture and with particular efforts to advance e-agriculture (MAAIF, 2016). Such institutions are funded by the government of Uganda and they place emphasis on provision of agricultural advisory services to farmers to improve their yields.

Different web-based and mobile-based applications have been developed in Uganda targeting provision of information (especially agricultural advisory information) to different stakeholders in agriculture (Katengeza *et al.*, 2011). In these applications, farmers are encouraged to use online banking applications and mobile money services in addition to SMS-based applications to ensure smooth flow of agricultural advisory information to different stakeholders in e-agriculture (Martin and Abbott, 2011). Consequently, a lot of information is availed by the different ICTs requiring proper coordination and control (management) in order to get value out of it. This creates a need to manage the acquisition, storage, distribution and use of such information to enable improved agricultural productivity.

E-agriculture implementation in Uganda, however, is faced with different gaps and challenges. Among these challenges is the absence of specific documented dedicated efforts to advance e-agriculture in Uganda. The available interventions to move forward e-agriculture in Uganda are dominated by general interventions to advance agriculture in general such as extension services. E-agriculture is not given the pre-eminence it deserves for its fast advancement. This leaves e-agriculture implementation in Uganda with specific issues that are not adequately addressed such as improper development and popularization of applications that are easy to use by farmers. Coupled with lack of appropriate e-applications for farmers are the issues of infrastructure and inadequate funding (Omotilewa et al, 2019). Infrastructure that supports ICT use for furthering of e-agriculture are inadequate to support the growing number of Internet and web users. In some areas, especially rural areas, the network equipment is inadequately installed making connection poor and almost un-accessible. Funding for farmers to access or use ICTs is still limited (Hailu *et al.,* 2018). Given that most of the people in Uganda are financially constrained, the limited funding of stakeholders in e-agriculture is still a big issue.

Additionally, cost of equipment is still a critical concern in the implementation of e-agriculture in Uganda's (Munyua *et al.*, 2008). The cost of equipment that is used in e-agriculture is high leading to different stakeholders in e-agriculture lacking them. Smart phones, for example, are still expensive compared to the limited earning of people in developing economies like Uganda's (Munyua *et al.*, 2008). E-agriculture is further limited by payment of Internet data that is still expensive for the local farmers, making many farmers in Uganda to miss training in what the value of ICTs is in e-agriculture (Tata and McNamara, 2018). Some farmers see purchasing of ICTs equipment for e-agriculture as a waste of money, thus requiring training or education. Yet training is compounded by limited education of farmers engaged in e-agriculture leading to limitations in using different ICTs relevant to e-agriculture.

Implementation of e-agriculture in Uganda is further constrained by the existence of a lot of information generated from different sources intended for use by different stakeholders in e-agriculture (Wolfert *et al.,* 2017). This information is not properly managed leading to failure to get the value out of it (Zhang *et al.,* 2016). Stakeholders in e-agriculture, for example farmers, have limited mechanisms to support their acquisition, storage, distribution and use of agricultural advisory information that would help them to achieve high yields and increase agricultural productivity (Zhang *et al.,* 2016).

Information management is very necessary for e-agriculture in Uganda, as agricultural advisory information in general increases the worth or value obtained from this information. Information is an asset (Evans *et al.,* 2011; Hunter *et al.,* 2011; Eroglu and Cakmak, 2020). There are various ICT applications currently that provide advisory information to different small-scale farmers (Vidanapathirana, 2019) thus making its management necessary. The ratio of extension workers to farmers in Uganda is about 1:1800. This ratio makes it hard for small-scale farmers to receive agricultural information, especially agricultural advisory information, physically from extension workers. This situation thus calls for the need to use information technologies to facilitate access to agricultural advisory information. Still, Uganda is characterized by poor infrastructure such as roads, making it vital to acquire information from the web and the Internet by those people whose areas have poor infrastructure and therefore not easy to reach directly by the extension workers.

In addition, agricultural advisory information management in e-agriculture is necessary because there are different ICTs and software such as mobile-based applications, web-based, online, and desktop agricultural information systems that provide a lot of information used in e-agriculture (Zhang *et al.,* 2016). Mobile phones in Uganda have doubled, and these phones are used in the agricultural sector (Martin and Abbott, 2011; Katengeza *et al.,* 2011). Phones exchange messages and voices between farmers and between farmers and extension workers, participants in the market, and other stakeholders in e-agriculture (Aker, 2011). Agricultural practitioners use social media to exchange information such as tweets and WhatsApp messages that contain audio-visual formats of information aided by smartphones.

Although managing agricultural advisory information involves the coordination and control of the acquisition, storage, distribution and use of agricultural advisory information, gaps still exist in the acquisition of agricultural advisory information, severely felt more by the farmers and extension workers that acquire this information (Mark and Neil, 2018). Similarly, extension workers are faced with a lot of information that requires them to make a choice on which information they should disseminate to farmers. Conversely, farmers also interact with a lot of information from different sources leading to confusion on what kind of information they should acquire (Mittal and Mehar, 2013). Storage of agricultural advisory information is also problematic leading to hardships in retrieval and consequently use of that information. All these information gaps are amplified by a poor framework to support management of agricultural advisory information creating a confusing situation about the factors that are key in the management of agricultural advisory information.

The Role of Information Management Frameworks

The existence of a poor framework to manage advisory information by farmers underscores the need to establish appropriate information management frameworks suitable for farmer utilization. An information management framework has the potential to support the management of agricultural advisory information by highlighting critical success factors necessary in this process of managing agricultural advisory information in e-agriculture in Uganda. However, the framework ought to provide suggestions or recommendations on how issues in management of agricultural advisory information can be addressed. Although the framework has the potential to suggest ways that policy makers in agriculture can employ to address issues in the management of agricultural advisory information in e-agriculture, they should be user friendly to farmers. A framework is a structure/skeleton (real or conceptual) that supports or guides the realization of a defined result/goal (Edwin, 2014). Given that a framework has the potential to provide a basis for different implementations of efforts in the management of agricultural advisory information, it has to serve as a design for which implementation of different mobile-based applications and other ICT solutions in agriculture can enhance the farmers' usage for improved productivity and output.

Research Motivation

The need for a framework to support the management of agricultural advisory information for e-agriculture implementation in Uganda is overwhelming. Such a framework is useful because of the limited resources available to farmers in utilizing the advisory information that is availed to them. More critical is that fact that there is no documented framework that supports the management of agricultural advisory information by small-scale farmers and other stakeholders engaged in e-agriculture in Uganda. If a similarity of such a framework exists, it is inadequately used because issues in agricultural advisory information management are still rampant. However, it is worth to acknowledge that there are different information management frameworks used to support the management of information in other sectors other than agricultural advisory information. Nevertheless, currently, it is not known what information management framework can adequately support the management of agricultural advisory information in e-agriculture in Uganda. It is against this background that this research attempts to investigate a framework supporting management of agricultural advisory information in e-agriculture in Uganda.

1.2. Problem Statement

Agriculture is the backbone of Uganda's developing economy (World Bank, 2019). It accounts for 20% of the African continent's GDP and supports livelihoods of up to 90% of the population in Africa (OECD and FAO, 2016; World Bank, 2016). Enhancing the performance of agriculture has more potential to effectively reduce poverty and improve the quality and standard of life in the developing economies of Africa than enhancing the performance of any other sector (AFDB, 2017). In Uganda, agriculture contributes to reducing poverty and hunger (Bernstein and Wiesmann, 2019) and this sector employs 68% of the population and contributes 25% of Uganda's GDP (World Bank, 2019).

To improve productivity, ICTs have found use in the management of agricultural information, in what has come to be known as e-agriculture. Despite the use of ICTs in the agricultural sector to avail information to stakeholders, especially small-scale farmers, there is still poor access to agricultural advisory information. This negatively impacts on this sector leading to low productivity. Poor access to agricultural advisory information is caused, *inter alia*, by poor management of this information that is not backed up by an appropriate framework. Challenges in the management of agricultural advisory information without a proper framework are manifested in retrieval, processing, custodianship, disposal, and dissemination of information. In information retrieval, there are challenges faced like hardship in adapting content to local needs, for example, local languages (Shyam, 2015; Maumbe, 2009), coupled with challenges of low literacy (Kante *et al.,* 2016; Kumar and Timalsina, 2016). In information processing, challenges of the high cost of processing information and low levels of skills needed for information processing are documented (Rashid and Islam, 2016; Barakabitze *et al.,* 2015). Challenges exist in information custodianship, for example, lack of clear government policies and high cost involved (Uzezi, 2015; Kumar and Timalsina, 2016; Kante *et al.,* 2016; Barakabitze *et al.,* 2015). Information dissemination is also challenged by low literacy and high cost (WSIS+10, 2015; Nick *et al.,* 2008). Information disposal challenges like unclear disposal policies and a limited number of skilled personnel have been documented (Pejova, 1996).

Generally, different studies have attempted to address challenges in information management by suggesting sector-specific information management frameworks. For instance, in the global enterprise sector, Peppard (1999) proposed an organizing framework for information management that focuses on global business strategy, global business drivers, global information strategy, and global business model. Rowley (1998) suggested a general information management framework that proposes information environment, information context, information retrieval, and information systems as crucial components. Middleton (2007) suggested improvements in Rowley, (1998)'s framework after testing and applying it in the context of science and technology information management. In the organizational sector, Nguyen *et al.* (2014) suggested an information management framework consisting of people, processes and practices, technology, and information. These frameworks have been substantial in streamlining information management practices in the developed economies and thus addressing information management challenges. However, these frameworks have found little use in addressing issues underlying management of agricultural advisory information in e-agriculture in the context of Uganda, as a developing economy.

Given the inadequacy of the existing frameworks, Uganda's small-scale farmers still face challenges in retrieval, processing, custodianship, disposal and dissemination of agricultural advisory information in e-agriculture in developing economies like Uganda. The question of what framework can support management of agricultural advisory information in e-agriculture in Uganda remains an important question for empirical investigation. This study sought to develop a framework for supporting the management of agricultural advisory information in e-agriculture in Uganda.

1.3. Research Question

This research sought to answer the following research question:

What framework can support management of agricultural advisory information in e-agriculture in Uganda?

This main research question was decomposed into other specific research questions:

1. What are the underlying critical success factors (CSFs) for the management of agricultural advisory information in e-agriculture in Uganda?
2. What should constitute a framework for supporting management of agricultural advisory information in e-agriculture in Uganda?

3. What evaluation techniques can be used as proof of concept for the framework that supports management of agricultural advisory information in e-agriculture in Uganda?

1.4. Main Objective

The main objective of the study was to develop a framework that supports management of agricultural advisory information in e-agriculture in Uganda**.**

1.4.1. Specific Research Objectives

The specific objectives of this study were:

1. To establish the CSFs for effective management of agricultural advisory information in e-agriculture in Uganda.
2. To design a framework that supports management of agricultural advisory information in e-agriculture in Uganda.
3. To evaluate the framework that supports management of agricultural advisory information in e-agriculture.

1.5. Scope of the Study

In this section, the geographic and content scope for this study are described.

1.5.1. Geographic Scope

This study was conducted in Uganda. Two districts were selected from the following regions: East, Central, West, and North. Namayingo and Mbale districts were selected from the Eastern region. Wakiso and Masaka districts were selected from the central region. Ntungamo and Mbarara districts were selected from the western region. Finally, Gulu and Lira districts were selected from the northern region.

1.5.2. Content Scope

Information management is the coordination and control of the acquisition, storage, distribution, use, processing, and archival of information (ECM, 2021). The researcher focused on the following information management activities: acquisition, storage, distribution, and use. These activities were selected because they are commonly performed by small-farmers and extension workers. Small-scale farmers form the biggest percentage of respondents in this study.

Additionally, given the time limitation of the study, it was not possible to handle all the information management activities. Furthermore, emphasis was on agricultural advisory information in e-agriculture. This information was selected because of the high ratio of extension workers to farming households in Uganda (1:1800) compared to the internationally accepted ratio of 1:500 (Ssempijja, 2019). This makes it hard for some household to access extension workers face to face leaving farmers with an option of accessing agricultural advisory information from other available sources. Given that ICTs avail a lot of agricultural advisory information to farmers and that ICTs use in agriculture is increasing in developing economies (Aker, 2011), it was deemed appropriate to support management of agricultural advisory information that these ICTs avail. In investigating the management of agricultural advisory information, the qualities of information have been taken as a given, implying that agricultural advisory information has the qualities of information like recency, timely, and completeness.

1.6. Significance of the Study

Among the stakeholders in e-Agriculture are agricultural communities, government policymakers, researchers in e-Agriculture, agribusinesses, rural traders, entrepreneurs, Non-governmental organizations (NGOs), and farmers (Maumbe, 2010). These stakeholders can benefit from developing a framework that supports the management of agricultural advisory information in e-Agriculture in Uganda. This framework can enable different stakeholders to have improved access to and utilization of information and thus improve e-agricultural development. Having improved access to and utilization of agricultural advisory information improves decisions like market decisions, investment decisions, risk management decisions, climate change adaptation, and food safety decisions (FAO, 2017; Cavus *et al.,* 2019) and increases agricultural productivity (Misaki *et al.,* 2018).

Universities and other agricultural research institutions generate research findings intended to improve e-Agriculture (Umeh and Chukwu, 2015; Obidike 2011; Adetimehin *et al.,* 2018). Due to challenges in information management, these findings, for example, on how to improve productivity, have not been fully utilized by small-scale farmers to improve e-Agriculture (FAO, 2017). The development of a framework that supports management of agricultural advisory information will enable research findings from these institutions to be utilized by small-scale farmers to improve e-Agriculture.

Extension workers in developing economies like Uganda's cannot visit small scale farmers frequently to provide them with agricultural and extension advice because of poor roads, high costs of visiting a widely dispersed farmer community in countries in developing economies (FAO, 2017; Nakasone *et al.*, 2014; Cole and Fernando, 2016). A framework that supports agricultural advisory information management will enable extension workers to coordinate agricultural advisory information thus enabling farmers to use this information to increase e-Agricultural productivity.

A framework for supporting management of agricultural advisory information can improve the acquisition and use of information. As a result, this enables government policymakers, researchers, agribusinesses, rural traders, entrepreneurs, and NGOs to conduct effective communication with farmers and vice versa. Farmers in developing economies like Uganda's lack awareness of new technologies, new crop varieties, new markets, new policies, and new financial opportunities, which is a big challenge in e-Agriculture (Namisiko and Aballo, 2013; Shyam, 2015). Using a framework to support the management of this information can mitigate this challenge.

1.7. Key Contributions of this Research

The research has contributed to theory by developing a framework for supporting the management of agricultural advisory information (FMAAI) in e-agriculture. FMAAI borrows from existing theoretical frameworks that support the management of information in different contexts especially the framework by Nguyen *et al.* (2014). Existing frameworks, as listed in section 1.2, provided the basic elements relevant to the context of agricultural advisory information management in e-agriculture. Based on the literature conducted, there has been no framework developed specifically for supporting the management of agricultural advisory information in e-agriculture in a developing economy's context like Uganda's.

Another contribution for this research, a prototype (PMAAI) was developed arising from FMAAI. This prototype is a proof of concept for FMAAI. PMAAI is a combination of implementable aspects of FMAAI suitable for supporting the management of agricultural advisory information in e-agriculture. This prototype supports stakeholders involved in agricultural advisory information management like small-scale farmers, extension workers, and the ministry of agriculture animal industry and fisheries. In particular, the prototype is used to manage information management training, manage participation in information management systems development and to manage model information management practices. In addition, the prototype is used to manage information management rules and regulations, manage funding opportunities manage budget creation and enabling generation of reports relevant to information management in e-agriculture in Uganda.

This research proposes to practitioners in the management of agricultural advisory information what can be done, in concrete terms, to support the management of agricultural advisory information in e-agriculture. The study follows these proposals with support from the literature. In a way, this research stipulates the details of what should be done by policy makers to support the management of agricultural advisory information in e-agriculture.

1.8. Thesis Outline

The remainder of this thesis is organized as follows:

Chapter 2 discusses the literature review concerning the state of the art and state of the practice of information management in general, information management frameworks, and information management in e-Agriculture. This chapter illuminates the strengths and weaknesses of the efforts to enhance the management of advisory information in e-agriculture. Afterwards, it highlights the knowledge gap that needs to be filled by this research.

Chapter 3 details the methodology followed in this research. This chapter documents how we achieved each of the research objectives. Chapter 4 details the key results of the analysis of quantitative data obtained from the field study. This chapter thus highlights the key factors critical in the management of agricultural advisory information in e-agriculture in Uganda.

Chapter 5 focuses on design of the framework based on structural equation modeling (SEM) with path analysis deriving from the factors elicited from chapter 4. Chapter 6 focuses on evaluation of the framework by implementing a prototype based on the design of the framework. Prior to implementation of a prototype, evaluation of the framework was done using subject matter experts. Chapter 7 focuses on discussion and recommendation for further research.

CHAPTER TWO
LITERATURE REVIEW

2.1. Introduction

This chapter presents a review of literature concerning information management in general, e-agriculture, information management in E-agriculture, and information management in e-agriculture in developing economies like Uganda. It also presents a conceptual framework for this study. In this chapter, we critically evaluate existing information management frameworks and assess their suitability in supporting the management of agricultural advisory information in e-agriculture in Uganda. Later in this chapter, gaps are identified in the existing knowledge about a framework capable of supporting the management of agricultural advisory information in e-agriculture in developing economies like Uganda.

2.2. Management of Agricultural Advisory Information in E-agriculture

ICTs Used in E-agriculture

There is growing evidence of use of ICTs in agriculture in areas of automation and computer-controlled devices, knowledge and information management systems (mobile phones and web portals), e-commerce, managing agricultural resources and services, wireless technologies and radio frequency identification (RFIDs), location-based services (for example, using Global Positioning System (GPS)), Geographical Information Systems (GIS), and digital repositories and agriculture metadata (ITU-T, 2012). In Uganda, ICTs are used to acquire, store, distribute and process information used in agriculture.

It is worth noting that ICT innovations penetrate the agricultural sector at different rates. In Uganda, ICT resources that have found their way in agriculture are hardware, mobile-based innovations, and web-based applications (ITU-T, 2012). This is coupled with the fact that mobile technology has prominence in e-agriculture in developing economies. This is indicated by the numerous mobile applications providing services like SMS that communicate to farmers about markets, agricultural techniques, and practices (Aker, 2011). In addition, web portals and community servers are used to exchange information between farmers, buyers, and sellers (ITU-T, 2012).

There are software applications developed to aid farmers in sharing field experiences and learn from one another (FAO, 2012). This section of the literature review intends to review such software applications and the information they provide to small-scale farmers in developing economies.

It is critical to note that many applications developed are mobile-based and these applications target sharing of information especially using text messages (FAO, 2012; Oxfam, 2011). These applications are expected to increase farmers' awareness and thus contribute to improved agricultural output. Many mobile applications have targeted providing mobile financial services, including mobile money, to small-scale farmers. Such financial applications are Agrinet Uganda and M-PESA in Kenya (FAO, 2012). In Uganda, there are web platforms intended to support the information management needs of farmers. A collaboration between USTA, UNADA, and CropLife has developed a platform in Uganda to help farmers choose high-quality inputs (seeds, fertilizers, and crop protection products) available every season, reliably and on time (CropLife Uganda, 2018). This platform is essential in providing information about agricultural inputs in E-agriculture in developing economies.

Radios and televisions are among the ICTs that are used to support farmers' information sharing and learning needs in developing economies (Mtega, 2018). Other avenues available for farmer information sharing and learning are regular workshops and annual expos organized, for example, by Central Broadcasting Service (CBS) radio station and Vision group publishing company (MAAIF, 2021). While these workshops and expos enable information sharing and learning, they do not follow up to ascertain how small-scale farmers manage such information. Videos combined with participatory processes have shown great potential in agricultural training and increasing productivity (insightshare, 2021; FAO, 2012). These technologies are influential in information dissemination and peer-to-peer learning. Digital Green's innovation is one such example of these technologies (FAO, 2012; Sisil, 2016; Gandhi *et al.*, 2009). What is not clear is that while the practice of using videos is seven times more likely to encourage farmers to adopt new practices compared to conventional agricultural extension systems, it is rarely and inadequately used by small farmers (FAO, 2012; Gaur, 2014). Digital Green produces videos that are useful for farmer learning and information sharing in India. This technology is only becoming attractive to some farmers in developing economies like Ethiopia and Ghana (FAO, 2012; Gandhi *et al.*, 2009).

Similarly, Community Knowledge Workers (CKWs) in Uganda provide real-time information on agricultural topics, including market prices, to farmers using mobile phones (FAO, 2012; Gaur, 2014). A call center supports these CKWs, and they produce and document content in local languages. However, several farmers are not utilizing the call centers.These CKWs work in connection with TECA (technologies and practices for agricultural producers). TECA is an online platform that provides information for smallholder agricultural producers worldwide (FAO, 2012).

Zhang et al. (2016) classified ICT systems that are used in agriculture and came up with the following categories:

(i) Portals: These are collections of links to other resources that farmers may need.
(ii) Voice-based Service: Information dissemination through telephone, i.e. call centers.
(iii) Text (SMS)-Based Service: Information dissemination through text message of mobile phones.
(iv) Self-support online community: This is where a community provides information services to its members. This means of information provision requires stakeholders to subscribe. It involves members sharing and exchanging information through interactive service platforms.
(v) Interactive video conferencing services: This is provision of information using online multimedia technologies.
(vi) Mobile internet-based service: This is provision of information using smart phone services.
(vii) Unified multi-Channel Service Model: This is provision of information using multiple methods or technologies like telephones, computers, and mobile phones.

These methods of providing the information as categorized by Zhang et al. (2016) are useful in understanding ICTs in agriculture in developing economies. There are different modes of developing, deploying, and managing such information dissemination systems to provide government-led, market-driven, and community self-supporting information services (Mittal and Mehar, 2015). These modes can be supplemented by efforts to support management of such information. The existence of different modes of developing, deploying, and managing such information dissemination systems to provide government-led, market-driven, and community self-supporting information services is not what actually matters, but the question is raised whether they benefit small scale farmers in rural areas in developing economies.

There are different requirements that Zhang et al. (2016) suggest for information systems intended for farmers. These requirements or operational features include comprehensive management and maintenance, providing diversified content to meet farmers' needs, and high-quality service standards such as information quality and security. Other requirements proposed by Zhang et al. (2016) are; rigorous management as a hierarchical structure to ensure information reliability, smooth contact system, and reliable system with authenticated information, constant improvement of service quality in terms of system improvements to meet the needs of the farmers. Though these requirements are essential to farmers, there is need to propose a structure that can support management of information contained in these different information systems in order to realize the value of this information to the farmers.

Stakeholders in E-agriculture and the information they interact with

While stakeholders in agriculture, especially farmers, have information requirements, the information generally required by farmers in e-agriculture in Uganda needs to be reviewed. There are many stakeholders in agriculture and even more stakeholders in e-agriculture. ITU-T (2012) attempted to provide a list of stakeholders in e-agriculture. Awuor *et al.* (2013) also enumerate the e-agriculture stakeholders in aggregations. Deloitte (2012) provides a summarized categorization of stakeholders in agriculture and tabulates the information exchange that these stakeholders make. The stakeholders include:

- Businesses including associations and other organizations.
- Farmers including individuals, organized and unorganized associations.
- Researchers including educators; and Trainers.
- Governments including the Ministry of Agriculture; Departments; and Parastatals.

The list of stakeholders in e-agriculture applies in the case of Uganda. Farmers are significant stakeholders in e-agriculture in Uganda, therefore, the subsequent paragraphs explain the farmers present in Uganda.

(a) Farmers in Uganda. Information that farmers acquire in e-agriculture in Uganda is about commodity prices, weather, disease outbreaks, and helpline services providing tips and real-time advice (FAO, 2012; Oxfam, 2011). Farmers also acquire information about inputs like seeds, fertilizers, and crop protection products (CropLife Uganda, 2018). Figure 2.1 summarizes farmers' information needs, and it is what we used to categorize the kind of information farmers in e-agriculture in developing economies like Uganda's require.

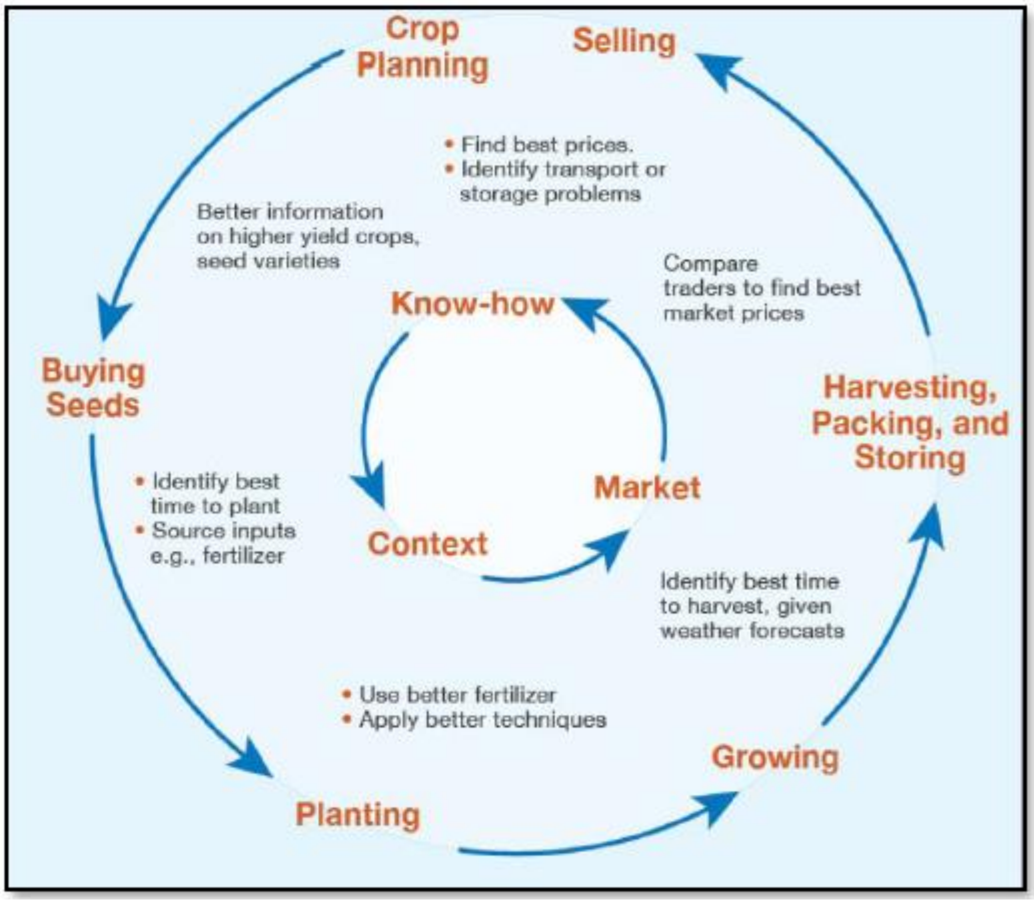

Figure 2. 1: Information needs of farmers (Adopted from Mittal et.al, 2010; p5)

Figure 2.1 provides evidence that there are different information needs that farmers have in agriculture for example when they are buying seeds, planting, growing crops, harvesting and selling their produce. Satisfying the information needs of these stakeholders is necessary for e-agriculture development and points to the need for mechanisms to manage this information.

Smallholder farmers dominate agriculture in developing economies (UN, 2015). Smallholder farmers are rural producers predominantly in developing economies. They use mainly family labor and get most of their income from agriculture (UN, 2015). They are also understood as farmers with limited resources (Fan and Rue, 2020), having a low asset base, operating less than 2 hectares of cropland (Fan and Rue, 2020). However, many smallholder farmers do not use or underuse modern technologies like improved fertilizers, improved seed varieties, pesticides, and insecticides. They have limited information or knowledge about these technologies and have little money to purchase such technologies (IFAD, 2010). Such farmers can benefit from mechanisms to support information management in order to gain from the money they allocate from their meagre income to purchase these technologies.

The level of education of many smallholder farmers is of concern in developing economies. There are few or no active farm field schools (FFS) in developing economies to help farmers obtain practical skills needed for their daily agricultural practices (Kariyasa and Dewi, 2011). Since there is a lot of information generated in agricultural research in developing economies, improved agricultural information management (especially agricultural advisory information management) can be helpful for these farmers. However, it is only a farmer with a high level of education that can obtain, interpret, process and use information more than the farmer with low education level (Mignouna *et al.,* 2011).

Much of agriculture in Africa, and other developing nations, is done on a subsistence level by small-scale farmers that occupy 70% of the land (Jayne *et al.,* 2014). Farmers in developing economies rely primarily on family labor for production (Mignouna *et al.,* 2011). These farmers use traditional farming methods that provide low yields compared with improved methods (African Development Bank Group, 2010). Improved agricultural advisory information management framework is a robust approach that can contribute to advancing the farmers' traditional agricultural practices for increased agricultural productivity.

Smallholder farmers ensure food security in Africa by supplying approximately 70% of the total food requirements and they provide 80% of the food consumed in Asia and Sub-Saharan Africa (UNCTAD, 2015). The aforementioned evidence confirms that smallholder farmers play a significant role in people's lives in developing economies by producing food. However, it is significant to investigate mechanisms to support the management of agricultural advisory information which is available for smallholder farmers in developing economies in order to improve agricultural productivity.

Environment in which Farmers Operate

The environment in which farmers operate today has greatly changed since 1970s. The agricultural sector in developing economies is increasingly becoming knowledge-intensive (Malhan and Rao, 2017). New information is produced at global, regional, national, community, and even individual levels. Farmers need information about agricultural inputs, cultivation practices, generating farm products, processing, and marketing (Malhan and Rao, 2017). In a nutshell, farmers in developing economies need agricultural advisory information. In this case, proper information management is inevitable if farmers are to continue receiving reliable, timely, and relevant information. Farmer's competitiveness rests on an environment where there is adequate agricultural advisory information management. The environment in which farmers in developing economies operate is full of fake agricultural inputs like seeds, fertilizers, and farm machinery (Shao and Edwards, 2014). In Uganda, for example, fake agricultural products are an issue leading to low production of the agriculture sector (Fairbairn *et al.,* 2017; Tjenstrom *et al.*, 2017; Kilic *et al.*, 2017). In developing economies, farmers purchase fake inputs due to a lack of information (Fairbairn *et al.,* 2017; Ashour *et al.*, 2017). Enhancing information management to enable farmers to obtain genuine agricultural inputs is necessary.

Unreliable and unpredictable rains continually put farmers in developing economies in serious jeopardy (McGuire, 2007). Even research to inform farmers on alternative methods of agriculture that do not necessarily rely on rains is rarely conducted (Wetangula, 2013). With unreliable rainfall, information is needed by farmers to help them know when to start cultivating (Wetangula, 2013). Due to inadequate agricultural advisory information management practices in developing economies, some information is unused leading to low agricultural productivity. Farmers therefore find themselves in an environment where there is little information and knowledge about markets for their produce. The situation is made worse by middlemen who exploit farmers by buying their produce at low prices and selling them at higher prices (Masters, 2008; Abebe *et al.*, 2015). As long as poor agricultural advisory information management continues to thrive in developing economies, such ignorance about markets and exploitation by middlemen are bound to happen.

The environment in which farmers in developing economies are operating is of little collaboration between farmers. Research shows that collaboration between farmers is critical in their development (Valentinov, 2005; Shreck *et al.,* 2006). Collaboration enables farmers to secure legislation and combat the pressure exerted on them by retailers (Abebe *et al.,* 2015). As Rahmann and Aksoy (2014) assert, trust, reliability, and timely communication are three critical factors before collaboration. Therefore, without proper agricultural advisory information management, collaboration is unattainable.

More so, few extension workers are practicing their profession in developing economies (Isaya *et al.,* 2018). The small number of practicing extension workers serves an increasing number of farmers that have unlimited challenges (Isaya *et al.,* 2018). The need to visit and train farmers has never ceased to prevail among farmers in resource-constrained settings (Ponniah *et al.,* 2008). In such a state prevailing, enhancing agricultural advisory information management can aid to ensure that farmers get the information and advice they need to carry out their agricultural activities.

Nature of Crops Grown by Farmers

Crops that characterize smallholder farmers in developing economies are mainly food crops and cash crops like coffee (IDH, 2013). In Uganda, coffee is a source of livelihood for 1.7 million people smallholder farmers. Most of the coffee in Uganda (98% and more) is grown by family farms each owning approximately 200 trees (0.18 ha coffee) (IDH, 2013). The farm sizes have been decreasing because families subdivide their farms to pass land on to their descendants (Anderson *et al.,* 2016). In families where coffee is grown, it provides 50% of the household income yet it takes approximately 20% of the total land owned by the family and the other common crops grown include bananas, maize, and beans which are foods (IDH, 2013). Farmers that grow excess of what they can consume sell this excess for money.

Yields of smallholder farmers can increase if they obtain agricultural advisory information and heed the advice provided by specialized agriculturalists (MAAIF, 2016). Coffee growers gain from knowing proper intercropping, for example, growing coffee and beans in the same garden. They also gain from applying fertilizers, better farm management practices, replacing aging trees, coffee disease and pest control practices, and better pruning practices (IDH, 2013). An example of how poor information management about pests and diseases can be detrimental is the coffee wilt disease that hit Uganda in the early 2000s destroying as much as half of the country's Robusta tree stock (Rutherford, 2006; IDH, 2013). Such a disease would not have caused as much loss if better agricultural advisory information management practices had been used. The other diseases like banana wilt and cassava mosaic cause loss to farmers in developing economies like Uganda's (Settumba, 2012) which losses are avertable with enhanced agricultural advisory information management practices.

Information needs of different stakeholders are determined by the activities in which those stakeholders engage (Soyemi, 2014). The activities farmers engage in dictate the information needs of farmers; for example, farmers engage in planting, so they need planting information, farmers engage in buying seeds and farm inputs so, they need information that helps them carry out these activities. In the same way, the other stakeholders' major activities will point to the information they need. In summary, farmers would gain from a strategy on ICT for agriculture (ICT4Ag) through increased access to agricultural information and services (FAO, 2017). A framework supporting management of agricultural advisory information in e-agriculture would be one of the components in the strategy for ICTT4Ag but such a framework is not documented.

(b) Governments. Governments are crucial stakeholders in e-agriculture given that this sector contributes to GDP, the livelihood of the people plus, food security. Governments participate in e-agriculture through their ministry of agriculture and other government-funded agricultural agencies. Governments promote agricultural products, provide food safety and inspection services, soil conservation, and environmental preservation (IPTV, 2019). Governments are responsible for agricultural state policies that regulate different activities like production, transportation, processing, exportation, and marketing of commodities (MAAIF, 2016). The government provides credit facilities to farmers, extension services to farmers, rehabilitation of feeder roads, land, modern storage facilities, establishing marketing boards, increase the cultivation of crops, quality assurance, formulation and implementation of agricultural policies (Informationhive, 2019). Although the government may carry out activities that overlap with those of other stakeholders, the stakeholders are also given attention separately. FAO (2017) highlights the value of an e-agriculture national action plan explaining that such an action plan helps governments to draw a logistic roadmap for its practical and actionable strategy on Information and Communications Technology for Agriculture (ICT4Ag). Consequently, it is the role of the government to identify activities and how they should be managed, funded and coordinated and to appoint those responsible for the design and implementation of the e-agriculture strategy (FAO, 2017). It is the role of the government to fund, plan, implement and monitor and evaluate the stages of the realization of the e-agriculture strategy (FAO, 2017). Under such a plan a mechanism or framework supporting management of agricultural advisory information would be expected. The government clearly plays a role in agriculture in general and e-agriculture in particular as has been highlighted in the previous paragraphs, however, governments have not documented any clear framework or mechanism that can support management of agricultural information in general. Particularly, there is no documented framework that guides management of agricultural advisory information in e-agriculture in Uganda. There is no framework that stipulates what critical success factors should be considered in the management of agricultural advisory information in e-agriculture.

(c) Researchers in E-agriculture. Researchers in e-Agriculture are another group of stakeholders in e-agriculture (Deloitte, 2012; FAO, 2017). Researchers operate in different institutions like research-based organizations, universities, agricultural research centers, and individual researchers interested in addressing problems that are of interest to agriculture. Their main activity is to conduct research and publish it so that it makes an impact on the agricultural sector. Having a clear framework that supports e-agriculture results into agricultural researchers achieving improved access to valuable literature, knowledge and resources (FAO, 2017). For the case of agricultural information, particularly agricultural advisory information, having a framework or mechanism that supports management of agricultural advisory information in e-agriculture is part of the framework that supports e-agriculture and therefore such a framework is *ipso facto* critical. Nevertheless, such a documented framework to support management of agricultural advisory information in e-agriculture is non-existent in a developing economy like Uganda.

(d) Agribusiness Industry (and ICT Service Providers). The agribusiness industry requires information about the production, distribution, and sales of produce. The ICT service providers need information about farmer's skills, needs, challenges to develop appropriate software to address these challenges. The agribusiness industry can gain from a strategy on ICT4Ag through improved management of agricultural inputs and outputs through the production cycle, or better access to international markets through certification and interconnected commodity exchanges (FAO, 2017). Given that a framework supporting the management of agricultural advisory information could be one of the components of the strategy on ICT4Ag, such a framework is critical. Nevertheless, such a framework supporting the management of agricultural advisory information in e-agriculture is nonexistent in a developing economy like Uganda.

(e) Non-Governmental Organizations. In this category, we find categories like private researchers, consultants, foundations, and non-profit organizations (Maumbe, 2010). FAO, (2017) looks at non-governmental organizations and extension agencies as examples of Agricultural service providers. These stakeholders need information about different farming communities, challenges they face, and how to improve agricultural processes for better yields. A strategy on ICT for agriculture (ICT4Ag) including an e-agriculture national action plan is vital for non-governmental organization as stakeholders in e-agriculture. Such a strategy aids agricultural service providers like non-governmental organizations and extension agencies to have access to information in the field and remotely (FAO, 2017). A framework supporting management of agricultural advisory information could be one of the components in the strategy on ICT for agriculture (ICT4Ag). Nevertheless, such a framework supporting management of agricultural advisory information in e-agriculture is not documented.

Categorizing Agricultural Information. Samarakoon and Shamil, (2010) categorize agriculture information and show the different users of the different categories as presented in table 2.1. Table 2.1. illuminates the diversity of agriculture information.

Table 2. 1: Agriculture information categories (Source: Samarakoon and Shamil, 2010)

Category of Information	**Type of Information**	**Information Users**
Technical/Scientific	▪ Research and Development in Agriculture	▪ Researchers ▪ Extension officers ▪ Agro business and services staff ▪ Policy makers and planners
Commercial	▪ Information on credit and cooperatives ▪ Ways of obtaining loan from government ▪ Prices of export commodities	▪ Farmers ▪ Extension officers ▪ Agro business and services staff ▪ Policy makers and planners
Social/Cultural	▪ Agricultural practices ▪ Background on farming communities ▪ Modern systems of farming ▪ Innovations in storage facilities ▪ Labor availability	▪ Policy makers and planners ▪ Extension staff ▪ Farmers

From table 2.1 it is evident that given the diverse information, there is need to manage this diversity of information in agriculture in order to obtain value out of it.

Another way to conceptualize agriculture information and relevant stakeholders is by looking at the agriculture value chain (See figure.2.2).

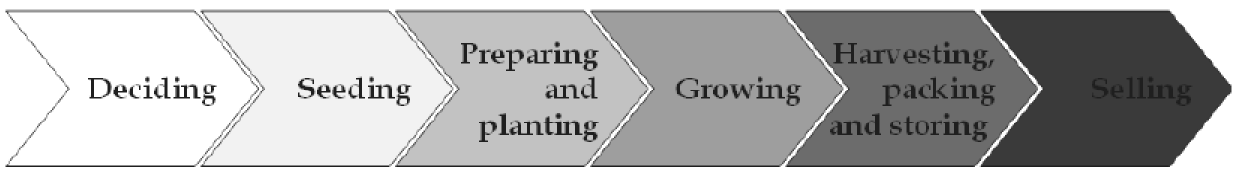

Figure 2. 2: Agricultural value chain (Adopted from De Silva & Ratnadiwakara, 2008 p.10)

From figure 2.2, it is implied that different stakeholders in agriculture need information on each stage of the agriculture value chain. Stakeholders in agriculture that add value by growing, buying, selling, processing, transporting, storing, checking, and packaging are critical. By looking at the agriculture value chain we can understand the kind of tasks on which there is a need for information. This implies that stakeholders need different kinds of information on different stages of the agricultural value chain. Although there is a lot of information as has been highlighted in the previous paragraphs, this research focuses on the agricultural advisory information needed in e-agriculture. The agricultural environment in which farmers in developing economies operate is so un predictable so agricultural advisory information is so critical yet there is no documented framework that can support management of this agricultural advisory information in e-agriculture.

Generators of Information in E-agriculture in Uganda. It is necessary to understand the sources or generators of this information in order to enhance information management in e-agriculture. This section is dedicated to sources or generators of this information.

Colleges and Universities are some of the sources of agricultural information at the local level (Opara, 2008; Demiryurek *et al.,* 2008; Ugwu and Kanu, 2011). The institutions conduct applied and basic research in response to the needs, conditions, and challenges of the local people engaged in agriculture. The information they generate is called scientific information (Ballantyne, 2009; Demiryurek *et al.,* 2009). Most of the agricultural information is obtained from universities and research institutes (Chandrasekan *et al.,* 2010; Rao, 2007). The scientific information is mainly about new crop varieties and what they require for proper growth. Thus, this information relates to drought, climate, weather, water stress periods, water sources, and water availability. Farmers get this information to improve productivity and quality of output (Sani *et al.*, 2015). As Demiryurek et al. (2008) assert, this information is intended to enable farmers to get informed about best practices. At the national level, information is obtained from national governments especially the government ministry of agriculture, national research organizations, and companies or corporations involved in agricultural research (Jones, 1990). In a developing economy like Uganda, evidence of the generation of agricultural information by numerous sources is a reality.

Another source or generator of agricultural information is Regional, International, and Professional Organizations. Professional associations and research organizations are sources of agricultural information (Jones, 1990). These organizations sponsor research, publish journals, books, and reports, establish standards and organize agricultural conferences where the generation and dissemination of agricultural information happen. Food and Agriculture Organization (FAO) is an example of such organizations that generate agricultural information. FAO is committed to increasing agricultural production, improving nutritional practices, and improving the quality of rural life (Jones, 1990). FAO produces numerous journals, reports, indexes, handbooks, and training manuals. These serve as sources of information for agricultural practitioners. Other sources of agricultural information are commercial publishers who publish journals and books on agriculture (Jones, 1990). In addition to these, computer software is a source of agricultural information. National agricultural libraries are also another source mentioned by Jones, 1990.

2.3. Information Management

2.3.1. Information Management as a Series of Tasks

Different authors explain Information management in terms of tasks involved (Bytheway, 2015; Choo, 2002; Butcher and Rowley, 1998). Butcher and Rowley (1998) look at information management as composed of acquiring information, information custodianship, dissemination of information, and disposal. Choo, (2002) views information management as a series of the following tasks; Establishing information needs, information acquisition, information organization and storage, information services and products, information distribution, information use, and adaptive behavior (See Figure 2.3.)

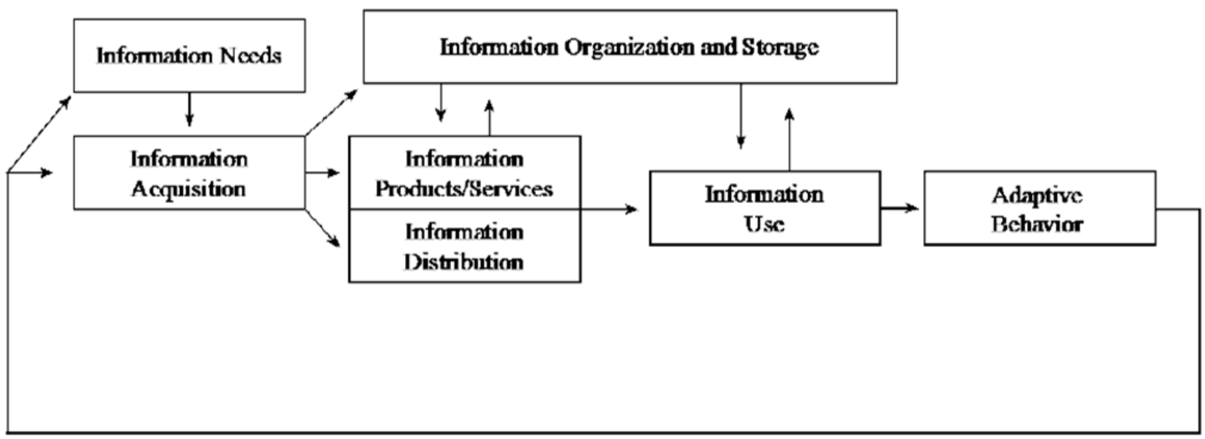

Figure 2. 3: Tasks in information management (Source: Choo, 2002)

In figure 2.3, information management is depicted as a series of related tasks that result in adaptive behavior and then the process starts all over again with information needs and information acquisition.

Based on the definition of information management as suggested by Rowley (1998), Butcher and Rowley (1998) proposed the '7 R's model of Information Management. The 7R's are information Reading, Recognition, Reinterpretation, Reviewing, Release, Restructuring, and Retrieval (See figure 2.4). Information management, therefore, is conceptualized as composed of tasks as suggested by Butcher and Rowley (1998).

In figure 2.4, information management is depicted as a cyclic process consisting of 7R's explained as follows (Butcher and Rowley, 1998): Information management involves **reading** documents to get or collect information.

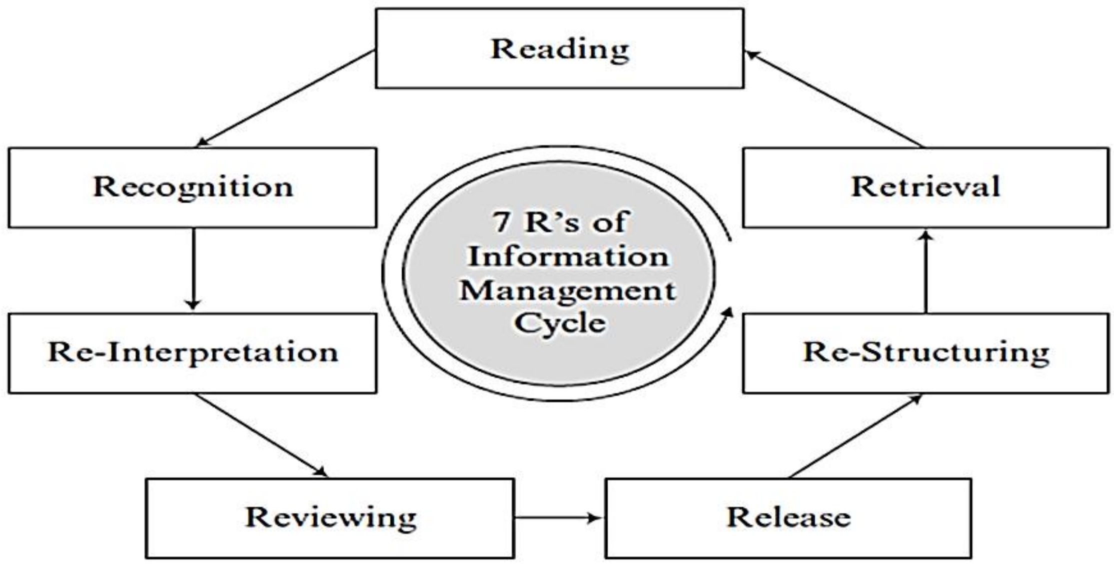

Figure 2. 4: The 7R's model of Information Management (Source: Butcher and Rowley, 1998).

Recognition entails absorbing the information that one has read into the cognitive framework and matching that information with the existing one in the cognitive framework. This is the process in which information is converted into subjective knowledge. **Reinterpretation** is the process in which information is converted into a form that can be easily communicated such as a document and graphical form. In this process, knowledge is made known to the public. In **review or evaluation,** the knowledge that has been made public in reinterpretation is validated. This task is done by organizations, not individuals. **Release or distribution** entails publicizing knowledge to those who need it. Therefore, this validated knowledge enters a database from which users can access it. This process is also done by organizations. **Restructuring** involves people accessing the information from the databases or any other storage areas and selecting information that meets one's needs. Organizations responsible for the databases carry out the indexing, rearrangement, and formatting of this information. Lastly, in the **retrieve** process, people get access to the information from databases, and then they read it. The cycle, therefore, repeats itself when the users read this information. Other authors like Detlor (2010) perceive information management as the management of the processes/activities and systems/resources that create, acquire, organize, store, distribute, and use information.

Information management aims to help people and organizations access, process, and use information efficiently and effectively (Detlor, 2010). As a result, people become more informed and organizations more competitive and strategic. The discussion in the previous paragraphs indicate that information management is composed of tasks. For the purpose of this study the tasks suggested by Choo, (2002) is the basis for which information management in this study was conceptualized and limited to acquisition, storage, distribution and use of information, particularly agricultural advisory information in e-agriculture. Choo, 2002 was opted for because the tasks suggested (acquisition, storage, distribution and use of information) are close and relevant to the activities done by stakeholders in e-agriculture in their information management activity.

2.3.2. Information Management Frameworks

There are several authors such as (Choo, 2002, Rowley, 1998, Deasy *et al.*, 2016; Middleton, 2007; Peppard, 1999 and Nguyen *et al.*, 2014) that have attempted to develop information management frameworks that are applied in different contexts. These frameworks are presented below.

Rowley (1998)'s Information Management Framework

Table 2.2 below summarizes the mega pillars in information management as suggested by Rowley (1998).

Table 2. 2: Key components in an information management framework by Rowley, 1998)

INFORMATION ENVIRONMENT	INFORMATION CONTEXT
- Political forces - Economic forces - Legal forces - Regulatory forces - Societal forces - Technological forces	- Context houses the user - Context influences systems design - There are categories of contexts like - Organizational - Home - Community. - Education - Business
INFORMATION SYSTEMS	**INFORMATION RETRIEVAL**
- Store information - Requires a big storage capacity - Requires a good logical database structure - Information systems include: - Hardware - User - Software - Data	- User interaction with the information system or information resource to meet the user information requirements. - Involves actions, methods and procedures for recovering information from stored data.

Table 2.2 presents major pillars with relevant sub-pillars that fit in each major pillar. This framework goes ahead to explain the entities or people responsible for the four levels shown in the framework (information context, information retrieval, information systems, and information environment) in table 2.3 below.

Table 2. 3: Entities or people responsible for the four levels shown in Rowley, (1998)'s framework.

Level	Information processor	Information managers	Definition
Information retrieval	Individual	Database designers, HCI designers, indexers, users	Information as subjective knowledge
Information systems	System	Systems analysts and designers	Information as useful data/Information as thing
Information contexts	Organisation	Strategic information managers, strategic Managers, organisational scientists	Information as a resource
Information environments	Society	Governments, multinational corporations, Educational institutions	Information as a commodity/ Information as a constitutive force in society

Table 2.3 clearly shows that for information management to be efficient, it is important to have information processors and information managers. Rowley (1998) also clarifies that information management is for specialists but information processing is for all people.

An Information Management Framework by MIDDLETON (2007)

The Information Management framework by Middleton (2007) is related to that of Rowley, (1998). Middleton (2007) puts into practice or applies Rowley (1998)'s framework in a specific context of science and technology information management. Table 2.4 shows the major elements and their sub-elements in this framework.

Table 2. 4: Major elements in an information management framework (Middleton, 2007)

INFORMATION ENVIRONMENT - Public policy development - Disciplinary demand - Technological change	**INFORMATION CONTEXT** - Information as a resource - Circumstances affecting functionality - User information needs
INFORMATION SYSTEMS - Systems analysis and design - Evaluation	**INFORMATION RETRIEVAL** - Information selection - Information design - Information organization - Information retrieval

In this framework, Middleton (2007) emphasizes the need for evaluation at the information systems level. He again suggests a merge of the information environment and information context levels. He suggests that the retrieval be called the information process. He asserts that it is appropriate to call information processing in Rowley, (1998) assemblies. He suggests that the three domains: operational, analytical, and strategic (Diener, 1992) be used to explain each level. In the operational domain, the information management processes are carried out. In the analytical domain, user needs are determined, the value of information is ascertained and the performance of information processes analyzed (Middleton, 2007). In the strategic domain, information managers plan and contextualize within a given policy agenda.

Information Management Framework by Nguyen et al. (2014)

Figure 2.5 shows an information management framework by Nguyen et al. (2014) consisting of people, processes & practices, technology and information as core elements.

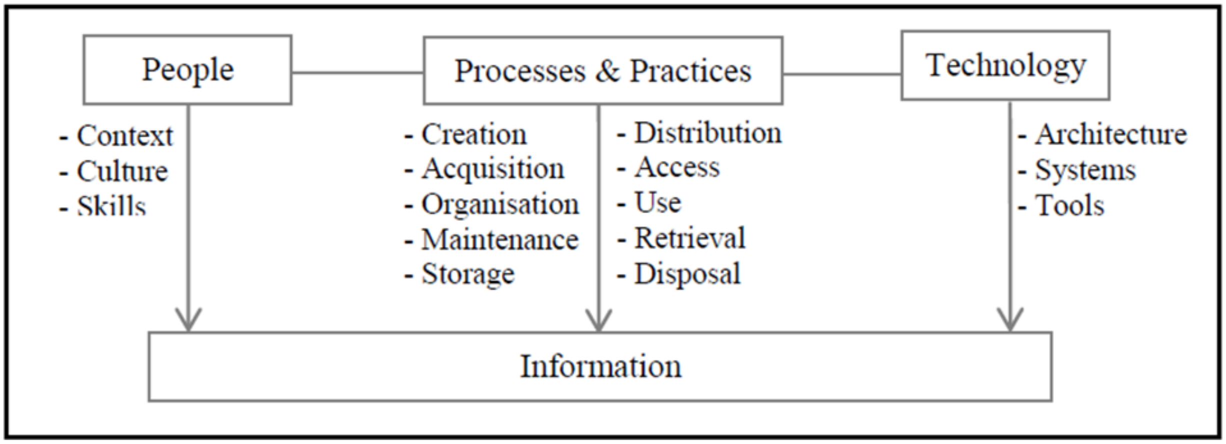

Figure 2.5: Information Management Framework by Nguyen et al. (2014)

The above framework puts emphasis on people as the key managers and users of information. The framework also details some elements of the information lifecycle under the processes and practices.

An Information Management Framework by PEPPARD, (1999)

The information management framework suggested by Peppard, (1999) was focusing on a global enterprise showing the core elements that need attention to have proper information management in a global enterprise. These elements are global business strategy, global business drivers, global information strategy and global business model. Figure 2.6 shows this information management framework.

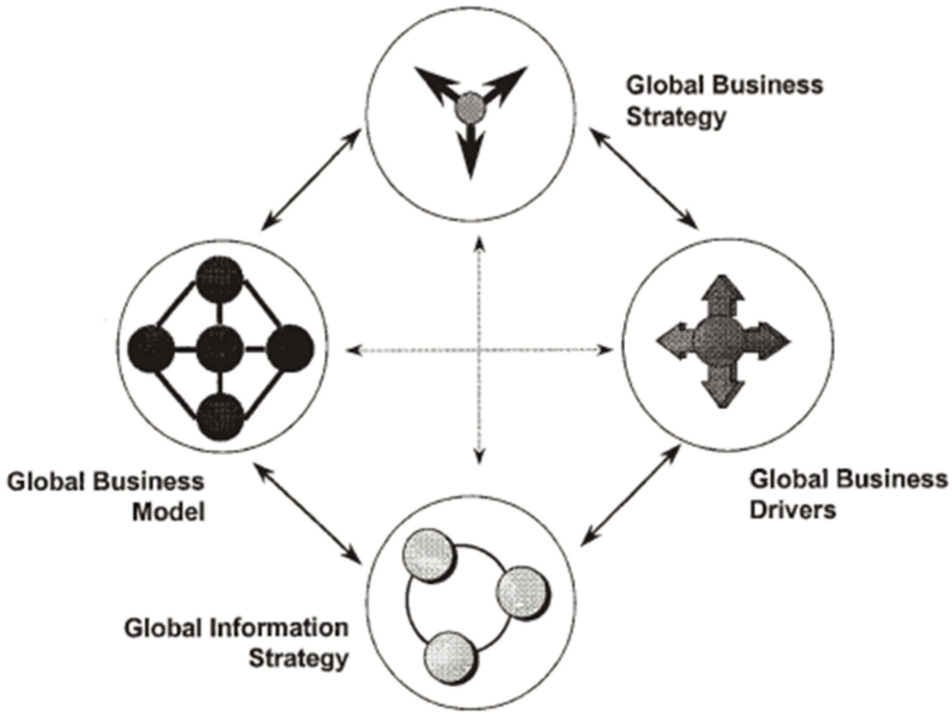

Figure 2. 6: An organizing framework for information management (Peppard, 1999).

Although all these elements in figure 2.6 are skewed to global business context, they are informative in our investigation of information management in e-agriculture. They serve as a basis for development of an information management framework supporting management of agricultural advisory information in e-agriculture.

An Information Management Framework by DEASY *et al.*, (2016)

Deasy et al. (2016) suggested a corporate information management framework that guides information in the European public sector. This framework highlights six components: Information is an asset, generate, manage, share, protect and preserve (see figure 2.7).

Figure 2. 7: A Corporate Information Management Framework (Deasy et al., 2016).

The above framework highlights processes (Generate, Manage, Share, Protect, Preserve, and value (implying a process of valuing information because it is an asset)). The six processes or tasks are based on the information life-cycle.

A Discussion about the Frameworks Presented

The evaluation of the frameworks presented in the previous paragraphs is intended to generally and sketchily search for some common components that can be relevant and applicable in the conceptualization of the information management framework that this study sought to develop. The evaluation of these frameworks is not to be rigorous or even tabulated since these are not candidate frameworks in the same context of our study but frameworks borrowed from other contexts to serve as aids to the conceptualization of a framework in this study context. The framework by Nguyen *et al.*, 2014 has components that are relevant to the context of agricultural advisory information management in e-agriculture. This framework has components that are shared with other frameworks and it is clear. Therefore, this framework provides foundation for the conceptualization of the framework that this study sought to develop.

The frameworks that have been presented in the previous paragraphs are silent about cost or budget as a critical success factor in information management frameworks. Cost is so important in e-agriculture in developing economies where finance is scarce. Any efforts to handle information need to think critically and to consider the issue of cost as paramount. Apart from the framework by Nguyen et al. (2014), other frameworks are silent about key processes in information management that is acquisition, custodianship, processing, disposal and dissemination of information as noted by Choo, (2002).

2.4. Adopting Information Management Approaches in E-agriculture

Information management in e-agriculture involves coordination of activities and resources needed in acquisition, custodianship, dissemination and disposal of information available in e-agriculture. The remainder of this section focuses on painting a picture of how information management is done in e-agriculture in Uganda.

Information Management in E-agriculture in Uganda

Information management in E-agriculture in Uganda is practiced uniquely. Before we elaborate on this unique way, an attempt is made to define information management in E-agriculture in Uganda. Information management in E-Agriculture is defined as whatever is needed (activities and resources) to acquire, update, create and disseminate information accessible to agricultural stakeholders at all levels (Nick *et al.,* 2008). Although this definition skews to the side of tools used in information management, it is foundational for our conceptualization. This definition, however, misses the element of management which could be incorporated by defining information management as: the control and coordination of the acquisition, update, creation, processing, storage, and dissemination of information.

2.5. Challenges in Information Management in E-agriculture

There are different challenges faced in information management in e-agriculture in Uganda. These challenges are presented below based on the key parameters highlighted in the information management frameworks reviewed in this study. These parameters are also presented in the conceptual framework for this research in this same chapter. These parameters are; Information, Information systems, Information technology, Information retrieval, Information context, Information environment, People, Processes, and practices (Rowley, 1998; Nguyen *et al.,* 2014; Middleton, 2007). These parameters have been selected because they are the most relevant components in the context of agricultural advisory information management in e-agriculture.

The challenges stated in the subsequent paragraphs were obtained from different developing economies. These challenges are applicable in the context of Uganda as a developing economy.

Therefore, these challenges that are presented below were conceptualized as belonging to the Ugandan context since there were scarce sources that conducted peculiar research to highlight these challenges in a Ugandan setting. These challenges are presented below:

Information Related Challenges

There are challenges in information management in e-agriculture in developing economies like Uganda's that relate to information. These include:

1. It is a challenge to adapt content to local context like language and local needs (WSIS+10, 2015; Rashid and Islam, 2016)
2. There is a challenge of data ownership in e-agriculture (Shyam, 2015; Chauhan, 2015; Chauhan and Abugho, 2013)
3. There is outdated information that still finds its way to stakeholders in e-agriculture (Uzezi, 2015; Munyua, 2008).
4. Some information is not appropriate to users' ability, needs, context, education level and culture (Kante *et al.,* 2016).
5. Much of the information is in text format, so there is little variety in information formats (Uzezi, 2015; Munyua, 2007).

Information Systems Related Challenges

There are challenges in information management in e-agriculture in developing economies like Uganda's that relate to information systems:

1. Some tools or information systems used to disseminate information are inappropriate to the users for example some of these tools may require additional skills to learn (Lamptey *et al.*, 2016; Munyua, 2008).
2. There are inadequate facilities to use to disseminate information for example community libraries that disseminate information needed by stakeholders in e-agriculture are few (Syiem and Raj, 2015; Lamptey *et al.*, 2016).
3. There is poor management of information management facilities like information systems (Angelo, 2017; Munyua, 2007).
4. There is a challenge of diversity of ICTs to learn both in form of hardware and software (Maumbe, 2009; Kante *et al.*, 2016).

Information Technology Related Challenges

There are challenges in information management in e-agriculture in developing economies like Uganda's that relate to information Technology:

1. Some information technology tools are expensive (Barakabitze *et al.*, 2015; Kumar and Timalsina, 2016);
2. There is a challenge of diversity of ICTs to learn both in form of hardware and software (Maumbe, 2009; Kante *et al.*, 2016).
3. There is fluctuation of power/ electricity and in some areas, there is no power (Chilimo 2008; Ajani and Agwu, 2012; Oyeyinka and Bello, 2013).

Information Retrieval Related Challenges

There are challenges in information management in e-agriculture in developing economies like Uganda's that relate to information retrieval:

1. There is poor information sharing culture among stakeholders in e-Agriculture in developing economies like Uganda (Asenso-Okyere and Mekonnen, 2012; Shyam, 2015).
2. There is a challenge of users of information sticking to traditional means of information dissemination and retrieval (Rashid and Islam, 2016; Syiem and Raj, 2015).
3. There is a problem of language barrier and low levels of literacy among stakeholders in e-agriculture especially farmers (Sri Lanka E-agriculture Strategy, 2016; Chandra and Malaya, 2011).

Information Context Related Challenges

There are challenges in information management in e-agriculture in developing economies like Uganda's that relate to information context:

1. Stakeholders in e-agriculture in Uganda have issues of limited resources like fluctuation of power that can be used to run ICTs that disseminate information (Chilimo, 2008; Rashid and Islam, 2016).
2. There are also few information dissemination centers like community libraries (Uzezi, 2015; Syiem and Raj, 2015)

3. Social and cultural beliefs of stakeholders in e-agriculture impede them from using different ICTs for accessing information they require (Rashid and Islam, 2016; Uzezi, 2015).

Information Environment Related Challenges

There are challenges in information management in e-agriculture in developing economies like Uganda's that relate to information environment:

1. There are issues of inefficient policies in e-agriculture (Kumar and Timalsina, 2016; Maumbe, 2009).
2. The cost of collecting data and creating cotent is a challenge (WSIS+10, 2015; Rashid and Islam, 2016; Chauhan, 2015; Chauhan and Abugho, 2013).
3. There is a challenge of poor public-private partnerships and collaborations (Munyua, 2008; Shyam, 2015).

People Related Challenges

There are challenges in information management in e-agriculture in developing economies like Uganda's that relate to people:

1. It is a challenge to develop individual capacity such as improving literacy of the stakeholders in e-agriculture especially farmers (UNDP, 2012; Jamaluddin, 2013; Sri Lanka E-agriculture Strategy, 2016).
2. People have limited awareness about the value of e-agriculture (Rashid and Islam, 2016; Shyam, 2015; Lwoga, 2010).
3. Stakeholders lack confidence in using ICTs that store, process and disseminate information (Syiem and Raj, 2015; Lamptey *et al.*, 2016).

Processes and Practices Related Challenges

There are challenges in information management in e-agriculture in developing economies like Uganda's that relate to processes and practices:

1. There is a challenge of users sticking to use of traditional means of information dissemination like face to face (Uzezi, 2015; Syiem and Raj, 2015).

2. There is poor information sharing culture among stakeholders in e-Agriculture in Uganda (Asenso-Okyere & Mekonnen, 2012; Shyam, 2015).

2.6. Conceptualization of Issues in Information Management in E-agriculture

Table 2.5 highlights different challenges in information management in e-agriculture in developing economies like Uganda's presented as one list without the categories in which they have been presented in the previous section. These categories have been dropped in light of the possible information management frameworks in which there is a component that can contribute to addressing these issues. To avoid repetition, the authors that suggested these challenges have been skipped since these authors appear in the previous section.

Here, we show a matrix of issues against the different available frameworks in which those challenges can fit if they were to be used in the context of agricultural advisory information management in e-agriculture in Uganda. For each challenge, we locate a framework (a particular element of the framework) where a given challenge fits or could be addressed. In addition, we isolate those challenges whose possibility of being addressed by existing elements of available frameworks is minimal. These give the gap, and thus they act as the basis for suggesting new components that appear in addition to the existing components in the conceptual framework. These challenges help in postulating probable elements of a proposed information management framework.

Table 2.5 presents the key issues in the management of agricultural information and they are the same issues that are faced in managing agricultural advisory information. These issues have been retrieved from literature pertaining to developing economies like Uganda's and now they are used in the context of Uganda. These issues are analyzed in light of the components of information management frameworks that were reviewed (Framework by Nguyen *et al.,* 2014; Middleton, 2007; Rowley, 1998; and Deasy *et al.,* 2016). The last column of table 2.5 shows the components in the existing frameworks responsible for a given issue and if the component is absent, a suitable component is suggested as a new component that can address the given issue. All these new and existing components form the conceptual framework of the information management framework to support management of agricultural advisory information in e-agriculture in Uganda. The last column of table 2.5 contains entities in bold, related attributes of such entities starting with a hyphen (-) and the proposed processes relevant in that context (starting with an equal sign (=)).

Table 2.5: Challenges/Issues in E-agriculture and the responsible components in the proposed Framework that can address them

ISSUES (Retrieved from literature cited in section 2.5)	Nguyen *et al.*, 2014 frame-work	Middleton, 2007 frame-work	Rowley, 1998 frame-work	Deasy *et al.*, 2016 frame-work	Component in the proposed framework that can address the challenge (Components adopted in the research)
Hard to adapt content to local context like local language and local needs	**People** - Context	**Information Context** -User information needs	**None**	**None**	+ **INFORMATION** entity, - A*ppropriateness* = Contextualize
A challenge to develop individual capacity such as improving literacy	**People** - Skills	**None**	**None**	**None**	+ **PEOPLE** entity - *Level-of-education, Exposure-level* = Train, Sensitize, Inform, Motivate, Communicate-To
High cost of collecting data and creating content is a challenge	**None**	**None**	**None**	**None**	+ **BUDGET** entity - *Budget-funder* = Finance, Analyze, Realize, Evaluate
There is a challenge of limited awareness about the value of e-agriculture	**None**	**None**	**None**	**None**	+ **INFORMATION** entity - *Availability* = Disseminate + **PEOPLE** Entity -*Exposure-level, Attitude* = Sensitize, Inform Train,
There are issues of inefficient policy in e-agriculture.	**None**	**Information Environment** - Public policy development	**Information Environment** - Legal forces - Regulatory forces	**Generate**	+ **POLICY** Entity -*Quality, Relevancy, Value* = Revise, Communicate, Set
There is a challenge of data ownership in e-agriculture.	**None**	**Information Environment** - Public policy development	**Information Environment** - Legal forces - Regulatory forces	**None**	+ **POLICY** Entity -*Quality, Relevancy, Value* = Revise, Communicate, Set, Apply
There are issues of poor public-private partnerships and collaborations.	**None**	**Information Environment** - Public policy development	**Information Environment** - Legal forces - Regulatory forces	**None**	+ **POLICY** Entity -*Quality, Relevancy, Value* = Revise, Apply, Communicate, Set, **PEOPLE** Entity - *Exposure-level, Attitude, Skills, Culture* = Engage, Consult, Sensitize,
There is a challenge of	**None**	**Information**	**None**	**None**	+ **TECHNOLOGY** Entity

wide diversity of ICTs to learn		**Systems** - Systems analysis and design			- *Level-of-user-friendliness, suitability-level* =Evaluate, Regulate, Analyze, Align, Streamline
Much of the information is in text format, so there is little variety in information format.	**None**	Information retrieval - Information organization - Information. Design	**None**	**Manage**	**+ INFORMATION entity** - Format, Appropriateness = Organize, Format
There is a challenge of users sticking to use of traditional means of information dissemination like face to face.	**None**	**None**	**None**	**None**	**+ PEOPLE entity** - Exposure-level, Attitude, Culture = Sensitize, Inform, Train
There are farmers that are not aware of the benefits of ICT in Agriculture	**None**	**None**	**None**	**Share**	**+ PEOPLE entity** - Exposure-level, Attitude, Culture = Sensitize, Inform, Train **+ TECHNOLOGY entity** - Usefulness, Suitability-level, Compatibility-level = Communicate,
There is information that is outdated.	**None**	**None**	**None**	**Manage**	**+ INFORMATION entity** - Recency-level, Appropriateness = Update, Review, Contextualize
There is fluctuation of power/electricity and in some areas there is no power.	**None**	**None**	**None**	**None**	**+ FACILITY AND FACILITATON entity** - Cost = Procure, **+ BUDGET entity** - Budget-funder = Finance,
There is information that is not appropriate to user's ability, needs, context, educational level and culture.	People - Context	Information Retrieval -Information selection	Information Retrieval - User interaction with I.S. or information resources to meet user information requirements	**Manage**	**+ INFORMATION entity** - Appropriateness, Relevance = Align, Review, Format, Update, Organize,
Information management is costly.	**None**	**None**	**None**	**None**	**+ BUDGET entity** - Budget-funder = Finance,
Some tools used to disseminate information	People - Context	Information Systems	**None**	**Manage**	**+ PEOPLE entity** - Exposure-level, Attitude, Culture

are inappropriate to users.		- Systems analysis and Design			= Sensitize, Inform, Train **+ TECHNOLOGY entity** - Level-of-user-friendliness, = Streamline, Align
There are inadequate facilities to use to disseminate information e.g. community libraries are few.	Processes and Practices - Distribution	**None**	**None**	**None**	**+ FACILITY AND FACILITATON entity** - Availability-level, = Procure **+ BUDGET entity** - Budget-funder = Finance,
There is a problem of language barrier and low levels of literacy.	People - Skills	**None**	**None**	**Share**	**+ PEOPLE entity** - Level-of-education, = Train, Educate
There is poor maintenance of information management facilities.	Processes and Practices - Maintenance	**None**	**None**	**Protect**	**+ FACILITY AND FACILITATON entity** - Cost, = Maintain **+ BUDGET entity** - Budget-funder = Finance,
Users lack confidence in operating ICTs that store, process and disseminate information.	People - Skills	**None**	**None**	**None**	**+ PEOPLE entity** - Level-of-education, = Train, Educate
The cost of managing information is high.	None	**None**	**None**	**None**	+ **BUDGET entity** - Budget-funder = Finance,

Based on table 2.5 above, no single framework is appropriate in addressing all the listed information management challenges in e-agriculture. The last column attempts to fill in the gaps and so elements highlighted in that column are candidates in a new framework that can address all these challenges. This research has selected the framework by Nguyen at al., (2014) as the suitable to be extended. This is because its components put into consideration the information lifecycle which is key in information management (Government of Alberta, 2005). This framework also puts into consideration the people, process and technology elements that are also key in information management. From table 2.5 above, the elements in the last column are closer to the Nguyen at al., (2014) framework than any other framework. Specifically, Nguyen et al. (2014) framework has elements that can address more challenges than any other single framework of the ones reviewed in this research. This serves as the basis for selection of the Nguyen et al. (2014) framework as suitable to be extended in this research.

In extending the framework by Nguyen at al., (2014) in this research, attempts have been made to present the components of the framework using schema in table 2.6. This schema presents the key entities in the information management process (these have been shown as nouns) and their attributes. In addition, key processes in the information management process have been highlighted (represented as verbs). This has been done to ensure uniformity of presentation and ease comparison in case other frameworks are developed later. Consequently, the suggested framework has been presented as an extension of the framework by Nguyen at al., (2014). Table 2.6 below shows the components of the suggested framework.

2.7. Proposed Framework for Information Management

Table 2.6 shows the major entities, major processes and detailed processes and attributes that have been adopted to constitute the proposed framework. This framework is based on Nguyen et al., 2014.

Table 2. 6: Major entities, major processes and detailed processes and attributes that constitute the proposed framework.

Major Entities	Detailed attributes of the major entities	Major Processes	Sub Processes Involved
INFORMATION	Quality, Timeliness, Recency-level, Accuracy, Relevance, Availability, Appropriateness, Simplicity, Cost, Value, Format	*Manage Information*	Acquire, Use, Store, Contextualize, Process, Dispose, Disseminate, Align, Secure, Generate, Share, Read, Review, Organize, Format, Update
PEOPLE (Users and Specialists)	Level-of-education, Age, Gender, Number, Income-per-capita, Exposure-level, Attitude, Skills, Culture, Level-of-experience,	*Manage people*	Train, Sensitize, Engage, Use, Communicate to, Inform, Coordinate, Motivate, Serve, Consult, Consider, Educate
POLICY	Quality, Number, Relevance, Enforceability-level, Understandability-level, Value,	*Manage Policies*	Conform To, Revise, Communicate, Enforce, Set, Apply
TECHNOLOGY (Hardware and Software)	Quality, Cost, Usefulness, Ease-of-use, Attitude-toward-using, behavioral-intention-to-use, Level-of-user-friendliness, Usability-level, Suitability-level, Recency-level, Compatibility-level, Level-of-compliance-to-standards, Availability-level	*Manage Technology*	Outsource, Develop, Upgrade, Evaluate, Maintain, Streamline, Regulate, Procure, Communicate, Monitor , Compare, Analyze, Design, Align
LEADERSHIP	Quality, Level-of-achievability, Level-of-usefulness, Level-of-Specificity, Measurability-level, Achievability-level, Scope, Timeframe, Relevancy-level, Realisticness-level	*Manage Leadership Goals*	Set, Realize, Revise, Communicate, Streamline, Focus, Prioritize, Align
PROCESS	Quality, Type, Size, Complexity-level, Information-dependency-level,	*Manage Processes*	Identify, Support, Organize, Prioritize, Plan, Evaluate, Coordinate, Revisit, Align
BUDGET	Quality, Accuracy-level, Period, Type, Budget-funder,	*Manage Budget*	Create, Revise, Implement, Finance, Evaluate, Communicate, Release, Follow-Up, Analyze
FACILITIES AND FACILITATON	Quality, type, cost, level of maintenance.	Manage facility and facilitation	Maintain, Procure, Monitor, Streamline, Regulate, Build,

Table 2.6 above shows that the new elements that are to be added to the framework by Nguyen at al., (2014) are Facility and Facilitation, Policy, Goal and Budget. We decided to rename "policy" to "rules and regulations" since rules and regulations are more appropriate at the level of small-scale farmers while "policy" is at a higher level. For the "Goal" element, it was renamed "leadership" since in the context of agricultural advisory information management process of small-scale farmers, "leadership" helps in achieving the targeted goals. "Information" is a given, in the conceptualization of information management thus information was not given an independent status in the conceptualized agricultural advisory information management framework.

The figure 2.8 shows the proposed framework in a non-tabular form (framework by Nguyen at al., (2014) plus the added components)

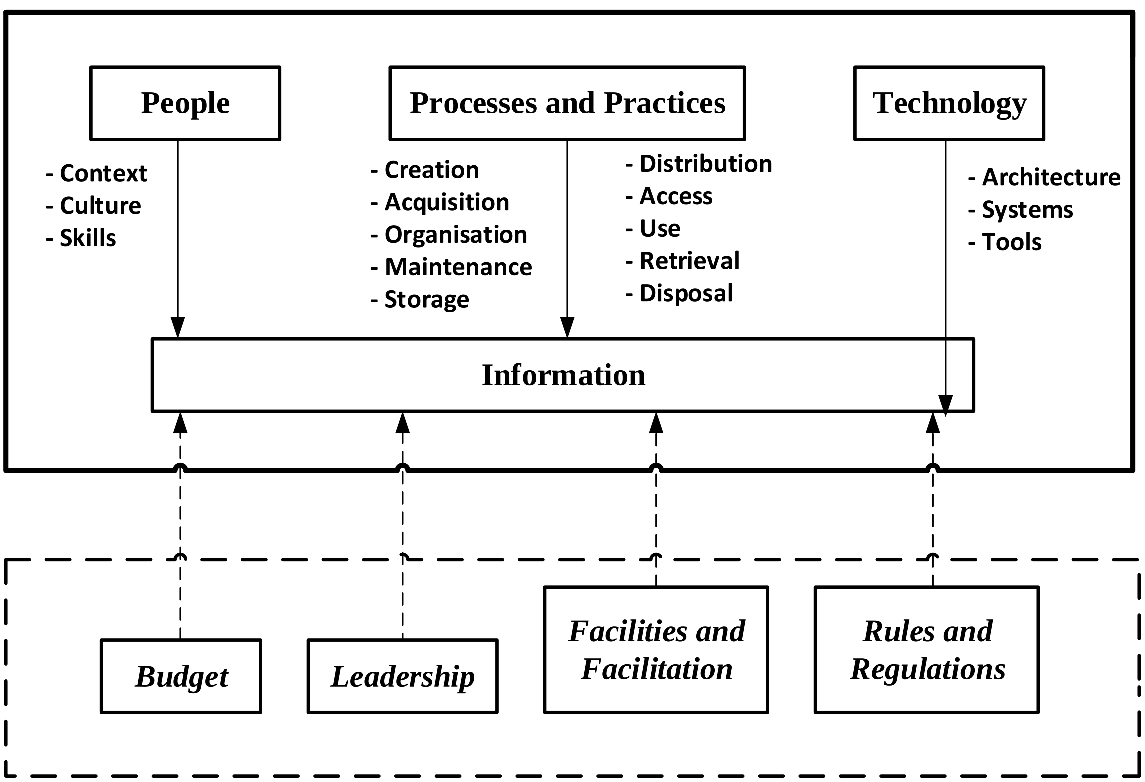

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Figure 2. 8. Proposed Extensions in the Information Management Framework of Nguyen et. al., (2014)

The components that have been proposed to be added to Nguyen *et al.*,2014 are presented in text boxes that are within a box with dotted/dashed boarders. The added components (Budget, Leadership, Facilities & Facilitation, and Rules & Regulations) plus the original components suggested by Nguyen et al. (2014) (Information, Process and Practices plus Technology) need to be tested in the field to ensure they all are important elements of an information management framework suitable for e-agriculture in Uganda.

2.7.1. Variables and Hypotheses in the Proposed Framework

The components shown in figure 2.9 (Proposed framework) serve as the starting point for a theoretical framework. These can now be regarded as critical success factors (CSFs) that influence agricultural advisory information management in e-agriculture as attested to by different authors, especially Nguyen et al. (2014). These components are the independent variables. The dependent variable is *information management in e-agriculture.* This is because a change in the components shown on figure 2.9 (a change in the critical success factors (CSFs)) is followed by a change in the state of information management in e-agriculture in Uganda. This kind of relationship was founded on Choo *et al.,* (2006). This relationship is presented diagrammatically in figure 2.9 below. This theoretical framework shows hypotheses from 1 to 7. These hypotheses are to be proved or disproved during the research. The *information management in e-agriculture* component of the framework in figure 2.9 contains different tasks that constitute information management based on the research by Choo (2002).

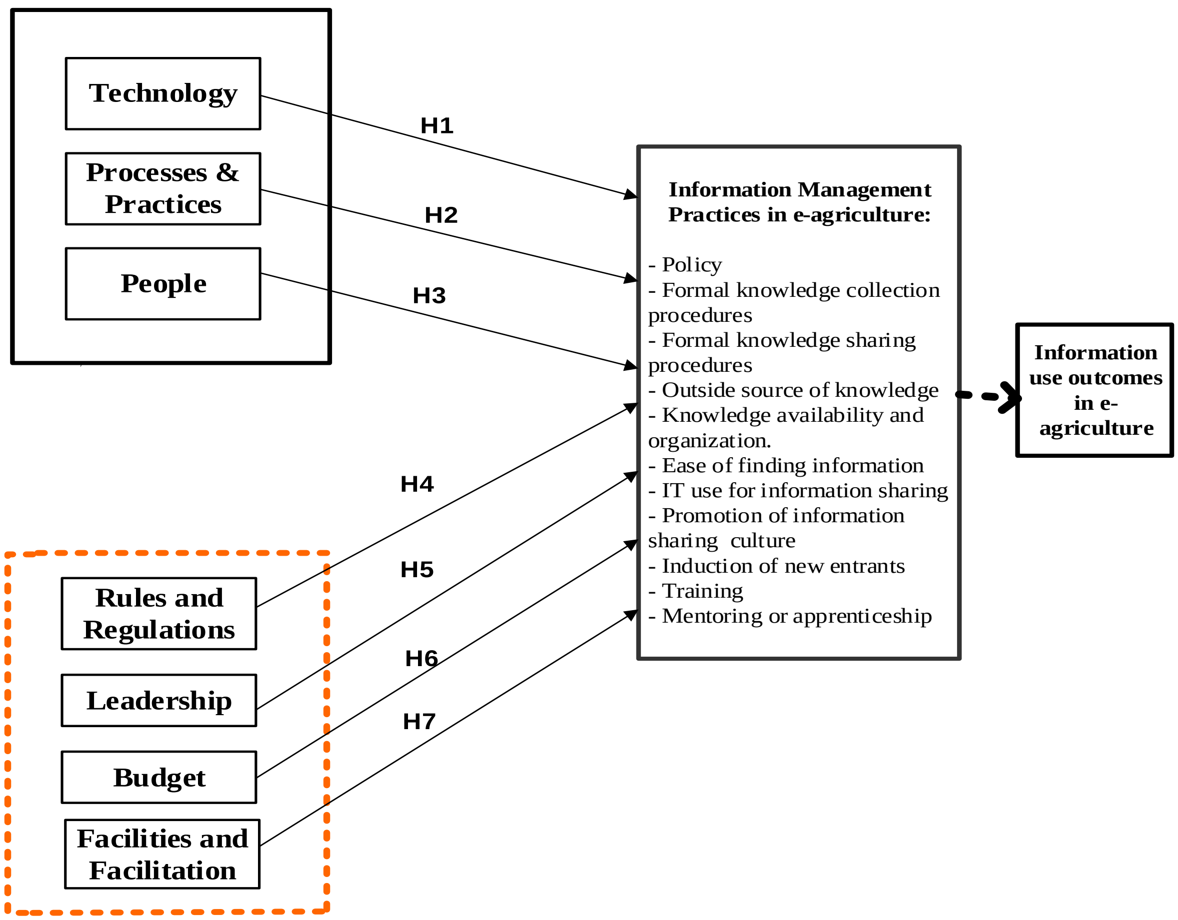

Figure 2. 9: Theoretical framework

In the figure 2.9, the box with dashed lines (containing four boxes from which H4, H5, H6 and H7 originate) contains components that are being proposed to be added to the components that were suggested by Nguyen et al. (2014). The components suggested by Nguyen et al. (2014) are presented in the box containing three boxes from which H1, H2 and H3 originate (see figure 2.9 above).

A. Independent Variable

The independent variable is the cause of the changes in the dependent variable. The independent variable in figure 2.9 is composed of two big boxes: (i) a box without dashed lines containing three components suggested by Nguyen et al. (2014) (ii) a box with dashed lines containing components proposed in this study. This means that when elements of the independent variable are varied, a corresponding variation in the dependent variable is expected.

(i) Components of the Independent Variable

The components of the Nguyen et al. (2014) framework are the same components of the independent variable enclosed in a rectangle without dashed lines (see figure 2.9). The added components (adopted from literature) of the proposed framework (Rules and Regulations, Leadership, Budget, Facilities & Facilitation) have been introduced to the framework based on the challenges in information management as presented in table 2.5. Below is an explanation of all the components of the independent variable starting from those suggested by Nguyen et al. (2014).

Description of Components Suggested by Nguyen et al. (2014)

Nguyen et al. (2014) suggested the following components as key in information management: People, processes & Practices, Technology and Information. We explain each of those components below:

People

People are a determining factor of information management and the criticality of this factor has been asserted by different authors (for example, Nguyen *et al.*, 2014; McKeen and Smith, 2007). People are critical because they directly implement processes in the information life-cycle management (ILM) following prescribed regulatory and legal requirements (Nguyen *et al.*, 2014). People ensure that information is complete, valid, consistent, accurate and timely (McKeen and Smith, 2007). Therefore, people need information skills in order to be useful in the process of information management. In addition, their information context and information culture are significant in the information management activity. This component is to be tested in the field to ascertain its suitability in the framework supporting agricultural advisory information in e-agriculture.

Technology

In information management, technology refers to the tools or equipment plus all the related procedures that are needed in the practice of information management (Nguyen *et al.*, 2014). Technology is required at every stage of the ILM like information creation, information acquisition, information organization, information storage, information maintenance, information distribution, information access, information processing, information use, information retrieval and information disposal (Lin, 2011; Nguyen at al., 2014). The technology factor of information management also incorporates design of suitable architecture and systems that facilitate information management (Rowley, 1998; Middleton, 2007). This technology component is to be tested in the field to ascertain its suitability in the framework supporting agricultural advisory information in e-agriculture.

Processes and Practices

Processes and practices are critical success factors of information management since they define and constitute the overall information management process (Nguyen *et al.,* 2014; Mutula and Wamukoy, 2009). Processes and practices encompass the realization of the managerial processes of the information life cycle in order to create, acquire, organize, maintain, store, distribute, access, use, retrieve and dispose information (Nguyen *et al.,* 2014). Therefore, coordinating these processes of the ILM is a critical success factor of information management. This component of processes and practices is to be tested in the field to ascertain its suitability in the framework supporting agricultural advisory information in e-agriculture.

Components Added to the Information Management Framework by Nguyen *et al.*, 2014

There are components that have been added to the information management framework by Nguyen et al. (2014) (see figure 2.9). These components or factors are rules and regulations, leadership, budget and facilities and facilitation. To justify these components, we present information from different authors that either directly or indirectly point to the value of these components in information management.

Budget

Apart from the fact that one of the challenges in information management in e-agriculture in Uganda is cost, the element of budget cannot be divorced from information management. This is because tools used in information management (like information systems, information dissemination systems, research tasks and processes) all need a budget. The users of information need money to obtain information or access information. Infrastructure used in information management like phones and electricity also needs a budget or cost.

There are certain authors that have pointed to the strength of cost or budget in the information management process. NSW Government, (2018) (in its information management framework that targets government) highlights this budget concept in form of funding. Funding is seen in maintaining tools used in information management like archives, information risk assessments, data retention and disposal.

Rules and Regulations

Masuku *et al.,* (2017) presented an information management framework in the context of e-government in Zimbabwe. This framework, *inter alia*, highlights the legislative standards as an important component in information management. This clearly points to policy as a key factor that determines information management.

In the Information management framework by Blumenthal, (2009), the pillar of policy is indirectly pointed to in the compliance component of the framework. It is suggested in that framework that compliance to records management and privacy is key. These (privacy and records management) are policies and standards, because compliance is to standards and policies plus regulations. Chauhan and Abugho, (2013) highlighted the centrality of policy in ICT use in agriculture pointing out the mobile money system as being used by farmers to make and receive payment. Chauhan and Abugho, (2013) assert that policy about mobile money transactions contributes to higher chances of their use by farmers. Therefore, policy is also valuable in case of the information systems that are used in the information management process.

Leadership

Leadership helps organizations to achieve specified goals. The goal of the organization motivates that organization to ensure proper information management aided by proper leadership. In the context of e-agriculture, there is a goal that is aimed at by improving information management. This goal needs to be set, realized, revised, communicated, streamlined, focused, prioritized and aligned. At another level, different objectives may be set in line with the goal of information management. The pillar of goal has also been articulated and stressed by Hausmann *et al.,* (2014) in their information management framework in the context of a given enterprise. In that context, they refer to goal as vision and strategy. In the pillar of vision and strategy, the vision, mission, strategy, goals and objectives plus value propositions are highlighted and it is through proper leadership that the goals can be attained.

Facilities and Facilitation

Facilities and facilitation are a key parameter in information management since these facilities are the elements that are used in managing the information management lifecycle. Facilities are used in storage, processing, dissemination, and processing, archiving and acquiring information. Therefore, Facilities and facilitation suites to form an independent element in the proposed information management framework as a pillar in guiding agricultural advisory information management.

B. Dependent Variable

"Information management in e-agriculture" is the dependent variable in this study. This means that variation in the independent variable is followed by variation in the dependent variable (Information management in e-agriculture (see figure 2.9)). The components in information management are: Information needs, information organization and storage, information product/services, information processing, information distribution, information use, adaptive behavior and information disposal. All these components have been based on Choo, 2002 (see figure 2.3) apart from the two (information processing and information disposal).

Information processing is added as a separate element because in information management, it is necessary to process information and to transform it into different forms as required by the information users. The importance of information processing in information management is discussed by Hamilton *et al.*, (2014). The disposal element has been added because information becomes obsolete and therefore needs to be disposed (Government of Alberta, 2005). In addition, storage requirements may dictate disposal of information. Here disposal entails deleting and/or archival of information.

In the figure 2.9, H1 up to H7 mean hypothesis 1 up to hypothesis 7 and these are explained in the following paragraphs below:

H1: Technology is a determining factor in supporting management of agricultural advisory information in e-agriculture in Uganda.

H2: Processes and Practices are determining factors in supporting management of agricultural advisory information in e-agriculture in Uganda.

H3: People are a determining factor in supporting management of agricultural advisory information in e-agriculture in Uganda.

H4: Rules and Regulations are a determining factor in supporting management of agricultural advisory information in e-agriculture in Uganda.

H5: Leadership is a determining factor in supporting management of agricultural advisory information in e-agriculture in Uganda.

H6: Budget is a determining factor in supporting management of agricultural advisory information in e-agriculture in Uganda.

H7: Facilities and Facilitation are a determining factor in supporting management of agricultural advisory information in e-agriculture in Uganda.

2.8. Summary

All the information provided in this chapter show the state-of-the-practice of information management in e-agriculture in Uganda as documented by different authors. The same chapter highlights the state-of-the-art of information management and the gap is evident. This implies that the state-of-the-practice is less that the state-of-the-art, thus the gap that needs to be filled in this study. The chapter concludes with the conceptual framework that needs to be tested in the field.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1. Introduction

This chapter presents a detailed account of how the research objectives were achieved. It explains the underlying framework guiding the sequence of tasks and their implementation leading to attaining the stated research objectives. Philosophies that guided the choices of methods in the whole research process have been explained in this chapter. This chapter also explains the research methods, data collection methods, analysis, and methods of evaluating the accuracy of results obtained. The chapter concludes with highlighting the ethical considerations of this research.

3.2. Research Philosophy

Different authors present many research philosophies and paradigms in information systems research (Adebesin *et al.,* 2011; Terre Blanche *et al.,* 2006; Vaishnavi *et al.,* 2013). This research has used philosophies and paradigms presented in table 3.1. Philosophies and paradigms in table 3.1 were selected to provide a unified reference and avoid diverging meanings. This table highlights the ontological, epistemological, axiological, and methodological stances for each philosophical stand. These philosophies have also been used by other researchers like Gilliland (2014). The research paradigms that were analyzed to pick the appropriate to guide this study are Positivism, Interpretivism, Critica/Constructivism and Design as proposed by Adebesin *et al.*, 2011; Terre Blanche *et al.*, 2006; Vaishnavi *et al.*, 2013 (See table 3.1).

Table 3. 1: Research paradigms and philosophies

RESEARCH PARADIGMS	PHILOSOPHICAL ASSUMPTIONS			
	ONTOLOGY	EPISTEMOLOGY	METHODOLOGY	AXIOLOGY
Positivist	- Single, stable reality - Law-like	- Objective - Detached observer	- Experimental - Quantitative - Hypothesis testing	- Truth (objective) - Prediction
Interpretive	- Multiple realities - Socially constructed	- Empathetic - Observer subjectivity	- Interactional - Interpretation - Qualitative	- Contextual understanding
Critical/ Constructionist	- Socially constructed reality - Discourse - Power	- Suspicious - Political - Observer constructing Version	- Deconstruction - Textual analysis - Discourse analysis	- Inquiry is value-bound - Contextual understanding - Researcher's values affect the study
Design	- Multiple, contextually situated realities	- Knowing through making - Context-based construction	- Developmental - Impact analysis of artefact on composite system	- Control - Creation - Understanding

Each paradigm has a known stand on what the nature of reality is (Ontological stand), what true knowledge is and how we come to know it (Epistemological stand), what the optimal methods of finding true knowledge are (Methodological stand), and what is of value involving right and wrong in the research process (Axiology). Table 3.1 highlights the key assertions of each research paradigm in ontology, epistemology, methodology, and axiology.

Based on the information in table 3.1, Design was adopted as the appropriate paradigm to guide this research. Design was selected after analyzing the ontology, epistemology, methodology, and axiology assertions (see table 3.1) in light of the main research objective of this study. This research followed Design research paradigms as detailed below:

(a) Interpretive Research Paradigm

Interpretivism is a philosophy that considers reality as a product of the perceptions of the one observing it (Terre Blanche *et al.,* 2006). Reality is socially constructed (Vaishnavi *et al.*, 2013). In this stance, knowledge is based on subjective interpretations of reality. True knowledge is a product of human interactions (Adebesin *et al.*, 2011). It is a product of shared understanding and facts are not predictable with complete certainty. Interpretivism focuses on the mind's active participation in the process of knowing (Chin, 2007). Reality is not one, so multiple realities are possible when multiple groups or cultures are studied (Terre Blanche *et al.,* 2006; Adebesin *et al.,* 2011).

Interpretivism research in Information Systems and IT maintains that knowledge is not obtainable from passive observation of phenomena, but by engaging the mind in the process of understanding (Adebesin *et al.,* 2011). The knower has to participate in the reality that he/she wants to know. The researcher puts meaning to what he/she interacts with and true knowledge is a product of this interaction. Interpretivism stresses that reality is best studied in its natural environment and contends that scientists cannot avoid affecting phenomena that they study (Davison, 1998). In interpretivism, it is accepted that there may be many interpretations of the same reality; nevertheless, these interpretations are in themselves a part of the scientific knowledge that is pursued (Davison, 1998).

(b) Design Research Paradigm

The design research paradigm asserts that reality or being is contextually situated and that there are multiple realities according to the context (Vaishnavi *et al.,* 2013). This implies that the deliverable of this research can vary depending on the context. The information management framework obtained in the context of agricultural advisory information management in e-agriculture in Uganda may not be exactly the one obtained in a different context and setting. Based on this assumption, the information management framework of Nguyen *et al.,* 2014 provided the basis to develop a framework suitable in the context of agricultural advisory information management. The information management Framework by Nguyen *et al.,* 2014 cannot serve in all contexts but it is a foundation for our investigation into a framework that supports management of agricultural advisory information in e-agriculture.

According to the Design research paradigm, true knowledge is obtainable through making and context-based construction (Terre Blanche *et al.,* 2006). This epistemological stand is in line with information systems research and thus a foundation for our choice of attaining the third research objective (To validate the information management framework using a prototype of the design). Methodologically, the Design research paradigm stresses the developmental and impact analysis of artifacts on composite systems (Terre Blanche *et al.,* 2006). Axiologically, the Design research paradigm stresses control, creation, and understanding (Adebesin *et al.,* 2011).

Using the facts in the previous paragraphs about the Design research paradigm, this study developed or created a prototype as a proof of concept for the developed information management framework that supports management of agricultural advisory information in e-agriculture. This prototype was based on requirements and it was tested to ascertain if it meets the requirements on which its development was based.

3.3. Research Approach

There are three research approaches: Qualitative, quantitative and mixed (Newby, 2014). All these three approaches have characteristics that define them although they all are concerned with aiding the researcher to search for the truth about the issue on which research is being conducted (Newby, 2014). A description of each of these approaches is provided in the paragraphs that follow.

Qualitative Research Approach. The qualitative research approach uses behavior, words and images as evidence on which to base conclusions and its objective is to understand how people experience their lives as a means of providing rich and deep insights into why things happen the way they do (Miles and Huberman, 1994; Newby, 2014). This approach collects and analyses data which is used to build and test theory (Miles and Huberman, 1994)

The qualitative approach, seeks to uncover a deeper meaning of human behavior and experience (Gilliland, 2014). The qualitative research approach is inductive, involving theory development or looking for a pattern of meaning based on collected data (Simion, 2016). The qualitative approach studies phenomena in their natural setting with the aim of making sense of, or interpret, phenomena in terms of the meanings people bring to these phenomena (Miles and Huberman, 1994). The qualitative approach is bottom-up; it advances from specific situations to general conclusions (Simion, 2016). Qualitative researchers do not base their argument on a predefined hypothesis that they seek to prove, they identify a problem and seek its solution guided by a suitable theoretical lens as a framework that guides their research investigation process (Neuman, 2011).

Qualitative research with an inductive influence requires that we collect data procedurally in textual form based on observation and interaction with participants (Ritchie *et al.*, 2013). Data collection methods commonly used in this approach are participant observation, in-depth interviews, and focus group discussion (Ritchie *et al.*, 2013). In this approach, data is collected in several stages and several iterations until a researcher finds no new issues or ideas emerging. Although the qualitative approach is flexible, this does not make it less scientific (Schram, 2006).

Quantitative Approach. The quantitative approach is one that bases conclusions on numeric evidence and sets up questions as testable hypotheses and assesses these in terms of probabilities (Newby, 2014). The numeric data collected in this approach is analyzed using statistical and numerical procedures and conclusions are drawn based on this analysis.

Mixed Methods Approach. Mixed methods approach seeks to combine both qualitative and quantitative approaches in order to understand phenomena because phenomena is so complex that it cannot be understood thoroughly using a single approach (quantitative or qualitative) (Johnson and Onwuegbuzie, 1994; Newby, 2014). For example, people may provide an emotional view about something (qualitative) but it is vital to understand how many people hold that view (quantitative). The mixed methods approach is essentially fronted by pragmatic scholars to have an independent existence like the quantitative and qualitative approaches (Newby, 2014).

This research follows a quantitative methods approach. This approach is appropriate in guiding our investigation of the critical factors in supporting agricultural advisory information management in e-agriculture and developing an information management framework founded on these factors. Data that was collected was quantitative and this was analyzed using statistical methods and then based on that analysis, conclusions were made in this research thus the quantitative approach.

3.4. Research Methods

A summary of the research methodology followed in this study is provided in table 3.2.

Table 3. 2: Summary of the research methodology followed in this study

Methodological elements	Choice of methodological elements
Research philosophy	# Design research as explained in (Adebesin *et al.*, 2011; Terre Blanche *et al.*, 2006; Vaishnavi *et al.*, 2013)
Research approach to development of theory	# Deductive Reasoning (Reasoning from general to particular)
Methodological choice	# Quantitative methods
Research strategy	# Design Science # Survey # Case Study
Techniques of data collection and analysis	# Data Collection Technique - Questionnaire # Data Analysis - Exploratory Factor Analysis (EFA) - Structural Equation Modeling (SEM) # Evaluation Techniques - Expert Opinion - Experiment using a Prototype

This table is intended to aid in clearly highlighting the key choices of the research philosophy, research approach to development of theory, methodological choice, research strategy and techniques of data collection and analysis following these elements as provided by Saunders et al., 2016. The first column of table 3.2 shows the methodological elements as suggested by Saunders et al., 2016, and the second column highlights the choices made with respect to a given methodological element.

3.4.1. Design Science

With its roots in engineering and the sciences of the artificial, Design Science is a problem solving method that seeks to enhance human knowledge with the creation of innovative artifacts and the generation of design knowledge (DK) via innovative solutions to real-world problems (Hevner, March, Park, & Ram 2004). Design Science has three cycles: the rigor cycle, the design cycle and the relevancy cycle (Hevner *et al.*, 2004). Design science emphasizes iterative activities like construction, evaluation, and refining an artifact based on findings from the community of practice (Hevner, 2007).

Hevner et al., 2004 provides Design Science Research guidelines in information systems that contribute to streamlining the research process. These guidelines are presented in table 3.3.

Table 3. 3: Design Science Research Guidelines

Guideline 1: Design as an Artefact	Design science research must produce a viable artefact in the form of a construct, a model, a method, or an instantiation.
Guideline 2: Problem Relevance	The objective of design science research is to develop technology-based solutions to important and relevant business problems.
Guideline 3: Design Evaluation	The utility, quality, and efficacy of a design artefact must be rigorously demonstrated via well-executed evaluation methods.
Guideline 4: Research Contributions	Effective design science research must provide clear and verifiable contributions in the areas of the design artefact, design foundations, and/or design methodologies.
Guideline 5: Research Rigour	Design science research relies upon the application of rigorous methods in both the construction and evaluation of the design artefact.
Guideline 6: Design as a Search Process	The search for an effective artefact requires utilising available means to reach desired ends while satisfying laws in the problem environment.
Guideline 7: Communication of Research	Design science research must be presented effectively to both technology-oriented and management-oriented audiences.

The guidelines are in line with the design science research cycles of rigor, design and relevance which are the basis of design science research that this research followed.

Why Design Science was selected. This research adopts the Design Science research method as understood in the information systems and IT field. Design Science was opted for in this research because the nature of the problem being investigated and the environment in which it manifests itself, fits well in the Design Science method. This research investigates the information management problem that affects stakeholders in agricultural advisory information management in E-agriculture in Uganda. This problem is in an environment that comprises people and systems or processes that interact to achieve a given goal (Hevner, 2007). Design Science is suitable in such situations (Hevner, 2007).

The main deliverable of this research is a framework that supports the management of agricultural advisory information in E-agriculture in Uganda. Frameworks, models, and instantiations are among the artifacts that Design Science research delivers (Hevner *et al.*, 2004). This study develops an artifact called an information management framework, making Design Science appropriate in informing this study.

Design Science emphasizes iterative activities like construction, evaluation, and refining an artifact based on findings from the community of practice (Hevner, 2007). These activities are appropriate in developing a framework for information management in E-agriculture in Uganda. Interaction with the community of practice (people involved in information management in e-agriculture or stakeholders in information management in e-agriculture) in the problem domain (information management) is a viable strategy for realizing a framework in this research.

Design Science focuses on rigor (Hevner, 2007; Hevner *et al.*, 2004). In this research rigorous methods of developing and evaluating the information management framework were followed. For example, the information management framework by Nguyen *et al.* (2014) and other frameworks explained in the literature review section of this research, have aided the development of the information management framework. The information management framework by Nguyen *et al.* (2014) has been the basis of this research. This framework animated the data collection instruments and increased the chances of obtaining complete and relevant data from the field.

Design Science strongly recommends design evaluation (Hevner *et al.*, 2004). Evaluation results are significant inputs in improving frameworks in the iterative processes that culminate into a final version of the framework (Hevner *et al.*, 2004). Evaluation of the information management framework is appropriate using testing-oriented procedures with the community of practice that provides requirements for the artifact in question.

Instantiation of Design Science in this study. Figure 3.1 shows how Design Science advanced by Hevner, (2004) was followed.

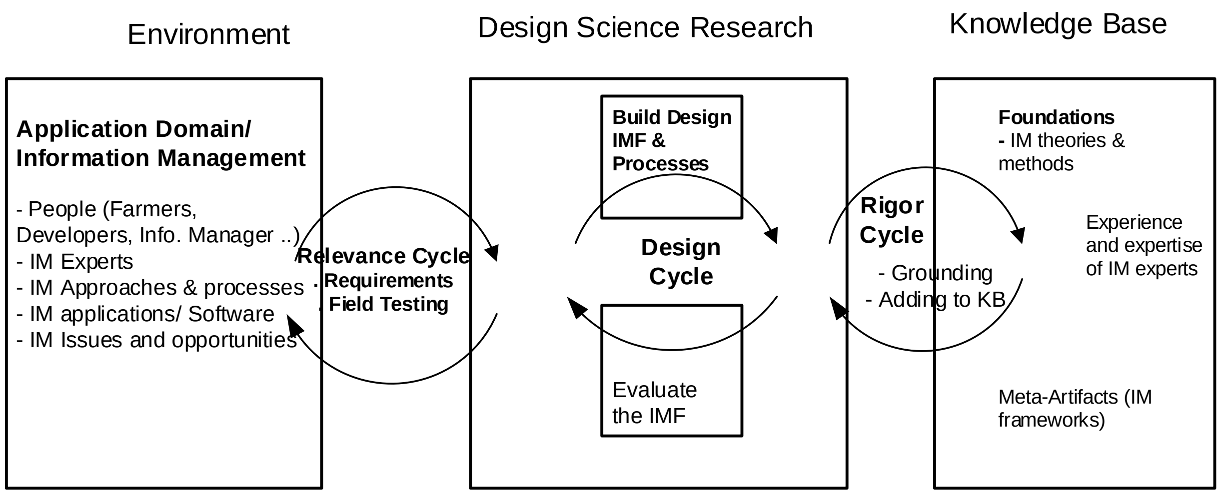

Figure 3. 1: Instantiation of Design Science unifying other methodology components (Based on Hevner, 2004).

KB = Knowledge Base, I.M = Information Management, IMF = Information Management Framework, Info = Information.

Drawing from Design Science, figure 3.1 illustrates the major cycles of this research as an information management framework is developed. In the design cycle, the researcher contacts the environment (see relevance cycle in figure 3.1) to obtain requirements for the information management framework after obtaining the key issues in information management in e-agriculture from the community of practice (stakeholders in e-agriculture information management). All these issues and requirements informed the design of the framework.

During the design of the framework, the researcher based on the knowledge base for rigor. Information management theories and methods, knowledge from information management experts and knowledge from meta-artifacts (in this case existing information management frameworks) all informed the design of the framework.

Design Science Cycles and attainment of research objectives

This research followed the Design Science strategy. Table 3.3 illustrates the different Design Science cycles and the corresponding activities that were performed in each of the cycles in order to achieve the objectives of the study.

Table 3. 4: Study objectives in light of Design Science Cycles

Study Objectives	Design Science Cycles	Activities performed to achieve study objectives
1. To establish the critical success factors for effective management of agricultural advisory information in e-agriculture in Uganda.	Relevance	- Eliciting requirements for the framework - Eliciting requirements for the prototype
2. To design a framework that supports management of agricultural advisory information in e-agriculture in Uganda.	Design	- Design a conceptual framework - Design the framework (FMAAI) - Design the prototype (PMAAI)
	Rigor	- Consulting subject matter experts - Literature Review conducted to establish the knowledge base - Identification of theories to ground the design
3. To evaluate the framework that supports management of agricultural advisory information in e-agriculture.	Relevance	- Evaluation of the framework - Evaluation of the prototype
	Rigor	- Identification and utilization of theories that ground artifact evaluation - Identification and utilization of theories that ground prototype evaluation

From table 3.4 it is shown that in order to achieve an individual research objective, two cycles were involved for example in achieving the second and the third research objectives. This is the case because Design Science cycles are cyclic in nature with the results of one cycle taken as the starting point of another cycle.

The activities of this research that reflect Design Science methodology have been again presented in figure 3.2

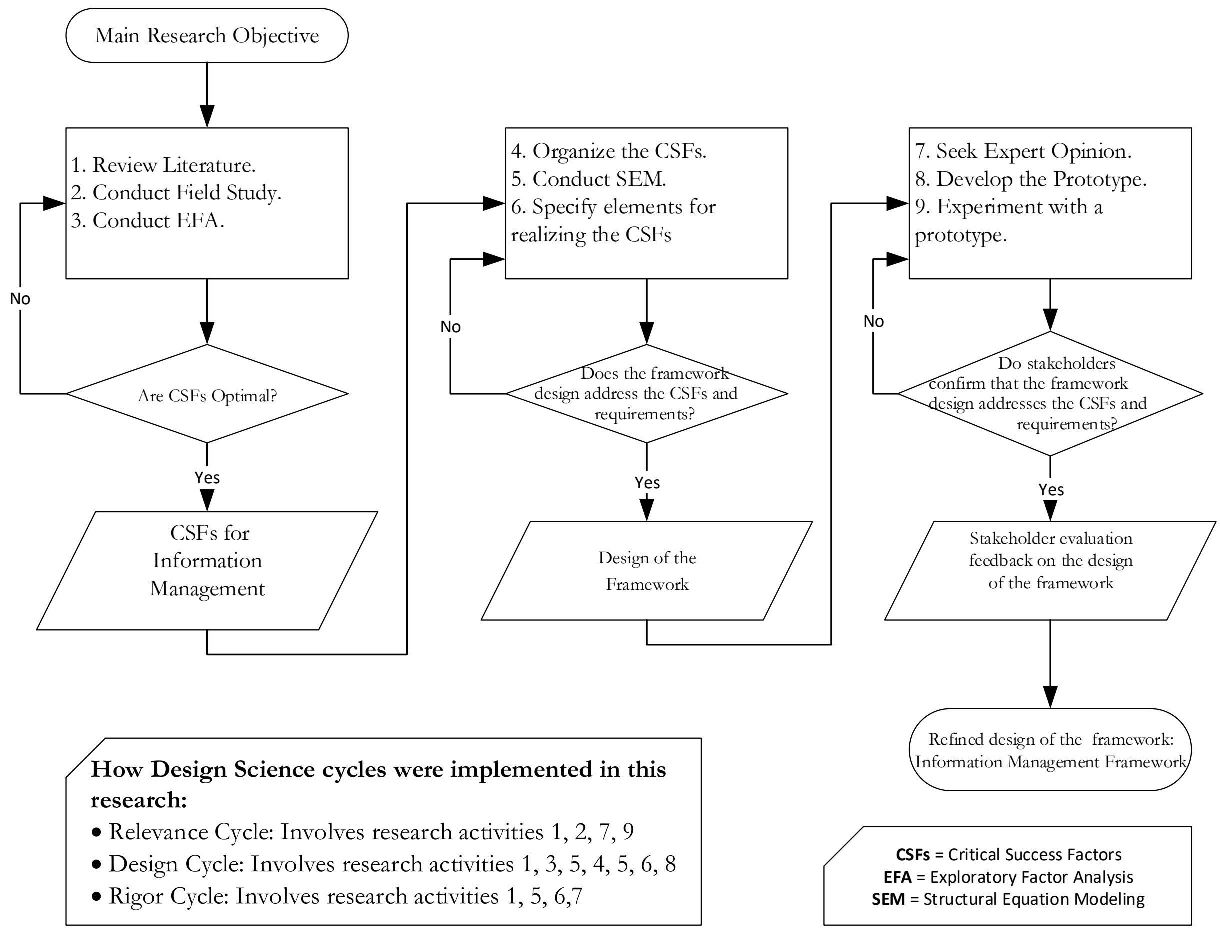

Figure 3. 2: A Flow chart showing how Design Science Cycles were implemented in this research

The activities in this research start with establishing the main objective of this study and then activities continue as named from 1 through to 9. The flow chart shows decision stages and the major outputs. The research activities have been grouped to reflect which activities were conducted in the context of design science cycles (Relevance, Design and Rigor). The research activities end with a deliverable of the refined design of the framework for information management.

3.4.2. Survey

The survey is a method of research used to collect primary data based on verbal or written communication with a representative sample of individuals or respondents from the target population (Enanoria, 2005; Groves *et al.*, 2004). Although the survey method is predominantly a quantitative strategy, its use in qualitative research is also documented (AIS, 2017). The survey method is a strategy that can help confirm and quantify the findings of qualitative research (AIS, 2017).

Why Survey was selected. Survey was adopted in this research because it is simple to administer and it suites the circumstances under which this study was conducted, for example all the stakeholders in the management of agricultural advisory information in e-agriculture cannot be contacted, so a selective sample was practical. This study chose a survey because, in Uganda, there are many stakeholders in the management of agricultural advisory information. Therefore, it was plausible to select a sample from the population. The number of the population is not documented or known with certainty. Therefore, this was handled well in the subsequent paragraphs to ensure the reliability and credibility of research findings.

3.4.3. Adopted Research Design

Survey Design. A survey design involves two main steps (Levy and Lemeshow, 1999). The first step consists of developing a sampling plan or the methodology used to select a sample from a population. Here the following tasks are articulated: how to select the sample, how to establish its adequacy and choosing a survey media (phone or face to face, emailed or postal). The second step is to obtain population estimates from sample data and establishing the reliability of those estimates.

(a) Aim of the Survey

The aim of the survey was to investigate and validate factors that influence agricultural advisory information management in e-agriculture in Uganda. Table 3.4 summarizes the survey design for this research and choices in it are explained thereafter.

Table 3. 5: Survey Design

	Setup parameter	**Details of how the parameter was set up**
1	Survey Goal	To investigate and validate factors affecting agricultural advisory information management in e-agriculture in Uganda.
2	Target Population or respondents/subjects	Stakeholders in the management of agricultural advisory information in Uganda are: Farmers that use ICTs like Phones and Internet in agriculture, Extension workers, Agriculture production officers., NAADS officers, Researchers in agriculture, Information Scientists, ICT specialists working in Agriculture.

3	Sampling method	Purposive sampling was used. Selection of the sample from the population was based on: (i) Availability and willingness to respond to the questionnaire questions AND (ii) The fact that one is presently practicing in information management in e-agriculture.
4	Sample size	This study focuses on small scale farmers engaged in management of agricultural advisory information in e-agriculture in Uganda, extension workers and specialists in information management in e-agriculture in Uganda. Two districts in each of the following regions (Central, West, North and East) were selected because of limited time available for the researcher that cannot allow visiting all districts in all regions of Uganda. A total of 400 respondents were targeted. The total number of people involved in information management is not known, therefore, this number was calculated from the formula by Kish, (1965). This adds up to the targeted number 48 (Refer to table 3.5 ahead). This number is the minimum and thus it can be increased in case more respondents are willing to take part in this research.
5	Data collection instrument	A questionnaire was used with most of the questions closed-ended and others open-ended (Refer to Appendix A). Closed-ended questions aimed at guiding the respondents on what to answer while open ended questions provided respondents with flexibility and ability to expound on their responses.
6	Procedure undertaken to administer the questionnaire	The questionnaire was pretested with 40 respondents. All these expressed their willingness to participate in the study after questionnaire improvement. The questionnaire was delivered to the offices of the respondents and filling of the questionnaire was either done there and then or later. For questionnaires filled later, the researcher collected them himself or his research assistants on a later date.

In the survey design in table 3.5, the survey goal, target population, sampling method, sample size, data collection instrument and procedure of administering the data collection tool have been presented and details of each provided.

(b) Sample Size

The population in this research was not predictable with certainty. We have no statistics of all people that are involved in agricultural advisory information management in E-agriculture in the Ugandan case. Therefore, it is necessary to establish a required sample size (s) from a formula defined by Kish, (1965).

Table 3. 6: Calculating the sample from a given population

Formula	Meaning of parameters in the formula
$s = \frac{z^2(p(1-p))}{e^2}$	***s*** *is required sample size,* z^2 *is the number equivalent to the desired level of confidence 0.18.* p *is the estimate of the proportion of people = 60%* e *is the acceptable sampling error = 0.4*

In this research we take the desired level of confidence as 90% which gives 0.18 from the *z* statistical tables. So, $z = 0.18$. For the proportion of people, we take 60% because the respondents to be contacted are approximately 60% of the whole population. This gives the *p* as 60%. So, p= 0.6. Thus, the sampling error is 40%. So, $e = 0.4$. When we substitute the values in the formula above, we get the value of *s* as 48. Therefore, the minimum required sample size is 48, meaning that it is sufficient to provide data collection tools to a minimum of 48 people from the community of practice. These calculations are based on *http://www.statisticshowto.com/tables/z-table/* where *z* tables are provided for reference.

(c) Sampling Method Used

There are two categories of sampling methods: probability and non-probability. In probability sampling methods, samples are selected following random selection giving each of these samples an equal opportunity to be selected as a representative sample (Doherty, 1994). In such a case the list of the target population is known with certainty (Doherty, 1994).

Non-probability sampling (purposive selection, judgment selection, or non-probability selection), is a sampling technique in which samples are selected based on the subjective judgment of the researcher rather than random selection (Doherty, 1994). In non-probability sampling, the list of the population is not known with certainty.

In this survey the researcher did not get access to a list of people in the community of practice (it is not known how many people involve in agricultural advisory information management in e-agriculture in Uganda). Therefore, we used the non-probability sampling method to obtain the minimum required number of respondents to participate in this study. People that manage agricultural advisory information in e-agriculture are the main focus of this research and so the respondents in this research. These respondents were contacted by the researcher in person as he was pre-testing the questionnaire and later collecting data. The other respondents were contacted by either email or telephone.

3.5. Choice of the Nature of Data Collected

In addition to methods of data collection, the kind of data that needs to be collected is also influenced by the paradigms and philosophies that guide the research. *Qualitative* data is data conveyed through words and text. The focus of qualitative data is text and meaning, it is inductive in nature, interactive and flexible (Rogers *et al.*, 2011). Qualitative data is mainly crucial when studying phenomena in their natural setting, when investigating feelings of stakeholders in a problem domain, when studying experiences and social situations in a real word setting. Studying all these elements is done through analysis of people's motivations, actions, words and experiences (Myers, 2009).

Quantitative data is in form of numbers and can be statistically analyzed. Quantitative data expresses objective facts, is suitable for prediction of phenomena, is law-like and amenable to generalization in a controlled environment (Rule and John, 2011). Quantitative data is mainly about what can be counted and measured (Oates, 2006).

In a research, it is possible to have or collect both qualitative and quantitative data as the goal of the research, context and the nature of phenomena under investigation may dictate. This triangulation of data is essential in enforcing comprehensiveness and rigor. Therefore, according to the goal of this research (developing an information management framework and evaluating it), the nature and context of our research, both qualitative and quantitative data was collected. Much of the qualitative data was collected during the validation of the framework.

In a research, one can use structured and/or unstructured data collection approaches. In structured approach, we have preset answers yet in unstructured we have no preset answers to questions that are asked to the respondents. Structured seeks for generalization and compatibility while unstructured seeks for validity and understanding (Maxwell, 2005). In the context of this research, both structured and unstructured approaches were used for better comprehensiveness of results and because one approach would not deliver all the answers to the questions posed to respondents.

Primary data sources are distinct from secondary data sources. Primary data is virgin data that has not been analyzed before for example data collected from participants of an interview. Secondary data is data gotten from existing sources like books and journal articles. In this research we relied on both secondary and primary data sources as complementary and not conflicting sources as we answered the main research question in this study.

Structure of the Questionnaire. The questionnaire consists of three sections (see Appendix A):

(a) Demographic information.
(b) Establishing if a respondent is involved in agricultural advisory information management.
(c) Validating of factors influencing agricultural advisory information management as stated in literature plus those suggested by the researcher.

3.6. Choice of Data Collection Methods

Data collection is an important stage in research. Data collected serves as the evidence for the conclusions that are made in research. Therefore, data collection methods chosen have a bearing on the success or failure of the research process. In this section, we explain the data collection methods that were used in this study. These are influenced by the research philosophy and approach that were selected to guide this research process as highlighted and explained at the beginning of this chapter. The data collection methods selected were: Questionnaires and focus group discussion (FGD). These are each elaborated upon in the context of this research in the sections that follow.

3.6.1. Interviews

Interviews are data collection methods that are suitable for collecting detailed information, for collecting information that may need the researcher to clarify issues in order to get comprehensive relevant information (Oates, 2006). In this research, we used semi-structured interviews that were essential in collecting a lot of information by giving respondents flexibility to express their views in a conversation like manner yet allowing them to have preset choices that need no much explanation.

Interviews were not used in the collection of data in this study. This is because they require more time. However, in order to avoid missing data due to not use of interviews, the questionnaire that was used was made as comprehensive as possible in order to cater for the questions that would have been included in the interviews.

3.6.2. Questionnaires

Questionnaires are important data collection techniques especially for collecting demographic data and users' opinions (Rogers *et al.*, 2011). Questions in the questionnaire should be clear, unambiguous and easy to answer without help external to the respondents. Questionnaires can reach large numbers of respondents simultaneously and they are not as time consuming as interviews. Although they do not allow the researcher to directly probe the respondents for deeper meanings, they are however economical (Rule and John, 2011). It is because of these advantages that questionnaires were used in this research.

Questionnaire Development. Different questions were drafted following Nguyen et al. (2014) information management framework. We generated drafts of questionnaires. Questions in the first draft of the questionnaires were tested by presenting them to 40 potential respondents to ensure that these questions were clear and capable of eliciting the information in line with the survey objectives as highlighted prior. These questionnaires were taken physically by the researcher to the respondents and filled by the respondents immediately, those that were filled later were either collected by the researcher or they were scanned and sent by email to the researcher. Thereafter, responses in the questionnaires were reviewed and coded. This information from the first draft of questionnaires was used to refine this draft. This refinement generated the second version of the questionnaires that were used in this survey.

In this research, we used semi-structured questionnaire where some questions had pre-set answers from which the respondent chose, and other questions allowed the respondent to express views in more detail and with more flexibility. The questionnaires were used mainly in investigating the key factors that influence agricultural advisory information management in e-agriculture in Uganda.

Questionnaire Distribution. The researcher distributed a total of 400 questionnaires to small scale farmers and other stakeholders in agricultural advisory information management in e-agriculture in Uganda. We pretested the questionnaire using forty (40) selected respondents (farmers and other selected stakeholders in agricultural advisory information management in e-agriculture). These respondents gave comments to the researcher who used these comments to improve and produce the final version of the questionnaire (please see Appendix A) that was used to collect data used in this research. Most of the questionnaires were distributed to small scale farmers who use ICTs in agriculture (small scale farmers who participate in e-agriculture) and other stakeholders in agricultural advisory information management in Uganda. 386 questionnaires were returned to the researcher out of the 400 that were distributed giving a response rate of 96.5%. This high response rate was due to the eight dedicated and well facilitated research assistants who delivered the questionnaires to respondents in person and either waited for the respondents to fill these questionnaires there and then or fixed appointments to go back and pick them at the convenience of the respondents. STATA was used to analyze data. We used factor analysis as a data reduction technique until the final version of the key factors and their associated variables were obtained. STATA is very powerful software for data analysis that uses useful graphical features for presentation of analyzed results. This explains why STATA was used.

3.6.3. Focus Group Discussions

A focus group discussion (FGD) is a rapid assessment, semi-structured data gathering method in which a purposively selected set of participants gather to discuss issues and concerns based on a list of key themes drawn up by the researcher/facilitator (Silverman, 2006; Kitzinger, 2006; Wong, 2008). FGDs are essential in investigating complex issues. We used FGD in order to obtain views from stakeholders in agricultural advisory information management in e-agriculture. These views obtained were about the evaluation of the prototype that in part, instantiated the framework.

Focus group discussions were conducted following guidelines stipulated by Freitas *et al.*, (1998) for using FGD. In FGD, participants freely interact with one another guided but not dominated by the researcher. This is what was done during focus group discussions conducted in this research.

Freitas *et al.,* (1998) recommend that a focus group discussion should be held by a group small enough to give a chance for participants to interact and share perceptions yet the group should be big enough to generate varying perceptions. Therefore, our groups were composed of between 5 to 12 participants each. Participants were selected based on their willingness to participate and their experience in information management in an e-agricultural setting. These 5 to 12 participants were contacted and invited to take part in the focus group discussion prior to the date of the FGDs.

3.7. Methods of Data Analysis

Data analysis is a process of converting raw data collected from the field into evidence that serves as the basis for conclusions made in the research (Rubin and Rubin, 2005). For quantitative data, two simple quantitative analyses techniques were used: percentages and averages. Qualitative data is classified, compared, weighed and combined (Rubin and Rubin, 2005). This is done to extract meaning and patterns that may lead to describing phenomena into a coherent narrative. In unstructured responses, the researcher may do a word count in order to develop codes or categories of interest to the research (Zikmund *et al.,* 2013). Categories can also emerge from theoretical foundations as may have been highlighted especially in literature review.

In the case of this research, the data collected from questionnaires was coded according to the theoretical foundation of Nguyen et al. (2014). For data collected using the questionnaire, given that it was quantitative, the researcher used structural Equation Modeling (SEM) involving exploratory factor analysis (EFA) in order to establish unobservable variables from the values of observable variables collected from the field using the questionnaire. The resultant unobservable variables aggregated to form the key factors that influence agricultural advisory information management in e-agriculture in Uganda. In this way, the first research objective was achieved. Structural equation modeling (SEM) was used to establish how these unobservable variables influence one another (structural model) and how strongly these do the influence (Thus the second objective was achieved) since the structural equation model presented the design of the information management framework. The design of the framework was used to establish the actual framework showing all the mega factors and their constituent sub factors. Later, evaluation of the information management framework was conducted including the instantiation of a framework using an information system prototype. The prototype was designed, implemented and tested. This framework was iteratively improved by contacting experts and other selected stakeholders in information management in e-agriculture and the final version was established. This was done to achieve objective number 3 of this research.

Data Handling. Data collected was quantitatively analyzed using STATA to establish how strongly the different factors relate with each other to form the information management framework. The other qualitative data that was collected was analyzed using thematic analysis.

3.8. Verification and Validation

Data collected was validated by taking it to experts in information management and practitioners in information management in e-agriculture to ensure that this information is right. This is regarded as a confirmatory process that aims at avoiding results that are biased by the researcher or results that are presented to be true based on the limited or poor capabilities of the researcher. The process of confirming the results is done also to help ensure that the same interpretation is obtained if the study is repeated using the same methods but by different researchers using different respondents (Zikmund *et al.,* 2013).

In addition to verification of data collected, verification of the developed information management framework was conducted. This involved selecting a group of stakeholders in agricultural advisory information management in e-agriculture in Uganda and bringing them together in a focus group discussion in order to establish if the components of the developed framework are right. Usefulness and usability were key parameters in the verification and validation process of the developed framework.

3.9. Ethical Considerations

Ethics in general is the study of right and wrong in human behavior. We can therefore understand research ethics as the study of right and wrong in conducting research. Rightness and wrongness in conducting research can be sought from a situation in which a researcher is studying human beings, animals or the environment (Mouton, 2001). It also extends to the honesty and integrity of the researcher. So, this requires that the researcher acts responsibly and be accountable while conducting research among the research community. In Design Science, this requires ethical treatment of the researcher, participants in the research and those to use the artifact developed (Oates *et al.,* 2006).

For a qualitative research to be considered ethical, emphasis should be placed on rigor, transparency and professional ethics, fidelity and trust (Guba, 1994). Rule and John (2011) stresses that an ethical research should provide the following:

(1) An account of detailed and true description of how actions and events in data collection stage of the research were conducted.
(2) Allow participants in the research (especially respondents) to review and confirm that there is a true record of data they provided to the researcher during data collection.
(3) Provide a mechanism of tracking findings back to the original sources of data collection.
(4) Allow the research community to check data interpretations.
(5) A mechanism where participants in the research are treated fairly and respectfully by providing freedom to respondents to decide whether to take part in a research or not, withdraw their participation if they wish to do so and ensure confidentiality as the respondents may wish.

All the above ethical considerations were considered as we conducted this research. This means that the research was conducted within the confines of ethical conduct by the researcher.

CHAPTER FOUR

CRITICAL SUCCESS FACTORS FOR INFORMATION MANAGEMENT IN E-AGRICULTURE

4.1. Introduction

The preceding chapter explained in detail the methodology of this research. This chapter presents the findings from the field study thus it answers the first objective of this research: *To establish the critical success factors (CSFs) that can support management of agricultural advisory information in e-agriculture in Uganda.* The CSFs were established after analysis of the quantitative data collected from the field study using the questionnaire. Section 4.2 highlights the demographic information of respondents where the researcher highlights the respondents' district of work, job title, length of time spent on the job, highest qualification attained, gender distribution and respondents' age group. Section 4.3 presents the descriptive statistics about ICTs used by farmers in information management, resource constrained environments and information management. In the same section, the researcher presented the descriptive statistics of the following hypothesized factors: people, technology, processes and practices, rules and regulations, facilities and facilitation, budget, leadership, information management practices, and information use outcomes. Section 4.4 elaborates on the exploratory factor analysis of the factors highlighted in section 4.3 yielding sixteen (16) latent sub factors, twelve (12) of which were valid (with reliability coefficient greater than 0.6). Section 4.5 elaborates on a further exploratory factor analysis of the twelve (12) latent sub factors yielding their categorization into three critical success factors (CSFs): (i) People and Technology, (ii) Processes, Funding and Regulations (iii) Information use outcomes and continuity. Section 4.6 elaborates on these three critical success factors (CSFs) and lastly section 4.7 presents the chapter summary.

4.2. Demographic Characteristics of the Sample

This section provides details of the analysis of the demographic data of respondents in this study. We present information about the respondents' institution of work in section 4.2.1, job title in section 4.2.2., length of time spent on the job in section 4.2.3., highest qualification attained in section 4.2.4., gender distribution in section 4.2.5. and respondents' age group in section 4.2.6.

4.2.1. District of Work

In this section, we present results from statistical analysis of the districts where the respondents have their information management in e-agriculture carried out. These are the districts where the farmers grow their crops and/or rare the animals. These districts are presented in the following Table 4.1.

Table 4.1: Respondents Districts

Districts	Frequency	Percentage
Gulu.	49	12.7
Lira	48	12.4
Masaka	50	13.0
Mbale	48	12.4
Mbarara	49	12.7
Namayingo	49	12.7
Ntungamo	48	12.4
Wakiso	45	11.7
Total	386	100.0

Figure 4.1 shows that respondents came from eight districts each district being represented by between 45 to 50 respondents. These districts were selected according to the following regions of Uganda: two districts (Namayingo and Mbale) from the Eastern region, two districts (Gulu and Lira) from the Northern region, two districts (Wakiso and Masaka) from the Central region, and two districts (Mbarara and Ntungamo) from the Western region. From the formula for deciding the sample size, the value obtained was 48 people (See table 3.4 in chapter 3). To increase the credibility of results, the targeted sample size was 400, and out of that 386 people were able to respond to our questionnaire. This means that the response rate was 96.5%.

4.2.2 Job Title

Results from statistical analysis of the respondents' job title are presented in the following table 4.2. Details of the various agricultural related professions are shown in appendix C.

Table 4.2: Respondents' job titles

Job title	Number	%
Farmers	354	91.7
Agriculture Officer	6	1.6
Other agricultural related professions	26	6.7
Total	386	100

Table 4.2 shows that most respondents are small-scale farmers who form 91.7% of the total number of respondents. These small-scale farmers are the key respondents in this research.

4.2.3. Length of Time Spent on the Job

Results from statistical analysis of the data regarding the length of time respondents have spent on their jobs are presented in the following Table 4.3.

Table 4.3: Time spent by respondents on their jobs

Years	Frequency	Percentage (%)
Between 2 to 5 years	90	23.3
Between 6 to 10 years	97	25.1
Less than 1 year	28	7.3
Over 10 years	171	44.3
Total	386	100.0

Table 4.3. shows that most respondents have spent over ten years on their jobs and these form 44.3% of the total number of respondents. 25.% have spent between 6 to 10 years while 23.3% have spent between 2 to 5 years.

4.2.4. Highest Qualification Attained

The results from statistical analysis of data representing the respondents' highest qualification attained are presented in the following table 4.4.

Table 4. 4: Highest qualification attained

Highest qualification	Frequency	Percent
Degree level	63	16.3
Diploma level	64	16.6
Other(s) Specify	52	13.5
Postgraduate Diploma	11	2.8
Primary Level	62	16.1
Secondary level	134	34.7
Total	386	100.0

Table 4.4 shows that most of the respondents attained secondary level as their highest level of education forming 34.7% of the total number of respondents. This is followed by diploma level (16.6%) and then followed by degree level (1.3%).

4.2.5. Distribution by Gender

The results from statistical analysis of data representing the respondents' gender are presented in the following table 4.5. Table 4.5 depicts the gender of respondents who filled the questionnaire.

Table 4.5: Gender of respondents

Gender	Frequency	Percentage
Female	170	44.0
Male	216	56.0
Total	386	100.0

Table 4.5 shows that most of the respondents that participated in this study are male (56.0%) and the rest (44.0%) are female.

4.2.6. Age Group

The results from statistical analysis of data representing the respondents' age group are presented in the following table 4.6.

Table 4. 6: Age group of respondents

Age group	Frequency	Percent
15 – 24 years	38	9.8
25 - 34 years	124	32.1
35 – 44 years	108	28.0
45 – 54 years	81	21.0
55 – 64 years	32	8.3
65+ years	3	.8
Total	**386**	**100.0**

Table 4.6 illustrates that most of the respondents are aged between 25 to 34 years (32.1%) followed by the age group of 35 to 44 years (28.0%).

4.3. Descriptive Statistics

This section of the thesis provides results of the descriptive statistics obtained from respondents to the questionnaire that the researcher used in the field study. The descriptive statistics have been presented per section in the questionnaire. Descriptive statistics of the following sections have been presented: ICTs used by farmers in information management in section 4.3.1., resource constrained environments in section 4.3.2., people factor in section 4.3.3., technology factor in section 4.3.4., processes and practices factor in section 4.3.5., rules and regulations factor in section 4.3.6., facilities and facilitation factor in section 4.3.7., budget factor in section 4.3.8., leadership factor in section 4.3.9., information management practices factor in section 4.3.10, and information use outcomes factor in section 4.3.10.

4.3.1. ICTs Used for Agricultural Advisory Information Management

Table 4.7 shows the responses that were obtained when respondents were asked which ICTs they use for agricultural advisory information (extension information) management in e-agriculture. This was done to ensure that farmers consulted were the ones using ICTs in agriculture (e-agriculture). Table 4.7 shows the ICTs used by the respondents in information management in e-agriculture.

Table 4. 7: ICTs used by respondents

Variable	Yes (%)	No (%)
Mobile Phones	93.78	6.22
Laptop/Computer	27.72	72.28
Internet	40.93	59.07
E-mail	31.95	68.05
Social Media like WhatsApp	48.70	51.30
Website	21.99	78.01
Agricultural Information System	56.03	43.97
Radio	81.77	18.23
Television	54.95	45.05
TOTAL	**50.87**	**49.13**

Table 4.7 reveals that majority of respondents use mobile phones (93.78%), radios (81.77%), Agricultural Information systems (56.03%) and television (54.95%). Figure 4.7 also depicts that the following ICTs are not commonly used: websites (78.01%), laptop or computer (72.28%), E-mail (68.05%), Internet (59.07%) and social media like WhatsApp (51.30%). This means that the information that small-scale farmers that engage in e-agriculture interface with is on phones, radios, agricultural information systems and televisions. This is in line with the documented evidence that mobile phones have penetrated most of the countries in developing economies (GSM, 2020) and that radios are still significant modes of transmitting information in RCEs (Hailu, *et al.,* 2018). This rhymes with the notion that radios and mobile phones have their infrastructure well established in these areas compared to internet connection. In addition, they do not need necessarily existence of electricity but batteries and traditional dry cells.

4.3.2. Resource Constrained Environments and Information Management

Section Two of the questionnaire was about resource constrained environments and the results of analysis of respondents' responses to that section are presented in table 4.8.

Table 4.8: Descriptive statistics results on RCEs and Information management

Code	STATEMENTS	Mean	Standard Deviation
RCe1	I have access to Electricity all the time.	4.05	1.13
RCe2	I use a telephone to access agricultural information all the time.	3.99	1.08
RCe3	I use a computer or laptop to access agricultural information all the time.	4.33	1.39
RCe4	I have access to computerized agricultural equipment.	4.79	1.53
RCe5	I use computerized agricultural equipment.	4.74	1.54
RCe6	I am conversant with the use of information management tools to access agricultural information	3.54	1.27
RCe7	I have all the funds I need to access agricultural information	3.88	1.33
RCe8	I have access to the Internet to get agricultural information required.	3.91	1.57
RCe9	The information management personnel are readily available to me.	4.54	1.37

Data shown in the table 4.8 above was coded using Strongly Disagree SD (1), Disagree D (2), Not Sure NS (3), Agree A (4), and Strongly Agree SA (5). Based on that coding, majority of respondents (with a mean of 4.05) agree that they have access to electricity all the time. Respondents amounting to the mean of 3.99 agree that they use a telephone to access agricultural information. From table 4.8 it is clear that majority of respondents agree that they use a computer or laptop to access information (with a mean of 4.33) and that the information management personnel are readily available (with a mean of 4.54). The column showing standard deviation has a mean value of around 1.2 meaning that the deviation from the mean is reasonably small.

4.3.3. People Factor

Section 3.1 of the questionnaire (see appendix A) was about the people factor and the results of analysis of respondents' responses to that section are presented in table 4.9.

Table 4.9: Descriptive statistics results on People (PEO) factor

Code	STATEMENTS	Mean	Standard Deviation
PEco1	My economic status (rich or poor) influences the way I seek agricultural information.	4.10	1.04
PEco2	My political thinking affects the way I seek agricultural information	3.88	1.48
PEco3	The people I interact with, influence my decision to seek and use agricultural information	3.96	1.12
PEs1	My interpersonal skills influence my decision to seek and use agricultural information	4.24	0.71
PEs2	My creativity skills influence my decision to seek and use agricultural information	4.26	0.72
PEs3	My communication skills influence my decision to seek and use agricultural information	4.28	0.75
PEcu1	My mother language influences my decision to seek and use agricultural information	4.02	1.20
PEcu2	My religion influences my decision to seek and use agricultural information	3.02	1.46

Data shown in the table 4.9 above was coded using Strongly Disagree SD (1), Disagree D (2), Not Sure NS (3), Agree A (4), and Strongly Agree SA (5). Based on Table 4.9, majority of respondents agree that economic status (with a mean of 4.10), political thinking (with a mean of 3.88), the people around (mean of 3.96), interpersonal skills (with a mean of 4.24), creativity (with a mean of 4.26), communication skills (with a mean of 4.28) and religion (mean of 3.02) are key elements in information management by small-scale farmers in e-agriculture. The standard deviation ranges from 0.71 to 1.48 meaning that the mean value of the deviation from the mean is a small value.

4.3.4. Technology Factor

Section 3.2 (a) of the questionnaire was about the Technology factor and the results of analysis of respondents' responses to that section are presented in table 4.10.

Table 4. 10: Descriptive statistics results on Technology (TEC) factor

Code	STATEMENTS	Mean	Standard Deviation
TEi1	The design structure of technology is vital in influencing information storage and use	4.17	0.76
TEs2	Technology designed for agricultural information management influences its usage	4.15	0.69
TEt1	Technology tools influence agricultural information management	4.21	0.72
TEC2	Information systems for agricultural stakeholders influence agricultural information management.	4.15	0.79
TEC3	Information systems developed based on requirements of agricultural stakeholders influence agricultural information management	4.23	0.74
TEC4	Information systems tested before their implementation for agricultural use influence agricultural information management.	4.15	0.87
TEC5	Information systems which are easy to use by agricultural stakeholders influence agricultural information management	4.32	0.73
TEC6	Information systems developed by involving agricultural stakeholders influence agricultural information management	4.27	0.82
TEC7	Agricultural information systems which are expensive influence agricultural information management.	3.49	1.41
TEC8	Agricultural information systems which are cheap to maintain influence agricultural information management.	4.26	0.89

Data in the questionnaire was coded following Strongly Disagree SD (1), Disagree D (2), Not Sure NS (3), Agree A (4), and Strongly Agree SA (5). Based on that coding, table 4.10 shows that, majority of respondents agree (A) (with a mean of approximately 4) that the following attributes of technology are essential in information management in e-agriculture in Uganda: Design structure of technology (mean of 4.17), designing technology specifically for information management (with a mean of 4.15), technology tools (mean of 4.21), information systems (mean of 4.15), requirement based information systems (mean of 4.23), testing information systems with users (mean of 4.15), ease of use (mean of 4.32), involving users in developing information systems (mean of 4.27) and little expense in maintaining these information systems (mean of 4.26). Table 4.10 also shows that the average deviation from the mean is between 0.69 to 0.89 with an extreme of 1.41 making this standard deviation from the mean low.

4.3.5. Processes and Practices Factor

Section 3.3 of the questionnaire was about the Processes and Practices factor and the results of analysis of respondents' responses to that section are presented in table 4.11.

Table 4. 11: Descriptive statistics results on Processes and Practices (PAP) factor

Code	**STATEMENTS**	**Mean**	**Standard Deviation**
PAP1	Generation/Creation of information is a critical process in agricultural information management.	4.4	0.57
PAP2	Acquisition of information is a critical process in agricultural information management	4.4	0.56
PAP3	Organization of information is a critical process in agricultural information management	4.32	0.62
PAP4	Maintenance of information is a critical process in agricultural information management	4.38	0.61
PAP5	Storage of information is a critical process in agricultural information management	4.41	0.65
PAP6	Distribution of information is a critical process in agricultural information management	4.42	0.58
PAP7	Use of information is a critical process in agricultural information management	4.52	0.55
PAP8	Retrieval of information is a critical process in agricultural information management	4.3	0.82
PAP9	Disposal of information is a critical process in agricultural information management	4.03	1.02

Data in the questionnaire was coded following Strongly Disagree SD (1), Disagree D (2), Not Sure NS (3), Agree A (4), and Strongly Agree SA (5). Based on that coding, table 4.11 shows that, majority of respondents agree (A) that the following attributes of information management processes and practices are essential in information management by small-scale farmers in e-agriculture: Generation of information (mean of 4.4), acquisition of information (mean of 4.4), organization of information (mean of 4.32), maintenance of information (mean of 4.38), storage of information (mean of 4.41), distribution of information (mean of 4.42) use of information (mean of 4.52), retrieval of information (mean of 4.3) and disposal of information (mean of 4.03). The standard deviation is low ranging from 0.56 to 0.82 with an extreme value of 1.02. So the responses deviated from the mean with a low value.

4.3.6. Rules and Regulations Factor

Section 3.4 of the questionnaire was about the Rules and Regulations factor and the results of analysis of respondents' responses to that section are presented in table 4.12.

Table 4.12: Descriptive statistics results on Rules and Regulations (RAR) factor

Code	**STATEMENTS**	**Mean**	**Standard Deviation**
POL1	Rules and regulations that are easy for information managers to comply with are vital in agricultural information management	4.36	0.71
POL2	Rules and regulations that are relevant to information managers' practices are vital in agricultural information management	4.23	0.65
POL3	Rules and regulations that are useful to information managers in their information management practice are vital in agricultural information management	4.35	0.65
POL4	Rules and regulations that are understandable to information managers are vital in agricultural information management	4.4	0.62
POL5	Rules and regulations that information managers get involved in making are vital in agricultural information management.	4.32	0.79
POL6	Rules and regulations that are known to information managers are vital in agricultural information management.	4.30	0.76

Data shown in table 4.12 was coded following Strongly Disagree SD (1), Disagree D (2), Not Sure NS (3), Agree A (4), and Strongly Agree SA (5). Based on that coding, table 4.12 shows that, majority of respondents agree (A) that the following attributes of rules and regulations are essential in information management in e-agriculture in Uganda: Easy to comply with (with mean of 4.36), relevance to information managers' practices (with mean of 4.23), usefulness of the rules and regulations to information managers (with mean of 4.35), understandable rules and regulations (with mean of 4.4), involvement of information managers in making the rules and regulations (with mean of 4.32) and making these rules and regulation known to those that they affect (with mean of 4.30). The responses deviate from the mean (Value of standard deviation) with values ranging from 0.62 to 0.79 which are low implying that responses did not greatly diverge from the mean.

4.3.7. Facilities and Facilitation Factor

Section 3.5 of the questionnaire was about Facilities and Facilitation factor and the results of analysis of respondents' responses to that section are presented in table 4.13.

Table 4.13: Descriptive statistics results on Facilities and Facilitation (FAF) factor

Code	STATEMENTS	Mean	Standard Deviation
FAF1	Availability of money for agricultural information management needs is vital for its success	4.25	**1.00**
FAF2	Availability of facilities to generate, acquire, store, process, disseminate and use information is vital for agricultural information management	4.13	**1.07**
FAF3	Quality of facilities used is vital for the success of agricultural information management.	4.12	**1.05**

Data shown in table 4.13 was coded following Strongly Disagree SD (1), Disagree D (2), Not Sure NS (3), Agree A (4), and Strongly Agree SA (5). Based on that coding, table 4.13 shows that, majority of respondents agree (SA plus A) that the following attributes of Facilities and Facilitation are essential in information management in e-agriculture in developing economies like Uganda's: Availability of money for agricultural information management needs (with a mean of 4.25), Availability of facilities to generate, acquire, store, process, disseminate and use information (with a mean of 4.13) and the quality of facilities (with a mean of 4.12). The standard deviation from the mean is low ranging from 1 to 1.07 meaning that the responses did not greatly diverge from the mean.

4.3.8. Budget Factor

Section 3.6 of the questionnaire was about the Budget factor and the results of analysis of respondents' responses to that section are presented in table 4.14.

Table 4.14: Descriptive statistics results on Budget (BUD) factor

Code	STATEMENTS	Mean	Standard Deviation
BUD1	A realistic budget to information managers is vital for the success of agricultural information management	4.37	0.70
BUD2	The ease with which the budget can be financed is vital for the success of agricultural information management	4.28	0.67
BUD3	Stakeholder participation in drafting the budget is vital for the success of agricultural information management.	4.18	0.89
BUD4	Thoroughness in the budget process is vital for the success of agricultural information management	4.22	0.65
BUD5	Management support to the budget is vital for the success of agricultural information management	4.29	0.76

Data shown in table 4.14 was coded following Strongly Disagree SD (1), Disagree D (2), Not Sure NS (3), Agree A (4), and Strongly Agree SA (5). Based on that coding, table 4.14 shows that, majority of respondents agree (Strongly Agree (SA) plus Agree (A)) that the following attributes of Budget are essential in information management in e-agriculture in developing economies like Uganda's: Realistic budget (with a mean of 4.37), ease of financing the budget (with a mean of 4.28), stakeholder participation in drafting the budget (with a mean of 4.18), thoroughness in the budget process (with a mean of 4.22) and management support for the budget (with a mean of 4.29). The responses deviate from the mean with a small value ranging from 0.65 to 0.89.

4.3.9. Leadership Factor

Section 3.7 of the questionnaire was about the leadership factor and the results of analysis of respondents' responses to that section are presented in table 4.15.

Table 4.15: Descriptive statistics results on Leadership (LEA) factor

Code	STATEMENTS	Mean	Standard Deviation
LEA1	Control and coordination efforts in order to achieve a specified goal, is vital for the success of agricultural information management	4.32	0.69
LEA2	Identification and use of skills relevant to agricultural information management is vital to its success.	4.31	0.63
LEA3	Leadership that stresses clear organization and arrangement of entities is vital for the success of agricultural information management.	4.26	0.78
LEA4	Leadership that enforces prioritization is vital for the success of agricultural information management.	4.23	0.90

Data shown in table 4.15 was coded following Strongly Disagree SD (1), Disagree D (2), Not Sure NS (3), Agree A (4), and Strongly Agree SA (5). Based on that coding, table 4.15 shows that, majority of respondents agree (SA (5) plus A (4)) that the following attributes of Leadership are essential in information management in e-agriculture in developing economies like Uganda's: Control and coordination efforts (mean of 4.32), identification and use of skills relevant to information management (mean of 4.31), clear organization and arrangement of entities (mean of 4.26) and prioritization (mean of 4.23). The responses deviate from the mean with small values ranging from 0.63 to 0.90.

4.3.10. Information Management Practices

Section 4.0 of the questionnaire was about the information management practices and the results of analysis of respondents' responses to that section are presented in table 4.16.

Table 4.16: Descriptive statistics for Information management practices (IMP) factor

Code	STATEMENTS	Mean	Standard Deviation
IMP1	My organization has a formal policy or strategy for managing knowledge and information.	3.54	1.24
IMP2	My organization has formal procedures to collect knowledge.	3.69	1.15
IMP3	My organization has formal procedures to share knowledge.	3.91	1.11
IMP4	My organization identifies and obtains knowledge from outside sources (e.g. industry partners, governments, universities).	4.13	0.98
IMP5	Knowledge and information in my organization is available and organized to make it easy to find what I need.	3.80	1.16
IMP6	Information about good work practices, lessons learned, and knowledgeable persons is easy to find in my organization.	4.02	1.05
IMP7	My organization makes use of information technology to facilitate knowledge and information sharing.	3.82	1.16
IMP8	My organization has a culture intended to promote knowledge and information sharing.	3.94	1.04
IMP9	My work unit encourages experienced workers to communicate their knowledge to new or less experienced workers.	4.20	0.84
IMP10	My organization encourages workers to attend training and/or education courses.	4.16	0.92
IMP11	My organization has formal mentoring programs and/or apprenticeships.	3.54	1.34
IMP12	My work unit has a culture intended to promote knowledge and information sharing.	3.94	1.08

Data shown in table 4.16 was coded following Strongly Disagree SD (1), Disagree D (2), Not Sure NS (3), Agree A (4), and Strongly Agree SA (5). Based on that coding, table 4.16 shows that, majority of respondents agree (SA plus A) that the following attributes of Information management practices are essential in information management in e-agriculture in developing economies like Uganda's: Formal policy for information management (a mean of 3.54), formal procedures to collect information (a mean of 3.69), identifying and obtaining information from external sources (a mean of 4.13), organizing information to make it easy to find (a mean of 3.80), easy to find information about good work practices, lessons learned and knowledgeable persons (a mean of

4.02), making use of IT to ease information sharing (a mean of 3.82), a culture to promote information sharing (a mean of 3.94), encouraging experienced workers to communicate their knowledge to new and less experiences workers (a mean of 4.20), attending training and/or education courses (a mean of 4.16), formal monitoring programs and apprenticeships (a mean of 3.54) and a culture to promote information sharing (a mean of 3.94). The standard deviation from the mean is small ranging from 0.92 to 1.34.

4.3.11. Information Use Outcomes

Section 5.0 of the questionnaire was about the information use outcomes and the results of analysis of respondents' responses to that section are presented in table 4.17.

Table 4.17: Descriptive statistics results on Information use outcomes (IUO) factor

Code	**STATEMENTS**	**Mean**	**Standard Deviation**
IUO1	I can quickly recognize the complexities in a situation and find a way of solving problems.	4.27	0.72
IUO2	My work tasks demand new, creative ideas and solutions.	4.3	0.75
IUO3	My work benefits my organization.	4.45	0.64
IUO4	I have influence over what happens within my work unit.	4.35	0.77
IUO5	Sharing information is critical to my being able to do my job.	4.40	0.77

Data shown in table 4.17 was coded following Strongly Disagree SD (1), Disagree D (2), Not Sure NS (3), Agree A (4), and Strongly Agree SA (5). Based on that coding, table 4.17 shows that, majority of respondents agree (SA plus A) that the following attributes of Information Use Outcomes are essential in information management in e-agriculture in developing economies like Uganda's: Quickly recognizing the complexities in a situation and finding a way of solving it (a mean of 4.27), ability of the work to demand new creative ideas and solutions (a mean of 4.30), benefit of one's work to others (a mean of 4.45), having influence over what happens within one's work unit (a mean of 4.35) and sharing information as a critical element in ones performance of tasks (a mean of 4.40). The standard deviation from the mean is small ranging from 0.64 to 0.77 meaning that the responses did not widely diverge from the mean.

4.4. Exploratory Factor Analysis

Factor analysis is a technique used to reduce data by grouping it into categories. This technique was used because data collected from the field (using the questionnaire) was about different constructs and so there was the need to summarize or reduce this data to obtain meaning from it. Factor analysis is also used to ascertain if a proposed measuring instrument measures what it was intended to do (Worthington and Wittaker, 2006). Exploratory Factor Analysis (EFA) and confirmatory factor analysis (CFA) are the two types of factor analysis (Kahn, 2006). Of the two, EFA was selected in this research since it is crucial in checking if variables fit well into given categories or constructs (Henson and Roberts, 2006). EFA is used to establish which variables co-vary (move together) and thus these variables form one category (Kahn, 2006). EFA is used to ensure that the information management framework, the main deliverable in this research, contains the right set of constructs. In the same way, EFA is used to eliminate those variables that have no other variables with which they co-vary (Kahn, 2006).

Confirmatory factor analysis on the other hand is used to confirm a given theory and to ascertain if variables fit well in the categories in which they have been positioned (Henson and Roberts, 2006). EFA was chosen in this research because in this study we are not confirming a given theory but rather building theory.

The questions that appear in the questionnaire in the individual sections were used to do factor analysis. Individual questions were inspected to find out if they share variance with other questions. Questions or variables that co-vary (that have a high communality value (a value close to 1)) were grouped together while those that have a low communality value (a value below 0.4) were considered to be having a variance unique to themselves and so were not grouped with others (Tabachnick and Fidel, 2001).

There are different criteria that were used to establish the number of factors during EFA, namely: cumulative percentages, Eigenvalues greater than 1, Scree plot inspection and parallel analysis (Ajigini, 2018). Cumulative percentages of variance were presented and those that were above 60% were used. Scree plot inspection was done by plotting Eigenvalues on the graph against number of factors. The graph obtained was inspected to see where great breaks are and these were considered. Eigenvalues show the sum of squared loadings of the given factor. All factors with Eigenvalues less than 1 were omitted while those with values greater than 1 were retained.

Factor loadings of a variable on a given construct or factor represent the weight that a given variable has in relation to the given construct or factor. A factor loading of 0.4 or 40% on a given construct is considered meaningful while that of 0.3 or 30% is considered not satisfactory (Wiid and Diggines, 2013; Ajigini, 2018).

4.4.1 Resource Constrained Environments

The output of EFA on section 2 of the questionnaire (Resource constrained environments (RCEs) and Information management) is shown in Table 4.18. The table shows Eigenvalues and the percentage of variance exhibited by the factors.

Table 4.18: Eigen values of section 2 of the questionnaire

Factor	**Eigenvalue**	**Difference**	**Proportion**	**Cumulative**
Factor1	**3.7463**	**2.3743**	**0.4163**	**0.4163**
Factor2	**1.3720**	**0.3408**	**0.1524**	**0.5687**
Factor3	**1.0312**	**0.2966**	**0.1146**	**0.6833**
Factor4	0.7345	0.1339	0.0816	0.7649
Factor5	0.6006	0.0588	0.0667	0.8316
Factor6	0.5418	0.0215	0.0602	0.8918
Factor7	0.5203	0.1719	0.0578	0.9496
Factor8	0.3484	0.2434	0.0387	0.9883
Factor9	0.1050	.	0.0117	1.0000

From the table 4.18 above, there are three factors whose Eigenvalues are greater than 1. The cumulative percentages of variance of three variables are **68.33%**. Since this value exceeds 60%, it is used as the basis to derive three factors (Wiid and DIggines, 2013). The value **68.33%** implies that these three variables explain **68.33%** of the variance in the original nine items making this value sufficient to determine the number of factors which is three.

The Scree Plot for the Eigenvalues against number of components (variables) is shown in figure 4.1.

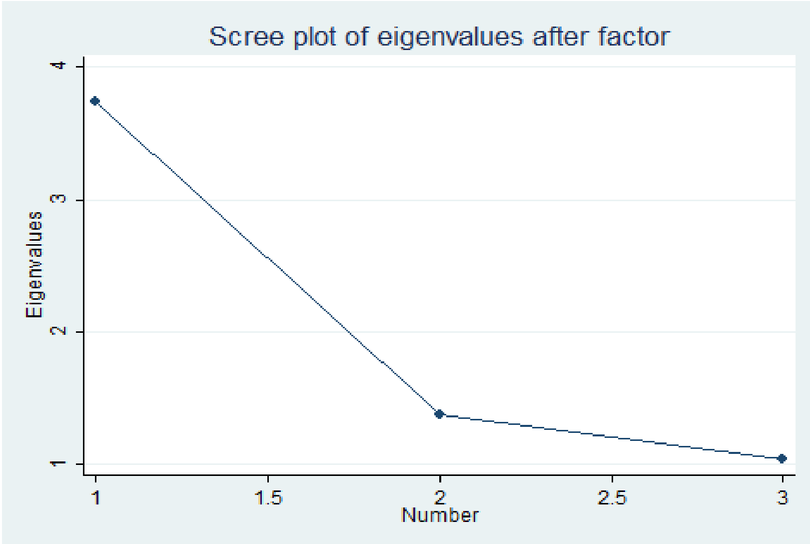

Figure 4.1: Scree Plot of factors in section 2 of the questionnaire.

The Scree Plot shows that the first three variables decline very steeply implying that the three are sufficient to be considered to decide on the number of factors. Therefore, the three factors that were extracted are shown in Table 4.19 below with the loadings in each factor.

Table 4.19: Factor loadings of section 2 of the questionnaire (See Appendix A)

Variable	Factor1	Factor2	Factor3	Uniqueness	Communalities	Comment
rce5	**0.9228**	0.1311	0.0051	0.1313	0.8687	Acceptable
rce4	**0.9075**	0.1217	-0.0062	0.1615	0.8385	Acceptable
rce3	**0.6566**	0.1586	0.3072	0.4493	0.5507	Acceptable
rce8	**0.5174**	0.3107	0.4980	0.3877	0.6123	Acceptable
rce1	0.0982	**0.8430**	0.0204	0.2793	0.7207	Acceptable
rce2	0.2029	**0.7844**	0.1385	0.3243	0.6757	Acceptable
rce6	0.4299	**0.4709**	0.3771	0.4513	0.5487	Acceptable
rce9	-0.1388	-0.0035	**0.8341**	0.2850	0.7150	Acceptable
rce7	0.2423	0.1836	**0.7258**	0.3807	0.6193	Acceptable

From table 4.19, it is shown that four variables load with values above 0.5 for factor 1, three variables for factor 2 and two variables for factor 3 as highlighted in column two, three and four of table 4.19 respectively. The reliability coefficients for all variables in section two of the questionnaire is shown. Reliability coefficients for the three factors that were obtained after EFA on section 2 of the questionnaire are shown also in Table 4.20.

Table 4.20: Reliability co-efficient for items in section 2 of the questionnaire (See Appendix A)

	All variables	Factor 1	Factor 2	Factor 3
	rec1, rec2, rec3, rec4, rec5, rec6, rec7, rec8, rec9	rec5, rec4, rec3, rec8	rec1, rec2, rec6	rec9, rec8
Average inter-item covariance	0.609	1.235	0.531	0.689
Number of items in the scale:	9	4	3	2
Alpha Scale reliability coefficient:	**0.8126 (Acceptable)**	**0.8253 (Acceptable)**	**0.658 (Acceptable)**	**0.5478 (NOT Acceptable)**

From the table 4.20, the scale reliability coefficients for all variables, factor1 and factor 2 are all acceptable while the reliability coefficient for factor 3 is 0.5478 and this value is not acceptable. Because the Scale reliability coefficient of factor 3 is not acceptable, this factor has been dropped and only factor 1 and factor 2 have been considered for further analysis.

4.4.2. People Factor

The output of EFA on section 3.1(a) of the questionnaire (People factor) is shown in **Table 4.21.** The table shows Eigenvalues and the percentage of variance exhibited by the factors.

Table 4.21: Eigenvalues of section 3.1 of the questionnaire

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	**2.39863**	**1.03815**	**0.2998**	**0.2998**
Factor2	**1.36048**	**0.23104**	**0.1701**	**0.4699**
Factor3	**1.12944**	**0.22702**	**0.1412**	**0.6111**
Factor4	0.90241	0.26369	0.1128	0.7239
Factor5	0.63873	0.01596	0.0798	0.8037
Factor6	0.62276	0.08897	0.0778	0.8816
Factor7	0.5338	0.12005	0.0667	0.9483
Factor8	0.41375	.	0.0517	1

Table 4.21 shows three factors with Eigenvalues above 1. These three factors are the basis for having three groupings within which all the other variables of section 3.1 load.

The Scree Plot for the Eigenvalues against number of components (variables) is shown in figure 4.2

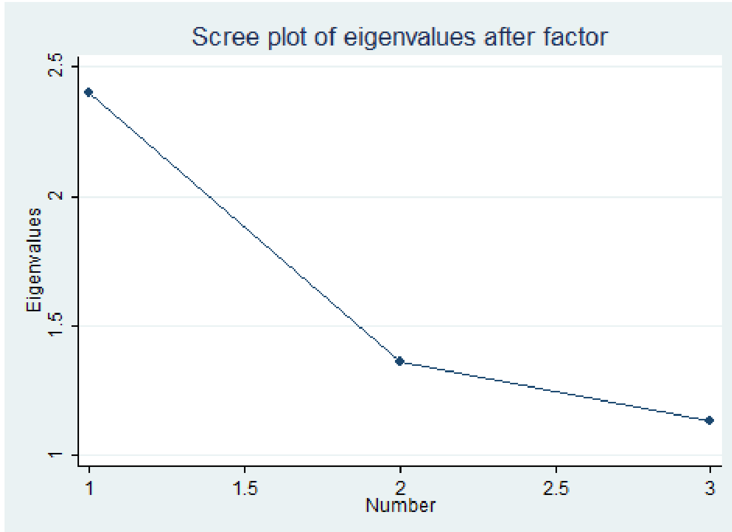

Figure 4. 2: Scree Plot of Eigenvalues against number of components

The Scree Plot in figure 4.2 shows that the first three variables decline very steeply implying that the three are sufficient to be considered to decide on the number of factors. Therefore, the three factors that were extracted are shown in table 4.22

Table 4.22: Rotated factor loadings (pattern matrix) and unique variances sorted

Variable	*Factor1*	*Factor2*	*Factor3*	*Uniqueness*	*Communalities*	**Comment**
pes2	**0.7672**	0.2013	-0.1645	0.3438	0.6562	Acceptable
pes3	**0.7431**	0.1199	0.0655	0.4291	0.5709	Acceptable
pes1	**0.7242**	0.1045	0.1755	0.4338	0.5662	Acceptable
pecu2	0.1116	**0.7555**	0.3484	0.2954	0.7046	Acceptable
pecu1	0.2165	**0.7437**	-0.1922	0.3631	0.6369	Acceptable
peco3	0.0683	**0.5054**	0.4341	0.5515	0.4485	Acceptable
peco2	-0.0897	0.1895	**0.8096**	0.3006	0.6994	Acceptable
peco1	0.4338	-0.2762	**0.5841**	0.3943	0.6057	Acceptable

Table 4.22 shows the rotated factor matrix with factor loadings. This figure shows how the questions in section 3.1 were rearranged after EFA on section 3.1. Consequently, factor 1 has three variables that load highly in it, this is the case also with factor 2. Two variables load highly in factor 3.

Table 4.23: Reliability coefficients for items in section 3.1 of the questionnaire

	All variables	Factor 1	Factor 2	Factor 3
	peco1, peco2, peco3, pes1, pes2, pes3, pecu1	pes2, pes3, pes1	pecu2, pecu1, peco3	peco2, peco1
Average inter-item covariance	0.2069429	0.2150304	0.53089	0.3280869
Number of items in the scale:	8	3	3	2
Scale reliability coefficient:	**0.6224 (Acceptable)**	**0.6733 (Acceptable)**	**0.5627 (NOT Acceptable)**	**0.3338 (NOT Acceptable)**

From the table 4.23, the scale reliability coefficients for all variables and for factor 1 are all acceptable while the reliability coefficient for factor 2 and factor 3 are not acceptable. Because the Scale reliability coefficient of factor 2 and factor 3 are not acceptable, these factors have been dropped and only factor 1 has been considered for further analysis.

4.4.3 Technology Factor

The output of EFA on section 3.2 (a) of the questionnaire (Technology factor) is shown in table 4.24. The figure shows Eigenvalues and the percentage of variance exhibited by the factors.

Table 4.24: Eigenvalues of section 3.2(a) of the questionnaire

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	**3.8827**	**2.67461**	**0.3883**	**0.3883**
Factor2	**1.20809**	**0.24202**	**0.1208**	**0.5091**
Factor3	0.96607	0.14482	0.0966	0.6057
Factor4	0.82125	0.07758	0.0821	0.6878
Factor5	0.74367	0.09111	0.0744	0.7622
Factor6	0.65257	0.11526	0.0653	0.8274
Factor7	0.5373	0.09715	0.0537	0.8812
Factor8	0.44015	0.04446	0.044	0.9252
Factor9	0.39569	0.04317	0.0396	0.9647
Factor10	0.35252	.	0.0353	1

Table 4.24 shows two factors with Eigenvalues above 1. These two factors are the basis for having two groupings within which all the other variables of section 3.1(a) load.

The Scree Plot for the Eigenvalues against number of components (variables) is shown in figure 4.3

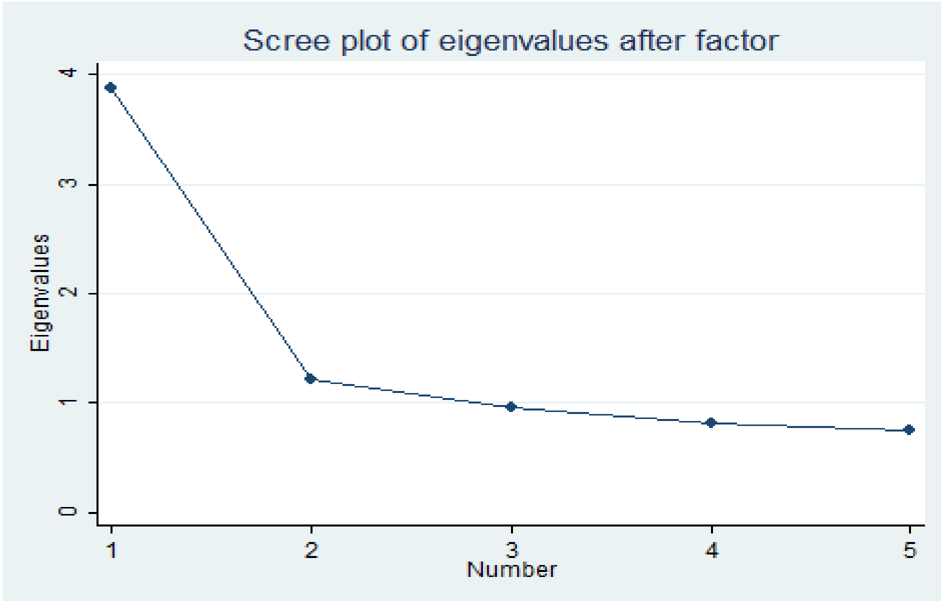

Figure 4. 3: Scree Plot of Eigenvalues against number of components

The Scree Plot shows that the first two variables decline very steeply implying that the two are sufficient to be considered to decide on the number of factors. Therefore, the two factors that were extracted are shown in table 4.25.

Table 4.25: Rotated factor loadings (pattern matrix) and unique variances sorted

Variable	**Factor1**	**Factor2**	**Uniqueness**	**Communalities**	
tes2	**0.7907**	0.0896	0.3667	0.6333	Acceptable
tei1	**0.7595**	0.1529	0.3998	0.6002	Acceptable
tec2	**0.6883**	0.1617	0.5001	0.4999	Acceptable
tet1	**0.6573**	0.3128	0.4701	0.5299	Acceptable
tec3	**0.6298**	0.3918	0.4499	0.5501	Acceptable
tec5	0.2389	**0.7971**	0.3076	0.6924	Acceptable
tec4	0.1569	**0.7075**	0.4748	0.5252	Acceptable
tec6	0.2471	**0.6763**	0.4816	0.5184	Acceptable
tec8	*0.0421*	***0.6103***	*0.6258*	*0.3742*	*Unacceptable*
tec7	*0.2563*	*0.3186*	*0.8328*	*0.1672*	*Unacceptable*

Table 4.26 shows the rotated factor matrix with factor loadings. This figure shows how the questions in section 3.2 (a) were rearranged after EFA on section 3.2(a). Consequently, factor 1 has five variables that load highly in it, while factor 2 has three variables that load highly in it.

Table 4. 26: Reliability coefficients for items in section 3.2(a) of the questionnaire

	All variables	**Factor 1**	**Factor 2**
	tei1, tes2, tet1, tec2, tec3, tec4, tec5, tec6 tec7, tec8	tes2, tei1, tec2, tet1, tec3.	tec5, tec4, tec6
Average inter-item covariance	0.2008838	0.2356795	0.2937575
Number of items in the scale:	10	5	3
Scale reliability coefficient:	**0.7868 (Acceptable)**	**0.794 (Acceptable)**	**0.7099 (Acceptable)**

From the table 4.26, the scale reliability coefficients for all variables, for factor 1 and for factor 2 are all acceptable. These factors (factor 1 and factor 2) have been considered for further analysis.

4.4.4 Processes and Practices Factor

The output of EFA on section 3.3 of the questionnaire (Processes and practices (PAP)) is shown in table 4.27. The figure shows Eigenvalues and the percentage of variance exhibited by the factors.

Table 4.27: Eigenvalues of section 3.3 of the questionnaire

Factor	**Eigenvalue**	**Difference**	**Proportion**	**Cumulative**
Factor1	**3.9461**	**2.98203**	**0.4385**	**0.4385**
Factor2	0.96408	0.15981	0.1071	0.5456
Factor3	0.80426	0.06751	0.0894	0.6349
Factor4	0.73675	0.08323	0.0819	0.7168
Factor5	0.65352	0.08442	0.0726	0.7894
Factor6	0.56911	0.08755	0.0632	0.8526
Factor7	0.48155	0.04589	0.0535	0.9062
Factor8	0.43566	0.0267	0.0484	0.9546
Factor9	0.40896	.	0.0454	1

Table 4.27 shows one factor with Eigenvalues above 1. This factor is the basis for having one grouping within which all the other variables of section 3.3 load.

The Scree Plot for the Eigenvalues against number of components (variables) is shown in figure 4.4

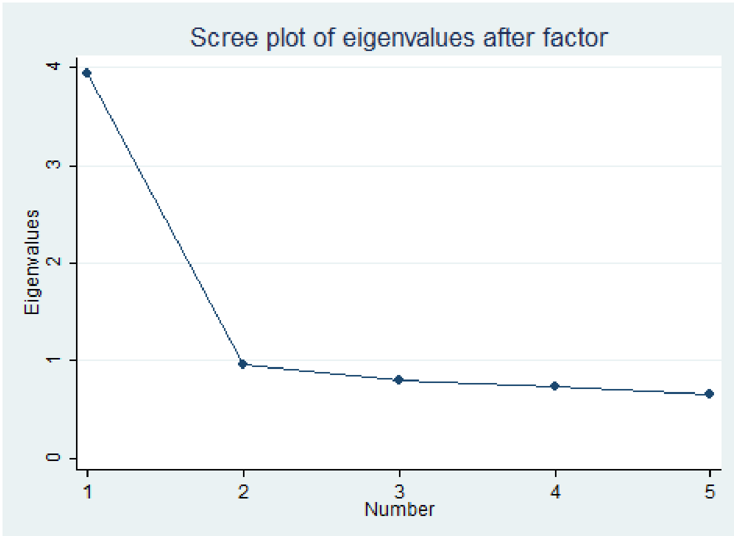

Figure 4. 4: Scree Plot of Eigenvalues against number of components

This Scree Plot shows that one variable declines very steeply implying that the one is sufficient to be considered to decide on the number of factors. Therefore, the one factor that was extracted is shown in table 4.28.

Table 4.28: Rotated factor loadings (pattern matrix) and unique variances sorted

Variable	**Factor1**	**Uniqueness**	**Communalities**	
pap3	**0.7708**	0.4058	0.5942	Acceptable
pap4	**0.7144**	0.4896	0.5104	Acceptable
pap2	**0.6910**	0.5226	0.4774	Acceptable
pap6	**0.6876**	0.5272	0.4728	Acceptable
pap5	**0.6875**	0.5273	0.4727	Acceptable
pap1	**0.6508**	0.5765	0.4235	Acceptable
pap8	**0.6381**	0.5928	0.4072	Acceptable
pap9	0.5895	0.6525	0.3475	unacceptable
pap7	0.4903	0.7596	0.2404	unacceptable

Table 4.28 shows the rotated factor matrix with factor loadings. This figure shows how the questions in section 3.3 were rearranged after EFA on section 3.3. Consequently, factor 1 has seven variables that load highly in it.

Table 4.29: Reliability coefficients for items in section 3.3 of the questionnaire

	All variables	**Factor 1**
	pap1, pap2, pap3, pap4, pap5, pap6, pap7, pap8, pap9	pap3, pap4, pap2, pap5, pap1, pap6, pap8
Average inter-item co-variance	0.1567017	0.1650668
Number of items in the scale:	9	7
Scale reliability coefficient:	**0.8216 (Acceptable)**	**0.7980 (Acceptable)**

From the table 4.29, the scale reliability coefficients for all variables and for factor 1 are all acceptable. In effect, factor 1 has been considered for further analysis.

4.4.5. Rules and Regulations Factor

The output of EFA on section 3.4 of the questionnaire (Rules and regulations) is shown in table 4.30. The figure shows Eigenvalues and the percentage of variance exhibited by the factors.

Table 4.30: Eigenvalues of section 3.4 of the questionnaire

Factor	**Eigenvalue**	**Difference**	**Proportion**	**Cumulative**
Factor1	**5.00083**	**4.09461**	**0.7144**	**0.7144**
Factor2	0.90622	0.47301	0.1295	0.8439
Factor3	0.43322	0.12847	0.0619	0.9058
Factor4	0.30474	0.09332	0.0435	0.9493
Factor5	0.21143	0.11556	0.0302	0.9795
Factor6	0.09587	0.04818	0.0137	0.9932
Factor7	0.04769	.	0.0068	1

Table 4.30 shows one factor with Eigenvalues above 1. This factor is the basis for having one grouping within which all the other variables of section 3.4 load.

The Scree Plot for the Eigenvalues against number of components (variables) is shown in figure 4.5.

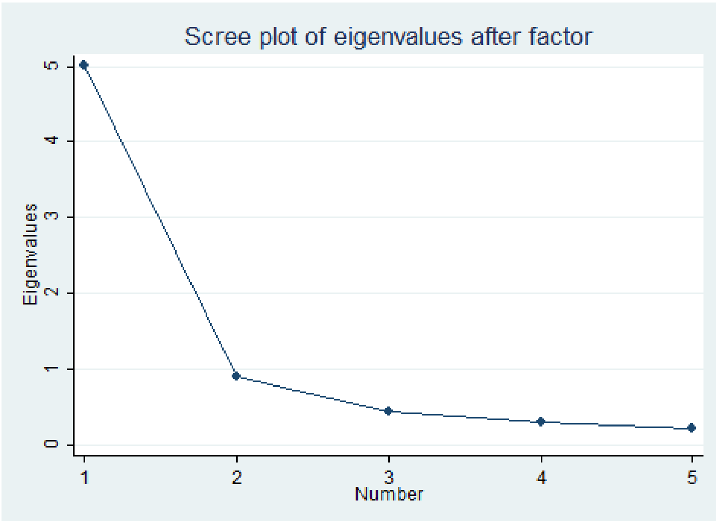

Figure 4.5: Scree Plot of Eigenvalues against number of components

This Scree Plot in figure 4.5 shows that one variable declines very steeply implying that the one is sufficient to be considered to decide on the number of factors. Therefore, the one factor that was extracted is shown in table 4.31.

Table 4.31: Rotated factor loadings (pattern matrix) and unique variances sorted

Variable	Factor1	Uniqueness	Communalities	Comment
pol4	**0.9479**	0.1015	0.8985	*Acceptable*
pol3	**0.9355**	0.1249	0.8751	*Acceptable*
pol5	**0.9335**	0.1286	0.8714	*Acceptable*
pol6	**0.8954**	0.1982	0.8018	*Acceptable*
pol2	**0.8494**	0.2785	0.7215	*Acceptable*
pol1	**0.8274**	0.3154	0.6846	*Acceptable*
pol7	0.3846	0.8521	0.1479	*unacceptable*

Table 4.31 shows the rotated factor matrix with factor loadings. This figure shows how the questions in section 3.4 were rearranged after EFA on section 3.4. Consequently, factor 1 has seven variables that load highly in it.

Table 4.32: Reliability coefficients for items in section 3.4 of the questionnaire

	All variables	**Factor 1**
	pol1, pol2, pol3, pol4, pol5, pol6, pol7	pol4, pol3, pol5, pol6, pol2, pol1
Average inter-item covariance	0.2452339	0.219968
Number of items in the scale:	7	6
Scale reliability coefficient:	**0.7861 (Acceptable)**	**0.8336 (Acceptable)**

From the table 4.32, the scale reliability coefficients for all variables and for factor 1 are all acceptable. In effect, factor 1 has been considered for further analysis.

4.4.6 Facilities and Facilitation Factor

The output of EFA on section 3.5 of the questionnaire (Facilities and facilitation) is shown in table 4.33. The figure shows Eigenvalues and the percentage of variance exhibited by the factors.

Table 4.33: Eigenvalues of section 3.5 of the questionnaire

Factor	**Eigenvalue**	**Difference**	**Proportion**	**Cumulative**
Factor1	**2.74808**	**1.80582**	**0.687**	**0.687**
Factor2	0.94226	0.67615	0.2356	0.9226
Factor3	0.26611	0.22257	0.0665	0.9891
Factor4	0.04354	.	0.0109	1

Table 4.33 shows one factor with Eigenvalues above 1. This factor is the basis for having one grouping within which all the other variables of section 3.5 load.

The Scree Plot for the Eigenvalues against number of components (variables) is shown in figure 4.6.

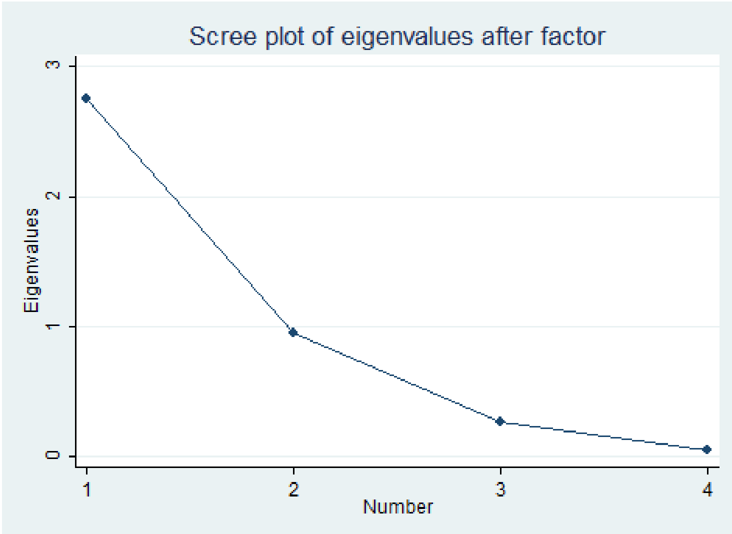

Figure 4. 6:. Scree Plot of Eigenvalues against number of components

This Scree Plot in figure 4.6 shows that one variable declines very steeply implying that the one is sufficient to be considered to decide on the number of factors. Therefore, the one factor that was extracted is shown in table 4.34.

Table 4.34: Rotated factor loadings (pattern matrix) and unique variances sorted

Variable	**Factor1**	**Uniqueness**	**Communalities**	**Comment**
faf2	**0.971**	0.0572	0.9428	Acceptable
faf3	**0.9561**	0.0858	0.9142	Acceptable
faf1	**0.884**	0.2185	0.7815	Acceptable
faf4	-0.3311	0.8904	0.1096	Unacceptable

Table 4.34 shows the rotated factor matrix with factor loadings. This table shows how the questions in section 3.5 were rearranged after EFA on section 3.5. Consequently, factor 1 has seven variables that load highly in it.

Table 4.35: Reliability coefficients for items in section 3.4 of the questionnaire

	All variables	**Factor 1**
	faf1, faf2, faf3, faf4	faf1, faf2, faf3
Average interitem covariance	0.8462524	0.8506516
Number of items in the scale:	4	3
Scale reliability coefficient:	**0.8905 (Acceptable)**	**0.9141 (Acceptable)**

From the table 4.35, the scale reliability coefficients for all variables and for factor 1 are all acceptable. In effect, factor 1 has been considered for further analysis.

4.4.7 Budget Factor

The output of EFA on section 3.6 of the questionnaire (Budget factor) is shown in table 4.36. The figure shows Eigenvalues and the percentage of variance exhibited by the factors.

Table 4.36: Eigenvalues of section 3.6 of the questionnaire

Factor	**Eigenvalue**	**Difference**	**Proportion**	**Cumulative**
Factor1	**2.53929**	**1.59656**	**0.5079**	**0.5079**
Factor2	0.94273	0.34921	0.1885	0.6964
Factor3	0.59352	0.11381	0.1187	0.8151
Factor4	0.47971	0.03497	0.0959	0.9111
Factor5	0.44475	.	0.0889	1

Table 4.36 shows one factor with Eigenvalues above 1. This factor is the basis for having one grouping within which all the other variables of section 3.6 load.

The Scree Plot for the Eigenvalues against number of components (variables) is shown in figure 4.7.

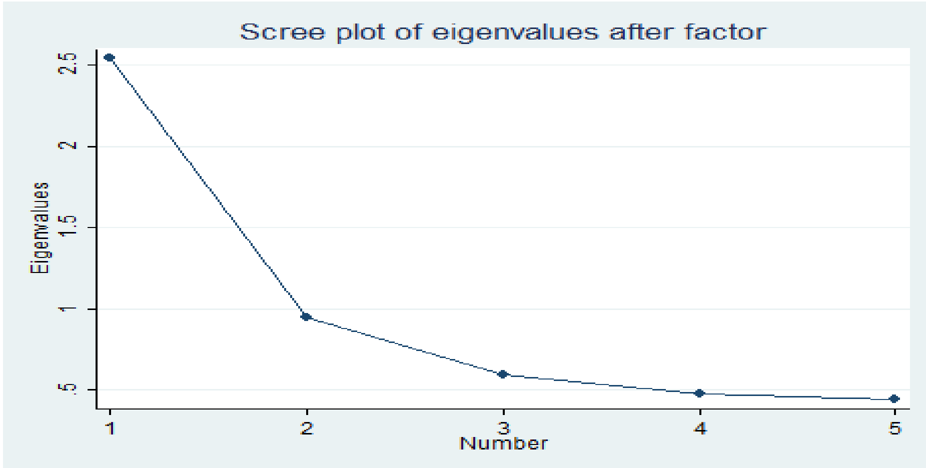

Figure 4. 7: Scree Plot of Eigenvalues against number of components

This Scree Plot shows that one variable declines very steeply implying that the one is sufficient to be considered to decide on the number of factors. Therefore, the one factor that was extracted is shown in table 4.37.

Table 4.37: Rotated factor loadings (pattern matrix) and unique variances sorted

Variable	**Factor1**	**Uniqueness**	**Communalities**	**Communalities**
bud4	0.7271	0.4713	0.5287	Acceptable
bud5	0.7239	0.4759	0.5241	Acceptable
bud1	0.7210	0.4802	0.5198	Acceptable
bud3	0.7120	0.4931	0.5069	Acceptable
bud2	0.6781	0.5402	0.4598	Acceptable

Table 4.37 shows the rotated factor matrix with factor loadings. This figure shows how the questions in section 3.6 were rearranged after EFA on section 3.6. Consequently, factor 1 has five variables that load highly in it.

Table 4.38: Reliability coefficients for items in section 3.6 of the questionnaire

	All variables	**Factor 1**
	bud1, bud2, bud3, bud4, bud5	bud1, bud2, bud3, bud4, bud5
Average interitem covariance	0.2042245	0.8506516
Number of items in the scale:	5	5
Scale reliability coefficient:	0.7524 (Acceptable)	0.9141 (Acceptable)

From the table 4.38, the scale reliability coefficients for all variables and for factor 1 are all acceptable. In effect, factor 1 has been considered for further analysis.

4.4.8. Leadership Factor

The output of EFA on section 3.7 of the questionnaire (Leadership factor) is shown in table 4.39. The table shows Eigenvalues and the percentage of variance exhibited by the factors.

Table 4.39: Eigen values of section 3.7 of the questionnaire

Factor	**Eigenvalue**	**Difference**	**Proportion**	**Cumulative**
Factor1	**1.84**	**1.02**	**0.46**	**0.46**
Factor2	0.82	0.12	0.21	0.67
Factor3	0.71	0.08	0.18	0.84
Factor4	0.63	.	0.16	1.00

Table 4.39 shows one factor with Eigenvalues above 1. This factor is the basis for having one grouping within which all the other variables of section 3.7 load.

The Scree Plot for the Eigenvalues against number of components (variables) is shown in figure 4.8

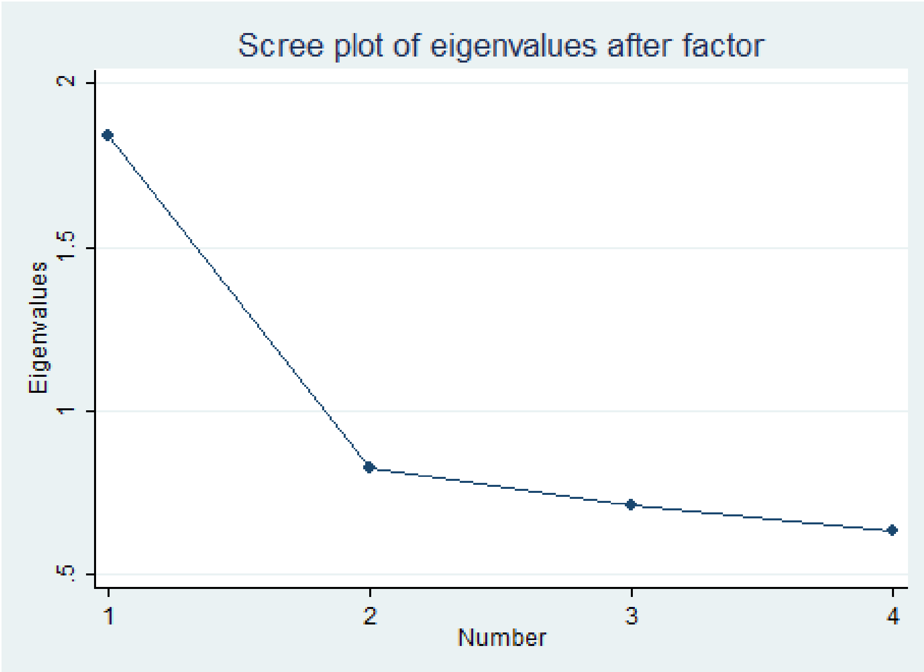

Figure 4. 8: Scree Plot of Eigenvalues against number of components

This Scree Plot shows that one variable declines very steeply implying that the one is sufficient to be considered to decide on the number of factors. Therefore, the one factor that was extracted is shown in table 4.40.

Table 4.40: Rotated factor loadings (pattern matrix) and unique variances sorted

Variable	Factor1	Uniqueness	Communalities	Comment
lea3	**0.7482**	0.4402	0.5598	Acceptable
lea2	**0.6918**	0.5214	0.4786	Acceptable
lea1	**0.6446**	0.5845	0.4155	Acceptable
lea4	*0.6203*	*0.6153*	*0.3847*	*Unacceptable*

Table 4.40 shows the rotated factor matrix with factor loadings. This figure shows how the questions in section 3.7 were rearranged after EFA on section 3.7. Consequently, factor 1 has three variables that load highly in it.

Table 4.41: Reliability coefficients for items in section 3.7 of the questionnaire

	All variables	**Factor 1**
	lea1, lea2, lea3, lea4	lea3, lea2, lea1
Average inter-item covariance	0.1520079	0.148702
Number of items in the scale:	4	3
Scale reliability coefficient:	**0.6 (Acceptable)**	**0.57 (Unacceptable)**

From the table 4.41, the scale reliability coefficients for all variables are acceptable but that for factor 1 is unacceptable. In effect, factor 1 has not been considered for further analysis.

4.4.9. Information Management Practices

The output of EFA on section 4 of the questionnaire (Information management practices) is shown in table 4.42. The figure shows Eigenvalues and the percentage of variance exhibited by the factors.

Table 4.42: Eigen values of section 3.8 of the questionnaire

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	**5.43**	**3.67**	**0.45**	**0.45**
Factor2	**1.76**	**0.90**	**0.15**	**0.60**
Factor3	0.86	0.17	0.07	0.67
Factor4	0.69	0.09	0.06	0.73
Factor5	0.60	0.04	0.05	0.78
Factor6	0.56	0.10	0.05	0.83
Factor7	0.46	0.04	0.04	0.86
Factor8	0.42	0.05	0.03	0.90
Factor9	0.37	0.01	0.03	0.93
Factor10	0.35	0.07	0.03	0.96
Factor11	0.28	0.07	0.02	0.98
Factor12	0.22	.	0.02	1.00

Table 4.42 shows two factors with Eigenvalues above 1. These factors are the basis for having two groupings within which all the other variables of section 3.8 load.

The Scree Plot for the Eigenvalues against number of components (variables) is shown in figure 4.9.

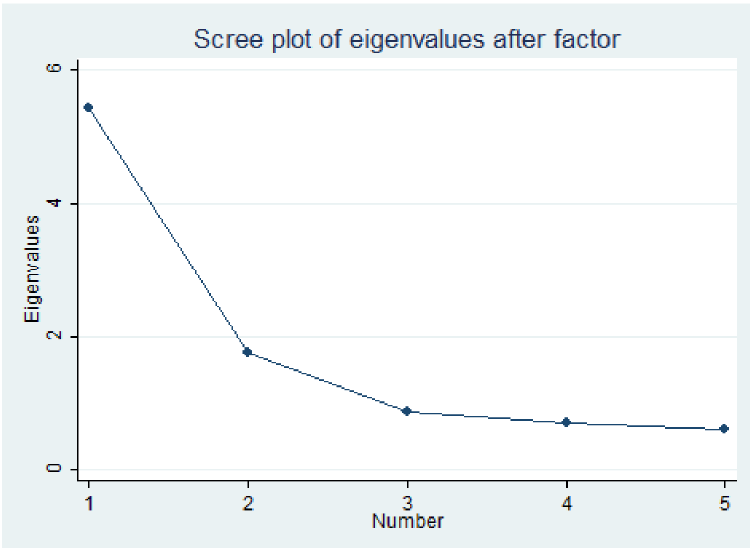

Figure 4. 9: Scree Plot of Eigenvalues against number of components

This Scree Plot shows that two variables decline very steeply implying that the two are sufficient to be considered to decide on the number of factors. Therefore, the two factors that were extracted are shown in table 4.43.

Table 4.43: Rotated factor loadings (pattern matrix) and unique variances sorted

Variable	Factor1	Factor2	Uniqueness	Communalities	Comment
imp5	**0.8136**	0.1147	0.3249	0.6751	Acceptable
imp1	**0.8093**	0.1148	0.3319	0.6681	Acceptable
imp7	**0.7395**	0.1367	0.4344	0.5656	Acceptable
imp2	**0.7230**	0.3792	0.3335	0.6665	Acceptable
imp4	**0.7050**	0.0676	0.4984	0.5016	Acceptable
imp6	**0.6881**	0.2542	0.4619	0.5381	Acceptable
imp11	**0.5967**	0.3707	0.5065	0.4935	Acceptable
imp12	0.1582	**0.8149**	0.3109	0.6891	Acceptable
imp10	0.0726	**0.7841**	0.3800	0.6200	Acceptable
imp8	0.2193	**0.7644**	0.3676	0.6324	Acceptable
imp9	0.1626	**0.7306**	0.4398	0.5602	Acceptable
imp3	0.5279	**0.5453**	0.4240	0.5760	Acceptable

Table 4.43 shows the rotated factor matrix with factor loadings. This figure shows how the questions in section 3.8 were rearranged after EFA on section 3.8. Consequently, factor 1 has seven variables that load highly in it while factor two has five.

Table 4.44: Reliability coefficients for items in section 3.8 of the questionnaire

	All variables	**Factor 1**	**Factor 2**
	imp1, imp2, imp3, imp4, imp5, imp6, imp7, imp8, imp9, imp10, imp11, imp12	imp5, imp1, imp7, imp2, imp4, imp6, imp11	imp12, imp10, imp8, imp9, imp3
Average interitem covariance	0.4767753	0.6641991	0.4822473
Number of items in the scale:	12	7	5
Scale reliability coefficient:	**0.8871 (Acceptable)**	**0.8713 (Acceptable)**	**0.8229 (Acceptable)**

From the table 4.44, the scale reliability coefficients for all variables and for factor 1 and factor 2 are acceptable. In effect, factor 1 and factor 2 have been considered for further analysis.

4.4.10. Information Use Outcomes

The output of EFA on section five of the questionnaire (Information use outcomes) is shown in table 4.45. The figure shows Eigenvalues and the percentage of variance exhibited by the factors.

Table 4.45: Eigenvalues of section 3.9 of the questionnaire

Factor	**Eigenvalue**	**Difference**	**Proportion**	**Cumulative**
Factor1	**2.61449**	**1.82641**	**0.5229**	**0.5229**
Factor2	0.78808	0.18494	0.1576	0.6805
Factor3	0.60314	0.05518	0.1206	0.8011
Factor4	0.54796	0.10162	0.1096	0.9107
Factor5	0.44633	.	0.0893	1.0000

Table 4.45 shows one factor with Eigenvalues above 1. This factor is the basis for having one grouping within which all the other variables of section 3.9 load.

The Scree Plot for the Eigenvalues against number of components (variables) is shown in figure 4.10

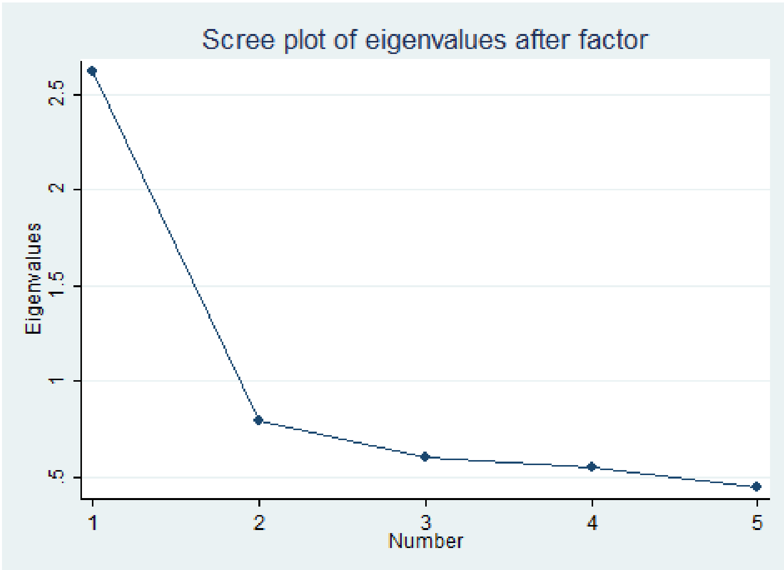

Figure 4. 10: Scree Plot of Eigenvalues against number of components

This Scree Plot shows that one variable declines very steeply implying that this one is sufficient to be considered to decide on the number of factors. Therefore, one factor that was extracted is shown in table 4.46.

Table 4.46: Rotated factor loadings (pattern matrix) and unique variances sorted

Variable	Factor1	Uniqueness	Communalities	Comment
iuo3	0.7804	0.3910	0.6090	*Acceptable*
iuo4	0.7776	0.3953	0.6047	*Acceptable*
iuo2	0.7508	0.4363	0.5637	*Acceptable*
iuo1	0.6496	0.5780	0.4220	*Acceptable*
iuo5	0.6442	0.5850	0.4150	*Acceptable*

Table 4.46 shows the rotated factor matrix with factor loadings. This figure shows how the questions in section 3.9 were rearranged after EFA on section 3.9. Consequently, factor 1 has five variables that load highly in it.

Table 4.47: Reliability coefficients for items in section 3.9 of the questionnaire

	All variables	**Factor 1**
	iuo1 iuo2 iuo3 iuo4 iuo5	iuo1 iuo2 iuo3 iuo4 iuo5
Average inter-item covariance	0.2093883	0.2093883
Number of items in the scale:	5	5
Scale reliability coefficient:	**0.7651 (Acceptable)**	**0.7651 (Acceptable)**

From the table 4.47, the scale reliability coefficients for all variables and for factor 1 are acceptable. In effect factor 1 has been considered for further analysis.

4.5 Exploratory Factor Analysis of the Derived Constructs

In order to find the final constructs, EFA was performed on the sub-constructs that were obtained after EFA of the sections of the questionnaire. A summary of the factors or constructs that were obtained after EFA of each section of the questionnaire is given in table 4.39.

Table 4.48: All the derived factors from the questionnaire sections

FACTOR	**NEW NAME**	**QUESTIONS**	**RELIA BI-LITY**	**COMMENT**	**SUGGESTED NAME FOR THE SUB-FACTOR**
Factor 1	sf1	rce5 rce4 rce3 rce8	0.825	Acceptable	Access and use of computers and Internet
Factor 2	sf2	rce1 rce2 rce6	0.658	Acceptable	Access to electricity, phones and training
Factor 3	***sf3***	***rce9 rce7***	***0.548***	***Unacceptable***	
Factor 4	sf4	pes2 pes3 pes1	0.673	Acceptable	Creativity and interpersonal skills
Factor 5	***sf5***	***pecu2 pecu1 peco3***	***0.563***	***Unacceptable***	
Factor 6	***sf6***	***peco2 peco1***	***0.334***	***Unacceptable***	
Factor 7	sf7	tes2 tei1 tec2 tet1 tec3	0.794	Acceptable	Technology design based on requirements
Factor 8	sf8	tec5 tec4 tec6	0.710	Acceptable	Technology tested with the users
Factor 9	sf9	pap3 pap4 pap2 pap5 pap1 pap8	0.798	Acceptable	Proper handling of Info. Mgt. constituent processes
Factor 10	sf10	pol4 pol3 pol5 pol6 pol2 pol1	0.834	Acceptable	Realistic and useful rules and regulations
Factor 11	sf11	faf1 faf2 faf3	0.914	Acceptable	Availability of finance and high-quality facilities
Factor 12	sf12	bud1 bud2 bud3 bud4 bud5	0.752	Acceptable	A good budget

Factor 13	***sf13***	***lea3 lea2 lea1***	***0.570***	***Unacceptable***	
Factor 14	sf14	imp5 imp1 imp7 imp2 imp4 imp6 imp11	0.871	Acceptable	Having proper information management practices
Factor 15	sf15	imp12 imp10 imp8 imp9 imp3	0.823	Acceptable	Proper information sharing and continuity
Factor 16	sf16	iuo1 iuo2 iuo3 iuo4 iuo5	0.765	Acceptable	Proper information use outcomes

The factors with comment as Unacceptable are to be discarded on the basis of their values for reliability. Consequently, twelve (12) factors are eligible for further analysis. These are from now on going to be referred to as sub-factors (sf). Suggested derived names of the reliable sub-factors are shown in the last column of table 4.48.

An EFA was further done on the twelve (12) reliable sub-factors and the results of that analysis are shown in table 4.49.

Table 4.49: Eigenvalues of the twelve sub factors

Factor	**Eigenvalue**	**Difference**	**Proportion**	**Cumulative**
Factor1	**3.37352**	**1.50524**	**0.2811**	**0.2811**
Factor2	**1.86828**	**0.74259**	**0.1557**	**0.4368**
Factor3	**1.12568**	**0.21185**	**0.0938**	**0.5306**
Factor4	0.91384	0.10629	0.0762	0.6068
Factor5	0.80754	0.06229	0.0673	0.6741
Factor6	0.74525	0.07058	0.0621	0.7362
Factor7	0.67468	0.08273	0.0562	0.7924
Factor8	0.59195	0.01279	0.0493	0.8417
Factor9	0.57917	0.08386	0.0483	0.89
Factor10	0.4953	0.05463	0.0413	0.9313
Factor11	0.44067	0.05654	0.0367	0.968
Factor12	0.38413	.	0.032	1

Table 4.49 shows three factors with Eigenvalues above 1. These factors are the basis for having three groupings within which all the other sub factors load.

The Scree Plot for the Eigenvalues against number of components /sub factors (variables) is shown in figure 4.10.

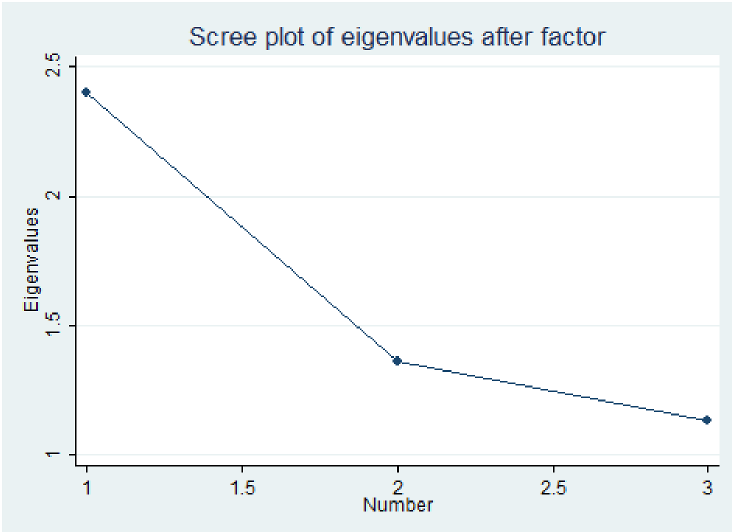

Figure 4. 11: Scree plot of Eigenvalues against number of components

This Scree Plot shows that three variables or sub factors decline very steeply implying that these three are sufficient to be considered to decide on the number of factors. Therefore, three factors that were extracted are shown in table 4.50.

Table 4.50: Rotated factor loadings (pattern matrix) and unique variances sorted

Variable	Factor1	Factor2	Factor3	Uniqueness	Communalities
sf2	**0.7491**	0.0364	0.1826	0.4041	0.5959
sf1	**0.7303**	-0.0657	0.1047	0.4514	0.5486
sf14	**0.6508**	-0.1057	0.4136	0.3942	0.6058
sf8	**0.5749**	0.385	-0.097	0.5118	0.4882
sf7	**0.5352**	0.4952	0.0343	0.4671	0.5329
sf4	**0.4033**	0.3138	0.2829	0.6588	0.3412
sf10	-0.0554	**0.7296**	0.067	0.4602	0.5398
sf12	0.1753	**0.6315**	0.0991	0.5607	0.4393
sf11	-0.3064	**0.6205**	-0.015	0.5208	0.4792
sf9	0.2732	**0.5855**	0.1037	0.5718	0.4282
sf15	0.17	-0.0711	**0.8442**	0.2534	0.7466
sf16	0.0486	0.3141	**0.7217**	0.3781	0.6219

Table 4.50 shows the rotated factor matrix with factor loadings. This figure shows how the sub factors were rearranged after EFA. Consequently, mega factor 1 has six sub factors that load

highly in it while mega factor two has four sub factors that load highly in it and lastly mega factor 3 has two sub factors that load highly in it.

Table 4.51: Reliability coefficients for items in section 3.9 of the questionnaire

	All variables	Mega Factor 1	Mega Factor 2	Mega Factor 3
	sf1, sf2, sf4, sf7, sf8, sf9, sf10, sf11, sf12, sf14, sf15, sf16	sf2, sf1, sf14, sf8, sf7, sf4	Sf10, sf12, sf11, sf9	sf15, sf16
Average inter-item covariance	0.1099562	0.2647129	0.1275948	0.1744044
Number of items in the scale:	12	6	4	2
Scale reliability coefficient:	**0.7189 (Acceptable)**	**0.703 (Acceptable)**	**0.5764 (Un-Acceptable)**	**0.5102 (Un-Acceptable)**

From the table 4.51, the scale reliability coefficients for all variables and for mega factor 1 are acceptable while the scale reliability coefficients for mega factors 2 and 3 are slightly low but above 0.5. These factors were considered. What we have been referring to as mega factors are from this point on going to be called critical success factors (CSFs)

4.6. The CSFs for Information Management in E-agriculture

The table shows the CSFs (1, 2 and 3) and their constituent sub-factors and the sub-factors' constituent variables as they appear in the questionnaire. These CSFs influence information management by small-scale farmers engaged in e-agriculture in Uganda.

Table 4.52: The three mega factors derived from field study analysis

	NEW NAME	QUESTIONS	NAMES FOR INIVIDUAL VARIABLES	SUGGESTED NAME FOR THE SUB-FACTOR
CSF 1	**SF1**	rce5	Use of computerized tools	**ACCESS AND USE OF COMPUTERS AND INTERNET**
		rce4	Owning computers	
		rce3	Use of computers	
		rce8	Access to Internet	
	SF2	rce1	Access to electricity	**ACCESS TO ELECTRICITY, PHONES AND TRAINING**
		rce2	Owning phones	
		rce6	Knowledge to use IM tools	
	SF4	pes2	Interpersonal skills	**CREATIVITY AND INTERPERSONAL SKILLS**
		pes3	Communication skills	
		pes1	Economic status	
	SF8	tec5	Easy to use information systems	**TECHNOLOGY TESTED**

		tec4	I.S tested with the users	**WITH THE USERS**
		tec6	Users involvement in I.S. development	
	SF14	imp5	Information organization to ease access	**HAVING PROPER IM PRACTICES**
		imp1	A strategy to manage information	
		imp7	ICT use to ease information sharing	
		imp2	Procedures to collect information	
		imp4	Get information from external sources	
		imp6	Easy information finding	
		imp11	Monitoring and apprenticeship	
	SF7	tes2	Technology suitable for I.M.	**TECHNOLOGY DESIGNED BASED ON REQUIREMENTS**
		tei1	Technology design structure	
		tec2	I.S. suitable for users	
		tet1	Availability of technology	
		tec3	Develop systems based on user requirements	
CSF2	**SF10**	pol4	Understandable rules and regulations	**REALISTIC AND USEFUL RULES AND REGULATIONS**
		pol3	Useful rules and regulations	
		pol5	User involvement in making rules and regulations	
		pol6	Make rules and regulations known	
		pol2	Relevant rules and regulations	
		pol1	Easy to comply with rules and regulations	
	SF12	bud1	Realistic budget	**BUDGET**
		bud2	Easy to finance budget	
		bud3	A budget made by involving users	
		bud4	Thorough budget	
		bud5	Management supported budget	
	SF11	faf1	Availability of money	**FINANCE AND HIGH-QUALITY FACILITIES**
		faf2	Availability of IM facilities	
		faf3	High quality IM facilities	
	SF9	pap3	Organization	**PROPER HANDLING OF IM CONSTITUENT PROCESSES**
		pap4	Maintenance	
		pap2	Acquisition	
		pap5	Storage	
		pap1	Generation	
		pap8	Retrieval	
C	**SF15**	imp12	Promotion of information sharing	**PROPER INFORMATION**

S F 3		imp10	Training and/or education courses	**SHARING AND CONTINUITY**
		imp8	Promote knowledge and information sharing	
		imp9	Mentoring/ Apprenticeship	
		imp3	Information sharing procedures	
	SF16	iuo1	Use information to solve problems	**PROPER INFORMATION USE OUTCOMES**
		iuo2	Creativity	
		iuo3	Increased user productivity	
		iuo4	User value addition	
		iuo5	Value information sharing	

Table 4.52 shows that there are three CSFs that influence management of agricultural advisory information in e-agriculture in Uganda and these are:

(i) CSF 1: People and Technology

(ii) CSF 2: Processes, Funding and Regulations

(iii) CSF 3: Information Use Outcomes and Continuity

Each of these three CSFs is elaborated upon in the subsequent sections of this thesis.

4.6.1. Critical Success Factor 1: People and Technology

The information management framework in figure 4.13 depicts in CSF 1 that people and technology are key elements in small scale farmers' information management practices. People are the hinge on which technology rotates, they are the determinants of what technology should be employed for information management in e-agriculture.

In SF8, for example, it is indicated clearly by the information management framework in figure 4.13 that technology should be tested with the users (people) because they are the users of that technology and the technology is intended for them. SF8 stresses this point further by enforcing that technology should be easy to use for the users, tested with the users and that users should be involved in developing this technology meaning that users should be consulted. SF7 suggests that technology should be designed based on user requirements, tested with the users and should be suitable for users' information management practices. This means that technology should be useful and used by the users mainly small-scale farmers in e-agriculture.

In the same way, CSF 1 in SF4 stresses that people should be creative and with interpersonal skills like communication skills. Their economic status should also be put into consideration. When people have good economic status, then they can afford technology for their information management practices. SF14 echoes the need for the people to have proper information management practices like information organization, well laid down strategies for managing information, sound procedures for information collection, good mechanisms for obtaining information from external sources, proper means of finding information easily, plus proper monitoring and apprenticeship.

SF1 focuses on access and use of computers and Internet (as technologies). This sub factor stresses the need to own thee ICTs and having access to the Internet. These facts are in line with the idea of good economic status as indicated in SF4 in the same CSF 1. These ideas rhyme with what is indicated in SF2 (access to electricity, phones and training). In the same sub factor 2 (SF2) emphasis is put on knowledge to use these technologies. This knowledge can be obtained through training the people/users to use these technologies for better information management practices.

4.6.2 Critical Success Factor 2: Processes, Funding and Regulations

Table 4.52 depicts processes, funding and regulations as other key elements in small-scale farmers' information management in e-agriculture. Under this CSF 2 are found four sub factors, that is, SF10, SF12, SF11 and SF9 as shown in table 4.52.

Funding is an important element in information management since it drives other elements and activities that small-scale farmers engage in relating to information management. These funds are used and planned based on a budget with attributes like easy to finance, realistic, involving users in making the budget, thorough and management supported or supportable by funders. These elements are shown in SF12 in table 4.52.

SF11 points to the fact that there is need for money (finance) that can be used, based on a realistic budget, to procure high quality facilities that support information management practices and tasks.

SF10 emphasizes the need for realistic and useful rules and regulations. These rules should be understandable, useful, put in place or composed by involving users, known, relevant and easy to comply with.

SF9 echoes the need for proper handling of information management constituent processes like information organization, maintenance, acquisition, storage, generation and retrieval. All these processes need to be executed based on stipulated rules and regulations and enabled by funds obtained and used based on a stipulated budget. This makes CSF 2 a significant element in the information management framework since it highlights pertinent issues in small-scale farmers' information management practices.

4.6.3 Critical Success Factor 3: Information Use Outcomes and Continuity

CSF 3 (information use outcomes and continuity) contains two separate but related subfactors (SF15 and SF16). SF15 is about proper information sharing and continuity. Information management contains sharing of information and ensuring that good information management practices are passed on to the next generation. This involves promotion of information sharing, training and/or providing education courses, promoting knowledge and information sharing, mentorship/apprenticeship and following good information sharing procedures.

SF12 concerns with proper information use outcomes. This involves use of information to solve problems that small-scale farmers face. In this regard, information is seen as a tool that people use to empower themselves to address daily challenges and problems that they face. This requires creativity or thinking outside the box in order to apply information obtained in different contexts and to adjust that information in order to suite a given context that a given user faces in his/her daily life as a small-scale farmer in e-agriculture. This increases a farmer's productivity and makes the farmer have added value and competent to handle information management situations as they present themselves. In the same way, information sharing is the mechanism that enables this farmer to be empowered with information and to apply this information in new circumstances and thus information sharing is taken as a crucial process.

4.7 Summary

This chapter has elaborated on the results of the field study. Data from field study was analyzed following EFA using STATA. As a deliverable, from the EFA of different sections of the questionnaire, 12 sub factors were obtained, analysis of which produced three critical success factors: 1. People and Technology, 2. Processes, funding and regulations, 3. Information use outcomes and continuity.

CHAPTER FIVE

A FRAMEWORK FOR INFORMATION MANAGEMENT IN E-AGRICULTURE

5.1. Introduction

The preceding chapter explained in detail the exploratory factor analysis of data obtained from the field study. The final deliverable of this analysis was the three CSFs that influence agricultural advisory information management in e-agriculture in Uganda. All that was done to achieve the first objective of this study. In this chapter, we address the second objective of this study: *To design a framework that can support management of agricultural advisory information in e-agriculture in Uganda.* We provide an explanation of how these CSFs influence each other, thus deriving the framework for managing agricultural advisory information in e-agriculture in Uganda. Structural equation modeling was used with path analysis to obtain the structural model that provides the strength of how these CSFs influence each other and thus the resultant information management framework was derived. Section 5.2 explains the process of deriving the information management framework. This involves an explanation of the contribution of theory to the framework (section 5.2.1) and contribution of field study to the framework (section 5.2.2). Section 5.2.3 details the outline of the information management framework, section 5.2.4 outlines the relationship between framework components and section 5.3 explains the structural equation modelling (SEM) made to establish how the field data supports the earlier conceptualized model. Section 5.3.1. details the confirming or refuting of the hypotheses, section 5.4 explains model reliability and lastly section 5.5. presents the chapter summary.

5.2. A Framework for Supporting Management of Agricultural Advisory Information

This section explains the process of deriving the framework for supporting management of agricultural advisory information (FMAAI) in e-agriculture in Uganda. The framework at the highest level of abstraction is composed of three critical success factors: 1. People and Technology 2. Processes, Funding and Regulations and 3. Information use outcomes and continuity. A close inspection of these three CSFs is done in order to extract the factors that theory contributes to this framework as well as the factors that field study contributes to the framework. These components extracted are mirrored to the components that appear in the conceptual framework in chapter two section 2.9. This section is organized as follows: An explanation of the contribution from theory to the framework (section 5.2.1) and contribution from field study to the framework (section 5.2.2). Section 5.2.3 details the outline of the information management framework and section 5.2.4 outlines the relationship between framework components.

5.2.1 Contribution from Theory to the Framework

Nguyen et al. (2014) was the foundational framework on which the conceptual framework of this study was based. The elements from theory to the framework are:

People Factor

People element is a factor (CSF) in the framework that is encompassed in the People and Technology critical success factor (CSF 1). The people element was suggested by other authors as a significant element in the information management framework (Nguyen *et al.,* 2014; McKeen and Smith, 2007). People are responsible for managing the information management processes like storage, usage, acquisition and dissemination. They are responsible for ensuring that information is timely, accurate, valid and complete (Nguyen *et al.*, 2014).

FMAAI stresses the element of creativity and interpersonal skills (see Critical Success Factor (CSF) 1 sub factor 4). Creativity is necessary in managing the information management processes as highlighted by Nguyen et al. (2014). So, Nguyen et al. (2014) recognizes that people should carry out the information management tasks just as the framework suggests in CSF 1 sub factor 14 and then the framework adds that these should be carried out creatively (see sub factor 4).

The framework highlights, under sub factor 4, that communication skills are key in information management. This is a specific skill that can be put under what Johnson *et al.,* (2015) bundles into information skills. While authors like Nguyen *et al.,* 2014 mention context as an important element of people in information management, the framework particularizes it to economic status (See CSF 1 sub factor 4). This can be explainable by understanding the context of the framework, that is, resource constrained environments in e-agriculture in Uganda.

Technology Factor

The framework fronts the element of technology as very significant factor in agricultural advisory information management by small scale farmers engage in e-agriculture in Uganda (See CSF 1, sub factors 2,1,8 and 7). Technology has been considered as part of information management frameworks suggested by Rowley, (1998); Middleton, (2007) and Nguyen et al. (2014). Although in many of the frameworks information systems are presented instead of technology, information systems are the technology for handling information. The framework does not stop at highlighting the preeminence of technology in information management frameworks but goes ahead to specify what kind of technology.

Processes and Practices Factor

Processes and Practices factor is part of the Processes, Funding and Regulations critical success factor (CSF 2). The element of processes and Practices as part of the framework is in line with authors like Nguyen et al. (2014) and Deasy *et al.,* (2016) that assert that processes and practices form a significant part of an information management framework.

Information Use Outcomes

Proper information use outcomes (Use information to solve problems, creativity, increased user productivity, user value addition and value information sharing). Information Use Outcomes is a factor under the Information Use Outcomes and Continuity critical success factor (CSF 3) in the framework. This factor was also highlighted and documented in Choo *et al.,* (2006) as significant in information management. Choo *et al.,* (2006) highlights variables under that factor which are related to the variables suggested by this framework under information Use Outcomes and Continuity.

Information Sharing and Continuity

The framework highlights the following variables: Proper information sharing and continuity (promotion of information sharing, training and/or education courses, promotion of knowledge and information sharing, mentoring apprenticeship, information sharing procedures). Choo *et al.,* (2006) however highlight the following variables under information use outcomes and continuity: Recognition of complexities in a situation and finding a solution, one's work benefiting an organization, having influence over what happens in an organization and sharing information). In this case, information sharing is what this framework has borrowed from Choo *et al.*, (2006).

5.2.2 Contribution from Field Study to the Framework

The framework as it appears in figure 5.1 contains factors or/and sub factors that have not been borrowed from literature (elements that are not similar to those that existing literature proposes). These novel factors are the contribution to knowledge from this research and they are outlined in the following paragraphs.

Budget

Budget or funding as shown under CSF 2, (SF12) of the framework is a critical factor that influences extension information management by small scale farmers engaged in e-agriculture in Uganda. Budget or Funding explains that there is need for realistic budget, easy to finance budget, a budget made by involving users, a thorough budget and a management supported budget.

Rules and Regulations

Realistic and useful rules and regulations (SF10) found under CSF 2 is an essential factor in agricultural advisory information management by small-scale farmers engaged in e-agriculture in Uganda. Under this factor this study found out that these rules and regulations should be understandable, useful, a result of user involvement in making them, made known, relevant and easy to comply with.

Facilities and Facilitation

Facilities and facilitation presented as finance and high-quality facilities (SF11) under CSF 2 is an important factor in determining agricultural advisory information management by small scale farmers engaged in e-agriculture in Uganda. This factor stresses the need for availability of money, availability of information management facilities and high-quality information management facilities.

Leadership is a factor in the conceptual framework in section 2.9 that did not make it to the final framework.

5.2.3. Outline of the Information Management Framework

The information management framework by Nguyen et al. (2014) was the basis for the conceptual framework that guided this study. In addition to Nguyen et al. (2014), additional components of the framework were proposed by the researcher. Both components (suggested by Nguyen et al. (2014) plus those that were added by the researcher) were taken to the field for verification since these were the pillars on which the questionnaire was based. Since Nguyen et al. (2014)'s framework was not directly developed to support agricultural advisory information management by small scale farmers, the wording of some of the questions that were based on this framework was adjusted to suite the context of agricultural advisory information management by small scale farmers. Data obtained from the field was analyzed to stablish if the conceptual framework applies or is relevant in the context of agricultural advisory information management.

The framework that resulted from EFA of data obtained from the field contains three CSF factors and these are shown diagrammatically in figure 5.1.

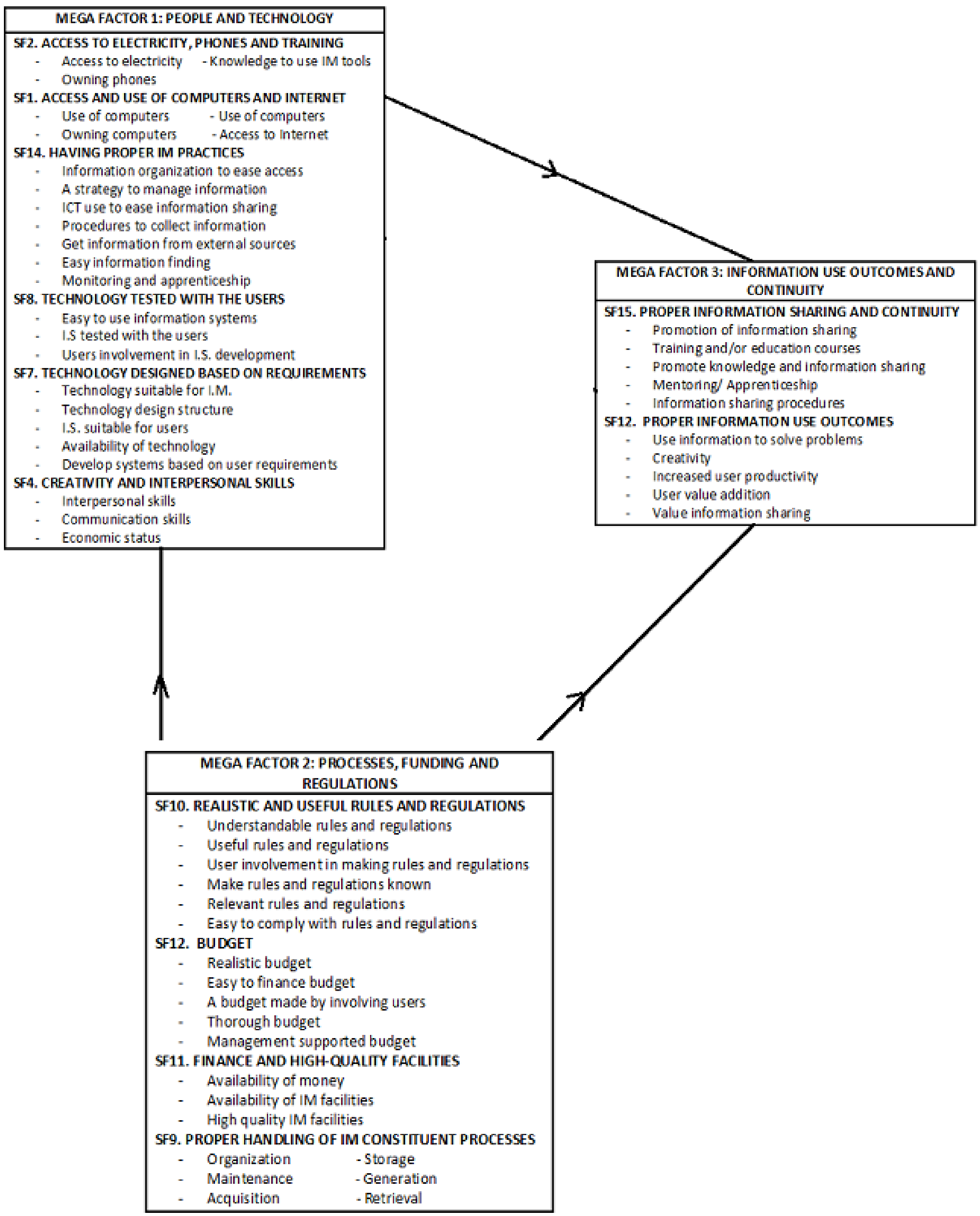

Figure 5.1: Diagrammatic representation of the three CSFs

The framework shown in figure 5.1 shows the three CSFs that support management of agricultural advisory information in e-agriculture in Uganda. Each of those CSFs is elaborated upon below:

Critical Success Factor one: People and Technology

This factor contains six sub factors namely SF2 (Access to electricity, phones and training), SF1 (Access and use of computers and Internet), SF14 (Having proper information management practices), SF8 (technology tested with the users), SF7 (Technology designed based on requirements), SF4 (Creativity and interpersonal skills). Each of those sub factors are composed of constituent variables as shown in Figure 5.1.

Critical Success Factor Two: Processes, Funding and Regulations

This factor contains four sub factors namely SF10 (Realistic and useful rules and regulations), SF12 (Budget), SF11 (Finance and high-quality facilities), SF9 (Proper handling information management constituent processes). Each of those sub factors are composed of constituent variables as shown in Figure 5.1.

Critical Success Factor Three: Information Use Outcomes and Continuity

This factor contains two sub factors namely SF15 (Proper Information Sharing and Continuity) and SF16 (Proper Information Use Outcomes). Each of those sub factors are composed of constituent variables as shown in figure 5.1.

5.2.4. Relationship Between Framework Components

The scale reliability coefficient for all the three main constructs (CSFs) is acceptable (0.7189) meaning that the sub factors (sf1, sf2, sf4, sf7, sf8, sf9, sf10, sf11, sf12, sf14, sf15, sf16) as seen in Table 4.42 are reliable. The scale reliability coefficient for sub factors that load highly under CSF 1 (sf2, sf1, sf14, sf8, sf4) is 0.703 indicating a high value that is acceptable. Although the scale reliability coefficient of sub factors that load highly under CSF 2 (sf10, sf12, sf11 and sf9) is slightly low (0.5764) this is sufficient for this CSF to be considered under this research. In the same way, the scale reliability coefficient of sub factors that load highly under CSF 3 (sf15 and sf16) is slightly low (0.5102) but was considered for this research. Therefore, the three CSFs (CSF

1, CSF 2 and CSF 3) formed the framework arising from quantitative data analysis. This framework is elaborated upon in the subsequent section of this research.

The coefficient of determination of CSF 1 on CSF 3 is 0.63 (63%) while the coefficient of determination of CSF 2 on CSF 3 is 0.34 (34%) and the coefficient of determination of CSF 2 on CSF 3 is 1.2 (120%). This means that CSF 1 influences CSF 3 by 0.63 (63%), CSF 2 influences CSF 3 by 0.34 (34%), CSF 2 influences CSF 1 by 1.2 (120%). These values were obtained by conducting structural equation modeling with path analysis. The structural equation model is shown in the next section of this thesis.

5.3. Structural Equation Model

The structural equation model that shows how the different critical success factors of the framework influence one another is shown in figure 5.2

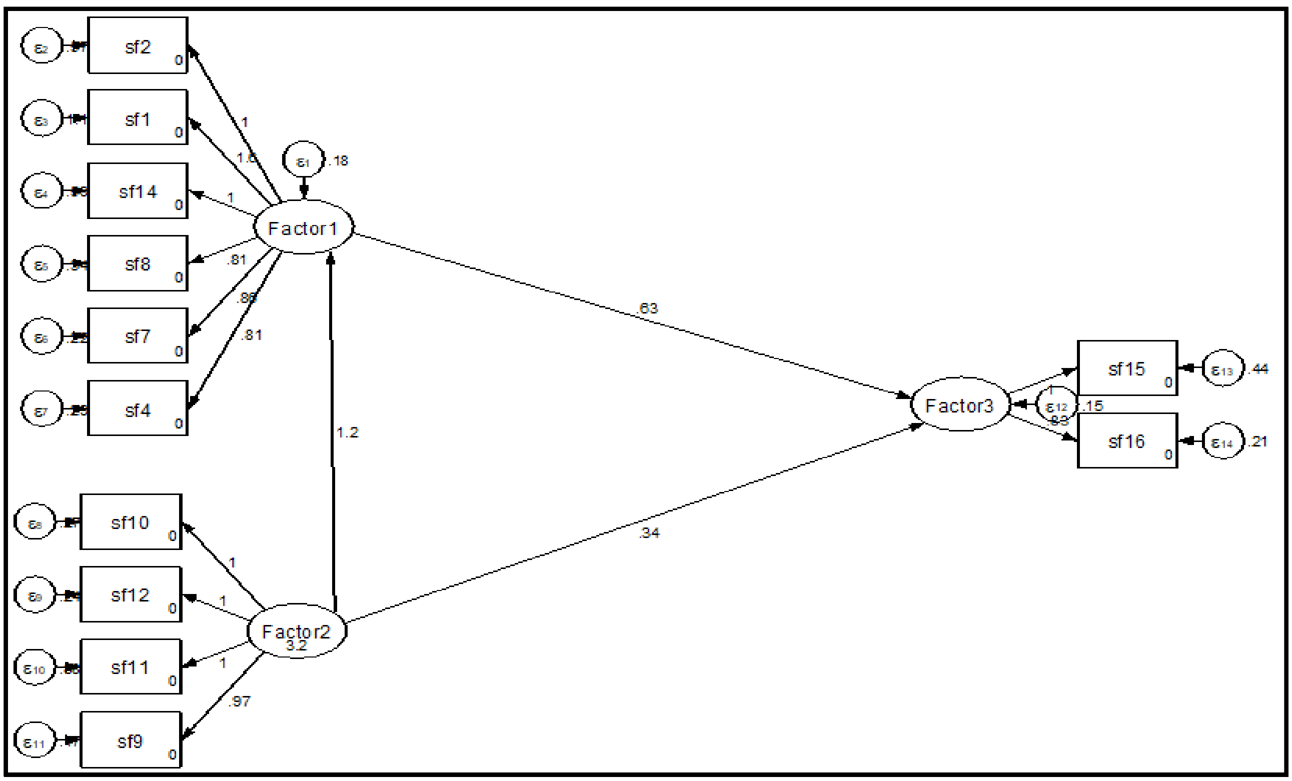

Figure 5.2: The structural equation model for FMAAI

This structural equation model as shown in figure 5.2 was obtained through structural equation modeling (SEM) using path analysis. The number on lines show the r^2 (coefficient of determination) between the CSFs and between the CSF and the related sub factors. The coefficient of determination between CSF 1 and CSF 3 which is 0.63 (63%) shows the contribution of CSF 1 to CSF 2. This means that CSF 1 contributes 0.63 (63%) to CSF 3.

The coefficient of determination between CSF 2 and CSF 3, which is 0.34 (34%), shows the contribution of CSF 2 to CSF 3. This means that CSF 2 contributes 0.34 (34%) to CSF 3.

The coefficient of determination between CSF 2 and CSF 1, which is 1.2 (120%), shows the contribution of CSF 2 to CSF 1. This means that CSF 2 contributes 1.2 (120%) to CSF 1. This is a very big contribution exceeding 100%.

Adding the contributions of CSF 1 to CSF 3 (63%) to the contribution of CSF 2 to CSF 3 (34%) yields a total contribution of 97%. This contribution is so high implying that the contribution of CSF 1 and CSF 2 is almost filling the 100% leaving the other factors plus the standard error with only 3%. The influence of each mega factor over the other was represented in form of an equation based on Klobner, (2019).

Included below is the structural equation model.

$$\eta = \alpha_\eta + \mathsf{B}\,\eta + \Gamma\,\xi + \zeta$$

Where:

The m (latent) endogenous variables η

The n (latent) exogenous variables ξ

The m-dimension error term ζ

The intercept term α_η

The fixed, but unknown quantities (model parameters) B and Γ

Since means were not considered in our analysis (given that these means had no meaning in this context), the α_η is left out in the SEM equation. By substituting the values on the SEM into the SEM equation, we obtain

$$\eta = \alpha_\eta + B\eta + \Gamma\xi + \zeta$$

$$= \quad 0 \quad + \quad 63\% \quad + \quad 34\% \quad + \quad \zeta$$

Giving the error term as 100 – 97 which is 3%

This means that the latent factors (CSF 1 and 2) have a very significant influence on latent factor 3 (CSF 3). CSF 1 and 2 have a 97% influence on mega factor 3 with the error term accounting for only 3% influence.

The structural equation model that is shown in figure 5.2 has been presented in figure 5.3 in form of an information management framework.

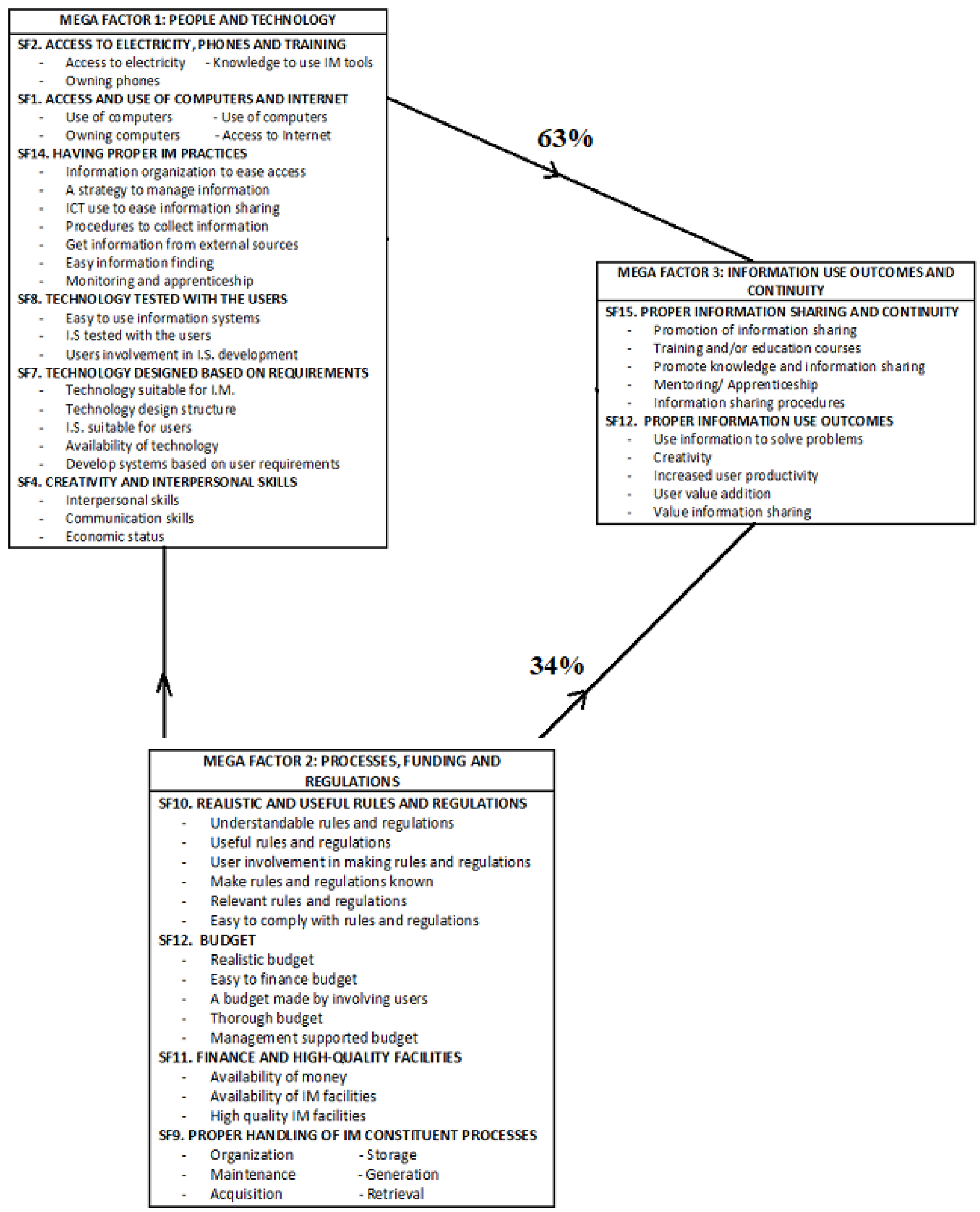

Figure 5.3: The framework with the strength of influence

Since the coefficient of determination between the three CSFs is strong (see figure 5.2), this implies that all the variables and sub factors that constitute the three CSFs are very important and must be considered during information management by small scale farmers in e-agriculture (See figure 5.3).

5.3.1 Confirming or Refuting the Hypotheses

By referring to the conceptual framework presented in figure 2.9, the following assertions are made in line with the hypotheses made:

Technology is a major factor that influences management of agricultural advisory information in e-agriculture (**H1**). Technology's influence is engrossed in the CSF 1 as shown in figure 5.3. This means that technology shares in the influence of the CSF 1 (people and technology) on CSF 3 (Information use outcomes and continuity). The influence of technology can be deduced from sub factor 8 (technology tested with the users and sub factor 7 (technology designed based on requirements)) (see CSF 1 in figure 5.3). The influence is positive meaning that the more technology attributes mentioned in sub factor 8 and sub factor 7, the more the information use outcomes and continuity. Meaning that the more technology (used in information management) is tested with the users and the more technology (used in information management) is designed based on user requirements, the more or better management of agricultural advisory information in e-agriculture in Uganda.

Processes and practices are a major factor that influences management of agricultural advisory information in e-agriculture in Uganda (**H2**). The influence of processes and practices is engrossed in the CSF 2 as shown in Figure 5.3. This means that processes and practices share in the influence of the CSF 2 (Processes, funding and regulations) on CSF 3 (Information use outcomes and continuity). The influence of processes and practices can be deduced from sub factor 9 (proper handling of information management (IM) constituent processes) (see CSF 2 in Figure 5.3). The influence is positive meaning that the more attributes mentioned in sub factor 9, the more the information use outcomes and continuity. Meaning that the more or the better information management (IM) constituent processes are handled (see these processes in SF9) the more or better the management of agricultural advisory information by small-scale farmers in e-agriculture is.

People is a major factor that influences management of agricultural advisory information in e-agriculture (**H3**). People's influence is engrossed in the mega latent factor 1 as shown in Figure 5.3. This means that people element shares in the influence of the CSF 1 (people and technology) on CSF 3 (Information use outcomes and continuity). The influence of people can be deduced from sub factor 4 (creativity and interpersonal skills), sub factor 2 (access to electricity, phones and training) and sub factor 1 (Access and use of computers and Internet) (see CSF 1 in figure 5.3). The influence is positive meaning that the more people related attributes mentioned in sub factor 4, sub factor 2 and sub factor 1, the more the information use outcomes and continuity. Meaning that the more people attributes (like interpersonal skills, communication skills, economic status, knowledge to use information management tools) are improved, the more or better management of agricultural advisory information by small-scale farmers in e-agriculture is.

Rules and regulations are a major factor that influences management of agricultural advisory information in e-agriculture (**H4**). Rules and Regulations' influence is engrossed in the CSF 2 as shown in Figure 5.3. This means that the rules and regulations element share in the influence of the CSF 2 (Processes, funding and regulations) on CSF 3 (Information use outcomes and continuity). The influence of rules and regulations can be deduced from sub factor 10 (Realistic and useful rules and regulations) (see CSF 2 in figure 5.3). The influence is positive meaning that the more the attributes of rules and regulations mentioned in sub factor 10, the more the information use outcomes and continuity. Meaning that the more the rules and regulations attributes (like understandability, usefulness, user involvement in making these rules and regulations, relevant rules and regulations), the more or better the management of agricultural advisory information by small scale farmers in e-agriculture is.

Leadership is a major factor that influences management of agricultural advisory information in e-agriculture (**H5**). This assertion is not provided with evidence from the field study findings. Therefore, in the context of agricultural advisory information management by small scale farmers in e-agriculture, leadership is not a significant factor. It should be noted that not being a significant factor in the context of agricultural advisory information management by small-scale farmers in e-agriculture does not necessarily mean that leadership is not a factor *per se* in all contexts.

Budget is a major factor that influences management of agricultural advisory information in e-agriculture (**H6**). The influence of budget is engrossed in the CSF 2 as shown in Figure 5.3. This means that budget shares in the influence of the CSF 2 (Processes, funding and regulations) on CSF 3 (Information use outcomes and continuity). The influence of budget can be deduced from sub factor 12 (Budget) (see CSF 2 in Figure 5.3). The influence is positive meaning that the more attributes mentioned in sub factor 12, the more the information use outcomes and continuity. Meaning that the more or the better the budget is (Budget SF12), that is the better the budget attributes like realistic, easy to finance, involvement of users in creating the budget, thorough and management support for the budget, the more or better the management of agricultural advisory information by small scale farmers in e-agriculture is.

Facilities and facilitation are a major factor that influences management of agricultural advisory information in e-agriculture (**H7**). The influence of facilities and facilitation is engrossed in the CSF 2 as shown in Figure 5.3. This means that the Facilities and facilitation element shares in the influence of the CSF 2 (Processes, funding and regulations) on CSF 3 (Information use outcomes and continuity). The influence of facilities and facilitation can be deduced from sub factor 11 (Finance and high-quality facilities) (see CSF 2 in Figure 5.3). The influence is positive meaning that the more the attributes of facilities and facilitation mentioned in sub factor 11, the more the information use outcomes and continuity. Meaning that the more the facilities and facilitation attributes (like availability of money, availability of information management facilities, and quality of IM facilities), the more or better the management of agricultural advisory information by small scale farmers in e-agriculture is.

Information in the preceding paragraphs about hypotheses has been summarized in table 5.1.

Table 5.1. Summary of results from hypothesis testing

Hypothesis	**Results of testing it**	**Implication on the framework constructs**
Technology is a major factor that influences management of agricultural advisory information in e-agriculture (**H1**).	Accepted	SF 8 and SF 7 (all under CSF 1) have been retained in the framework
Processes and practices are a major factor that influences management of agricultural advisory information in e-agriculture in Uganda (**H2**).	Accepted	SF 9 (under CSF 2) has been retained in the framework.
People is a major factor that influences management of agricultural advisory information in e-agriculture (**H3**).	Accepted	SF 4 and SF 2 (all under CSF 1) have been retained in the framework

Rules and regulations are a major factor that influences management of agricultural advisory information in e-agriculture (**H4**).	Accepted	SF 10 (under CSF 1) has been retained in the framework
Leadership is a major factor that influences management of agricultural advisory information in e-agriculture (**H5**).	Rejected	No SF retained
Budget is a major factor that influences management of agricultural advisory information in e-agriculture **(H6).**	Accepted	SF 12 (under CSF 2) has been retained in the framework
Facilities and facilitation are a major factor that influences management of agricultural advisory information in e-agriculture (**H7**)	Accepted	SF 11 (under CSF 2) has been retained in the framework

This table 5.1 shows the hypothesis in question, the comment on whether that hypothesis was accepted or rejected and finally the implication on the framework (which construct has been retained or dropped).

5.4. Construct Validity and Reliability

Construct validity and reliability are key elements in research especially when it comes to the construct or deliverable of a given research and the process through which this deliverable was arrived at. In this research, construct validity was established by exploratory factor analysis (EFA).

The reliability of the results were established through inspecting the scale reliability coefficients of all the variables in a given section of the questionnaire, then the coefficients of the sub factors as a group and then that of individual sub factors that load in a given CSF (See tables 4.9, 4.12, 4.15, 4.21, 4.27, 4.30 and 4.33).

5.5. Summary

Structural equation modeling was performed on the three CSFs and a structural equation model was obtained. It was shown how each CSF contributes to the other and how strongly each CSF contributes to the other. Then after, the structural equation model was transformed into an

Information management framework with the three CSFs each detailing the essential variables therein. Lastly an explanation on the construct validity and reliability of the framework was presented.

CHAPTER SIX
EVALUATION OF THE FRAMEWORK

6.1. Introduction

The previous chapter presented in detail the framework for supporting management of agricultural advisory information (FMAAI) in e-agriculture in developing economies like Uganda's. This chapter presents the evaluation of this framework based on validity, reliability and usefulness. The framework was evaluated using expert opinion and field experiment (which was implemented in form of prototyping). The prototype is in form of a web-based application which, in this study, is referred to as a platform for supporting management of agricultural advisory information (PMAAI). We evaluated the framework for information management in e-agriculture in that way in order to achieve the third objective of this study: *To evaluate the framework.* Section 6.2 presents the theoretical foundation for framework evaluation. This section provides insights into the evaluation process that was followed in this research and thus acts as guide and basis. Sections 6.3, 6.4, 6.5 and 6.6 document the evaluation of the framework using field experiment (prototyping). In detail, section 6.3 highlights the functional and non-functional requirements for the prototype. Section 6.4 documents the design of the prototype providing both data models and process models of the prototype. Section 6.5 presents the building of the prototype including the technologies that were selected to achieve this, plus the screenshots for selected major use cases. Section 6.6 documents the testing of the prototype to ensure it meets the requirements specified in section 6.3. In section 6.7, evaluation of the framework using expert opinion is documented. In section 6.8, the evaluation results from prototyping and from expert opinion are juxtaposed to make a founded opinion of the appropriateness of the framework in addressing the research problem stated in this study. Section 6.9 provides a summary of the chapter.

6.2. Theories of Framework Evaluation

This section explains the selected evaluation methods among the existing methods and the reasons why these methods were opted for. In addition, this section presents available criteria for artifact evaluation and presents the foundation for the selection of the evaluation criteria employed in this thesis.

Choice of Artifact Evaluation Methods

There are different examples of artifact evaluation methods documented in literature; among them are the ones documented by Hevner *et al.,* (2004) and Wieringa, (2010). The motivation to select from these methods has, therefore, been founded on their clarity and evidence of their use by prominent researchers.

Hevner *et al.,* (2004) and Wieringa, (2010) categorized the design evaluation methods into three:

(i) Experiment methods (Field experiment, laboratory experiment and laboratory demo)

(ii) Observational methods (Case study, action research, pilot project, field demo and opinion)

(iii) Descriptive methods (Illustration and benchmark)

For the purpose of this study, two methods (field experiment and opinion) were selected for their suitability in this research context. Opinion has been actualized in form of expert opinion and field experiment has been actualized in form of a prototype. After selecting the design evaluation methods, it was deemed essential to document the criteria for valuation that need to be followed during evaluation.

Criteria for Artifact Evaluation

Criteria for evaluation are essential to enable a uniform yardstick for evaluation of the framework using the two selected artifact evaluation methods in this study. Prat et al, (2014) provide a detailed diagram that depicts the common criteria for information systems artifacts evaluation. Figure 6.1 shows those criteria and sub criteria. These evaluation criteria fall under five broad dimensions.

(i) **Goal.** This dimension includes the following criteria: Efficacy, validity and generality.

(ii) **Environment.** This dimension includes the following criteria: Consistency with people, consistency with organization and consistency with Technology.

(iii) **Structure.** This dimension includes the following criteria: Completeness, simplicity, clarity, style, homomorphism, level of detail and consistency.

(iv) **Activity.** This dimension includes the following criteria: Completeness, consistency, accuracy, performance and efficacy.

(v) **Evolution**. This dimension includes the following criteria: Robustness and learning capability.

Informed by the information system artifact evaluation criteria described in the previous paragraphs, evaluation of the framework was conducted. The data collection instruments for both methods of evaluation conducted in this thesis (field experiment and opinion) mirrored the criteria described by Prat et al, (2014) as presented in figure 6.1.

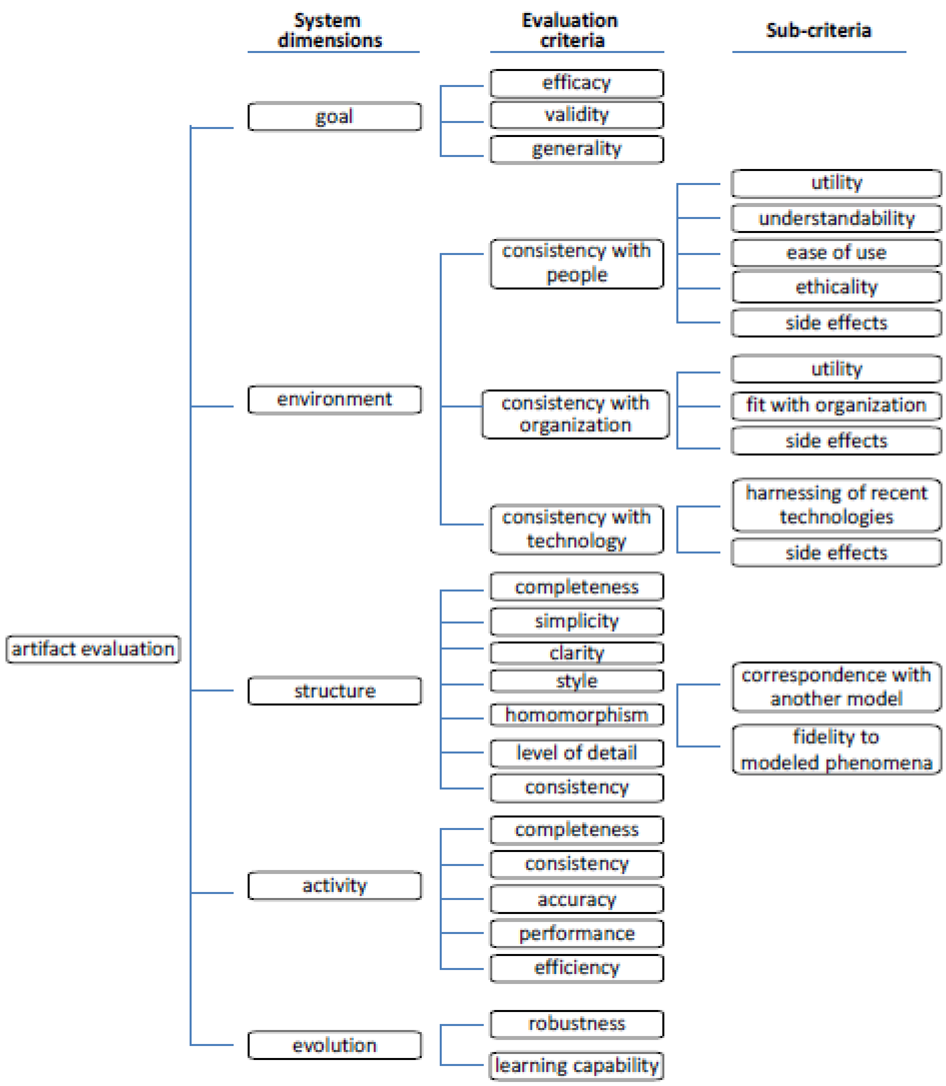

Figure 6.1: Hierarchy of criteria for IS artifact evaluation.

The criteria shown in figure 6.1 were the basis for formulating the questions that were used in expert opinion evaluation as well as field experiment (evaluation of the prototype). Using the same criteria on both evaluation methods availed a common standard for evaluation and thus enabling easy interpretation of results from both evaluation methods.

6.3. Evaluation of the Framework Using Expert Opinion

To ensure that the framework is accurate in supporting management of agricultural advisory information in e-agriculture in Uganda, it was taken to the community of practice mainly experts in information management. These experts include those who have written papers concerning information management frameworks, small scale farmers, researchers in agriculture and extension workers that have been involved in information management in agriculture.

6.3.1 Evaluation Results from Experts in Information Management

Forty-four (44) practitioners and/or experts in information management (selected authors in information management, small scale farmers, researchers in agriculture and extension workers) were selected to participate in the FMAAI evaluation. This choice of the number 44 was based on the central limit theory that allows a sample size of 30 or more participants (McLeod, 2019). The researcher targeted scholars who developed the information management frameworks that were reviewed in literature in chapter two of this thesis. Nevertheless, only one of these responded to the invitation requesting for the whole thesis in order to take part. This request was not honored by the researcher, thus the expert in this category only gave general comments about the framework. The other respondents that were considered as experts were those stakeholders in agricultural advisory information management that had been doing this for five years. The questions used in evaluation are shown in the questionnaire presented in appendix E and F. In the subsequent paragraphs we present an elaboration on the results from the validation questionnaire that was filled by those respondents.

A. Demographic Characteristics

The section that follows provides detailed information about the demographic characteristics of respondents.

Institution of Work of Respondents

The results about the institution of work of respondents to the validation questionnaire are not shown diagrammatically. It was clear that that 18.2% of respondents are from NACRRI (National Crop Resources Research Institute) and the second biggest number came from NARO (National agriculture research organization). The other respondents were from diverse organizations, and therefore, the diagram would not be clear since the organizations from which these respondents work were diverse. This diversity, it was later found out by the researcher, was because of the nature of the questionnaire question (State the name of the institution where you work) that led many farmers to put organizations where they work whereas these people were given this questionnaire not because of where they work, but because they are farmers. Many farmers work in diverse organizations not as farmers but with other titles. This matter also affected the response in the next question where respondents were asked their job title, again many farmers were having diverse job titles. “Farmer”, was not a job title for such farmers that are at the same time employed in other organizations.

Job Title of Respondents

The results about the job title of respondents to the validation questionnaire were not shown in form of a figure. Although it was clear that 13.6% of respondents are research assistants, the other respondents were from diverse organizations. This diversity has been explained in the previous section and it was the same reason why the diagram was not shown here.

Time Taken in the Practice of Information Management

The results in the subsequent paragraphs show how long the respondent has taken in the practice of information management, as a researcher in information management, small scale farmer or extension worker.

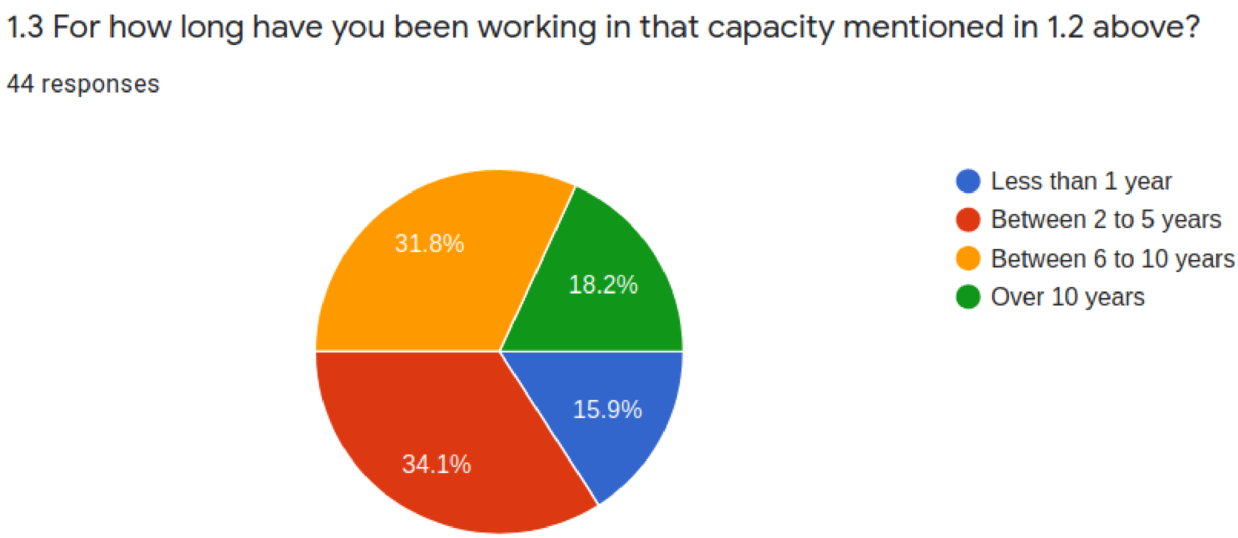

Figure 6. 2 : Time taken by the respondents in their field of practice.

The findings in figure 6.2 show that 34.1% of respondents have taken between 2 to 5 years, 31.8% of respondents have taken between 6 to 10 years, 18.2% of respondents have taken over 10 years while 15.9% of respondents have taken less than one year.

Highest qualification attained by respondents.

The results in the subsequent paragraph show the highest qualification of respondents.

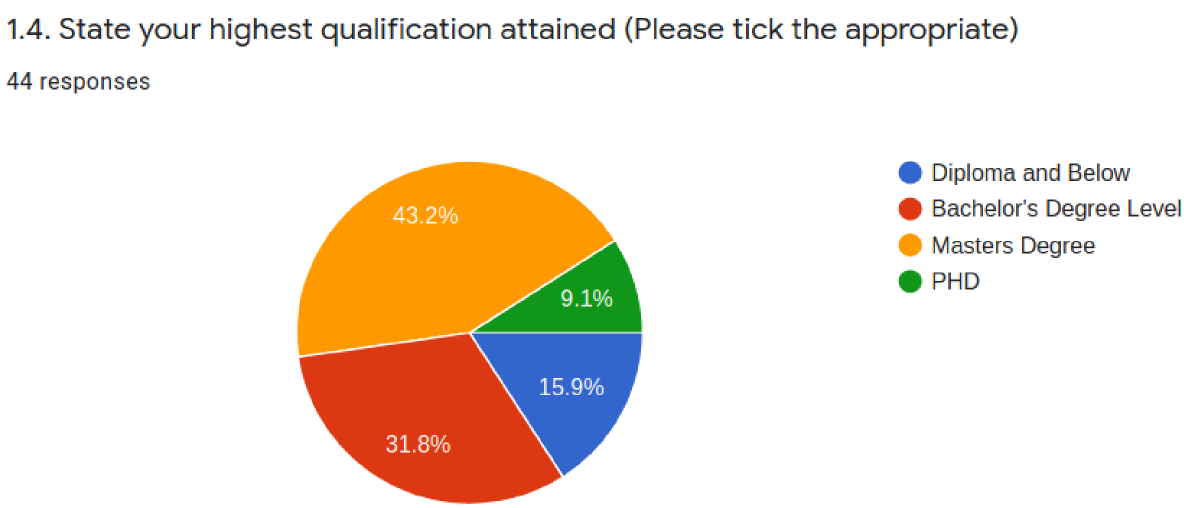

Figure 6. 3: Highest qualification attained

The findings in figure 6.3 show that 43.2% are masters agree holders, 31.8% of respondents are bachelor's degree holders 15.9% of the respondents are Diploma holders and below while 9.1% of the respondents are PhD holders.

Gender of respondents

The results in the subsequent paragraph show the gender of respondents that participated in this study.

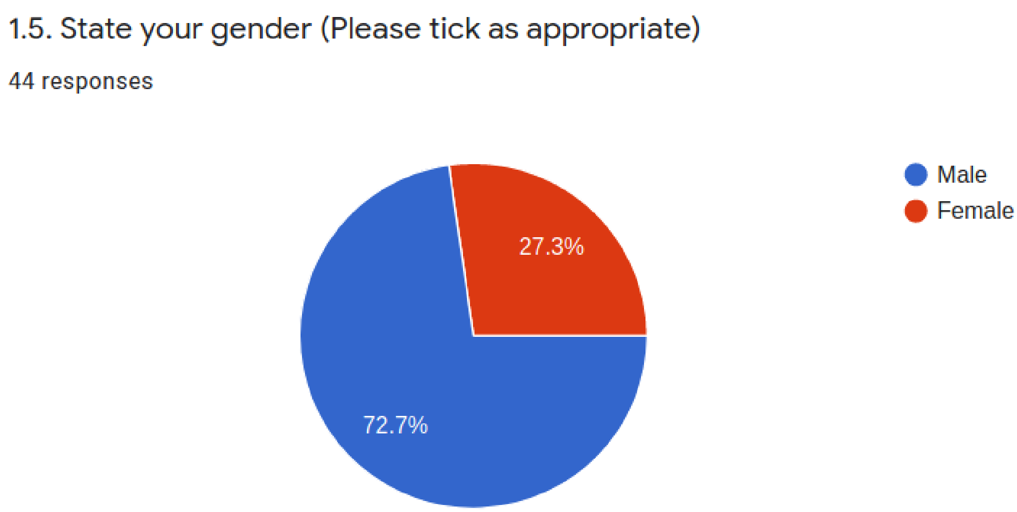

Figure 6. 4: Gender of respondents

The findings in figure 6.4 show that 72.7% of respondents are male while 27.3% of respondents are female.

B. Descriptive Statistics

This section presents the descriptive statistics of respondents to the validation questionnaire. These questions were composed based on the critical success factors that influence agricultural advisory information management as highlighted in the FMAAI. Statistics on how different respondents agree or disagree with these factors that form the framework are presented.

Table 6. 1: Responses from the CSF 1: People and Technology

	Rate how these People and Technology factors (as they appear in the FMAAI) support management of agricultural advisory information in e-agriculture in Uganda.	***Mean***	***Standard Deviation***
SF2	*Access to electricity, phones and information management training* supports management of agricultural advisory information in e-agriculture in Uganda.	4.622	0.716
SF1	*Access to and use ICTs like computers and Internet* supports management of agricultural advisory information.	4.422	0.657
SF14	*Proper information management practices* support management of agricultural advisory information.	4.511	0.549
SF8	*Testing Technology used for information management with the users* supports management of agricultural advisory information.	4.489	0.506
SF7	*Designing Technology used for information management based on user requirements* supports management of agricultural advisory information.	4.622	0.576
SF4	*Creativity and good interpersonal skills of people involved in information management* support management of agricultural advisory information.	4.533	0.589
	Any other, please specify		

Interpretation of findings under People and Technology

In this section we sum up the respondents' responses as presented in table 6.1 in order to obtain the mean of responses by using strongly agree (SA) as 5, agree (A) as 4, Not Sure (NS) as 3, disagree D as 2 and Strongly Disagree (D) as 1. The interpretation of findings from the questionnaire representing the key factors that constitute the FMAAI is presented below based on table 6.1:

From table 6.1, a mean of 4.622 of responses confirm that *Access to electricity, phones and information management training* supports management of agricultural advisory information in e-agriculture in developing economies like Uganda's. From the same table 6.1, the standard deviation from the mean is a low value of 0.716 meaning that the responses deviate from the mean with a low value. This makes the sub-factor (SF2) as it appears in the framework in figure 5.3 pass the test of experts and/or practitioners in managing agricultural advisory information. This factor is therefore retained as part of the framework.

A mean of 4.422 (tending to strongly agree) confirm that *Access to and use ICTs like computers and Internet supports management of agricultural advisory information.* This makes the sub-factor (SF1) as it appears in the framework in figure 5.3 pass the test of experts and/or practitioners in managing agricultural advisory information. The deviation from the mean is a low value of 0.657. This factor is therefore retained as part of the framework.

The responses provide a mean of 4.51 (tending to strongly agree) confirming that *Proper information management practices support management of agricultural advisory information.* This makes the sub-factor (SF14) as it appears in the framework in figure 5.3 pass the test of experts and/or practitioners in managing agricultural advisory information. The deviation from the mean is a low value of 0.549. This factor is therefore retained as part of the framework.

The responses provide a mean of 4.489 (tending to strongly agree) confirming that *Testing Technology used for information management with the users supports management of agricultural advisory information.* The deviation from the mean is a low value of 0.506. This makes the sub-factor (SF8) as it appears in the framework in figure 5.3 pass the test of experts and/or practitioners in managing agricultural advisory information. This factor is therefore retained as part of the framework.

A mean of 4.622 (tending to strongly agree) confirm that *Designing Technology used for information management based on user requirements supports management of agricultural advisory information.* The deviation from the mean is a low value of 0.576. This makes the sub-factor (SF7) as it appears in the framework in figure 5.3 pass the test of experts and/or practitioners in managing agricultural advisory information. This factor is therefore retained as part of the framework.

The responses provide a mean of 4.533 (tending to strongly agree) confirming that *that Creativity and good interpersonal skills of people involved in information management support management of agricultural advisory information.* The deviation from the mean is a low value of 0.589. This makes the sub-factor (SF4) as it appears in the framework in figure 5.3 pass the test of experts and/or practitioners in managing agricultural advisory information. This factor is, therefore, retained as part of the framework.

In summary, all the factors specified under people and technology in the framework in figure 5.3 pass the test after evaluation by experts and/or practitioners in managing agricultural advisory information. All these factors pass with the values of mean tending to strongly agree and with small values of standard deviation (the responses do not deviate widely from the mean) making it reasonable to accept these factors as part of the FMAAI.

In addition to the questions that tested if the availed factors (those factors as they appear in figure 5.3) under people and technology, are suitable to be part of the framework, the respondents were provided with an unstructured question that enabled them to add any other factor that they feel appropriate, as experts and/or practitioners in agricultural advisory information management, to be part of FMAAI. Their responses are provided below:

****

SF7: Any other, please specify 44 responses

None
Easy to use technologies.
User friendly technology should be emphasized. ***(CSF1...SF8... ..1)***
Nothing more
Record keeping ***(CSF2 ...SF9 ...4)***
Must, be down to the farmers to get more information ***(CSF1 ...SF7 ...4)***
User friendly with appropriate and simplified language that avoids Jargon ***(CSF1..SF7 ...3)***
Ease of use of the technology should be considered at both the input and output level e.g. report generation ***(CSF1 ...SF8 ...1)***
Nothing for now
People using information management should be trained ***(CSF1 ...SF2 ...3)***
We are using a web-based application ***(CSF1 ...SF14 ...3)***
N/A
Involve the end user in doing this so that they can accept it as their own ***(CSF1 ...SF8 ...3)***
n/a
Usability & user interface design shd also be emphasized ***(CSF1 ...SF8 ...3)***
Some villages have a challenge of network ***(CSF1 ...SF1 ...4)***
*The information channel or system should be affordable (****MF1 ...SF4 ...3)***
*Different languages should be considered (****CSF1 ...SF7 ...3)***
information should be tailored to critically address the prevailing challenges in a given setting, hence should be specific to a given area.
Training in simple relevant ICT packages to small scale farmers ***(CSF1 ...SF2 ...3)***
Timeliness of information
not really

Figure 6.4a Respondents suggesting another factor.

All the factors that the respondents highlighted as suitable additions to the FMAAI are presented. The highlights indicate where those additions were already catered for in the framework that was taken for evaluation (see figure 6.4a). For example, if the highlight is like (***CSF1 ...SF2 ...3)*** this means that the item suggested has been catered for already under CSF 1, sub factor 2, item number 3. It is evident therefore that most of the suggested additions had already been catered for. Nevertheless, two main suggestions (as bolded above) that is (**information should be tailored to critically address the prevailing challenges in a given setting, hence should be specific to a given area.) and (Timeliness of information)** are worth of particular attention.

Although these two attributes (suitability and timeliness of information) are key, attributes of information in this research were not investigated and thus were taken as a given. These attributes therefore, although highlighted by experts and/or practitioners in agricultural advisory information management in e-agriculture, have not been included as factors in the FMAAI for that reason.

FUNDING, PROCESSES AND REGULATIONS

This section of the questionnaire focuses on the second major factor of the FMAAI. Findings from this section are presented in the table 6.2 below. The questions requested respondents to present their level of agreement or disagreement with the following assertions.

Table 6. 2: Responses from the CSF 2: Funding Processes and Regulations

	Rate how these funding, processes and regulations factors support management of agricultural advisory information in e-agriculture.	***Standard Deviation***	***Mean***
SF10	*Realistic rules and regulations that govern information management* support management of agricultural advisory information in e-agriculture.	4.422	0.657
SF12	*A good budget for information management* supports management of agricultural advisory information in e-agriculture.	4.556	0.687
SF11	*Finance and high-quality facilities for information management* supports management of agricultural advisory information in e-agriculture.	4.267	0.504
SF9	*Proper handling of information management constituent processes like acquisition and storage of information* supports management of agricultural advisory information in e-agriculture.	4.489	0.589
	Any other, please specify.		

Interpretation of Findings under Funding, Processes and Regulations

In this section we sum up the respondents’ responses as presented in table 6.2 in order to obtain the mean of respondents that strongly agree (SA)(5), those that agree (A)(4), those that are not sure (NS) (3), those that disagree (D) 2 and finally those that strongly disagree (DA) 1. The interpretation of findings from the questionnaire representing the key factors that constitute the FMAAI is presented below based on table 6.2:

A mean value of 4.422 (tending to strongly agree) accepted *that Realistic rules and regulations that govern information management support management of agricultural advisory information in e-agriculture.* The standard deviation from the mean was 0.657 which is a small value meaning that the responses did not deviate greatly from the mean. This makes the sub-factor (SF10) as it appears in the framework in figure 5.3 pass the test of experts and/or practitioners in managing agricultural advisory information. This factor is therefore retained as part of the framework.

A mean value of 4.556 (tending to strongly agree) accepted that *a good budget for information management supports management of agricultural advisory information in e-agriculture.* The standard deviation from the mean was 0.687 which is a small value meaning that the responses did not deviate greatly from the mean. This makes the sub-factor (SF12) as it appears in the framework in figure 5.3 pass the test of experts and/or practitioners in managing agricultural advisory information. This factor is, therefore, retained as part of the framework.

A mean value of 4.267 (tending to strongly agree) accepted *that Finance and high-quality facilities for information management supports management of agricultural advisory information in e-agriculture.* The standard deviation from the mean is a small value of 0.504. Therefore, the sub-factor (SF11) as it appears in the framework in figure 5.3 passes the test of experts and/or practitioners in managing agricultural advisory information. This factor is therefore retained as part of the framework.

A mean value of 4.489 (tending to strongly agree) accepted *that Proper handling of information management constituent processes like acquisition and storage of information supports management of agricultural advisory information in e-agriculture.* The standard deviation is 0.589 which is a very small value of deviation from the mean. This makes the sub-factor (SF9) as it appears in the framework in figure 5.3 pass the test of experts and/or practitioners in managing agricultural advisory information. This factor is therefore retained as part of the framework.

In summary, all the factors specified in the framework in figure 5.3 relating to funding, processes and regulations, pass the test after evaluation by experts and/or practitioners in managing agricultural advisory information. All these factors pass with a mean above 4.2 making it reasonable to accept these factors as part of the FMAAI.

The other question that required respondents to provide additional factors to those that had been specified in the structured questions. In this section, we provide the findings from that unstructured question in figure 6.4b:

****

SF12: Any other, please specify14 responses

None
Nothing more
n/a
N/A
Quality of information managed.
None

Source of information should be supervised.
****

Figure 6.4b Respondents' suggestions of additional factors

From the above responses in figure 6.4b, two are of specific importance (Quality of information managed) and (Source of information should be supervised). These factors or attributes are attributes of information which were taken as a given in this research. Based on this reasoning, we do not append these attributes to the FMAAI.

Based on Prat *et al.,* 2014, the framework was also subjected to evaluation to establish if the goal, environment, structure, activity and evolution criteria were met by this FMAAI. Below are the findings from that evaluation. Table 6.3 provides responses about those criteria (Goal, environment, Structure, Activity and Evolution) from respondents that were contacted.

Table 6. 3: Responses about those criteria (Goal, environment, Structure, Activity and Evolution)

	Rate how you agree or disagree with the following factors related to goal of the Framework	***Mean***	***Standard Deviation***
	I think the components of the framework as presented in section A and B are logical	0.603	4.334
	I think the components of the framework as presented in section A and B can support not only agricultural advisory information management but also other information management contexts.	0.654	4.400
	Environment		
	The framework is useful to small scale farmers engaged in management of agricultural advisory information in e-agriculture in Uganda.	0.523	4.334
	The elements of the framework are understandable	0.739	4.000
	The framework is easy to use (It is easy to see the components of the framework that support information management and follow them)	0.701	4.089
	The framework is useful in management of agricultural advisory information in e-agriculture in Uganda.	0.588	4.200
	The framework fits in the context of small-scale farmers engaged in management of agricultural advisory information in Uganda	0.757	4.044
	STRUCTURE		
	The framework is complete	*0.725*	3.556
	The framework is simple	*0.723*	4.022
	The framework is clear	0.701	3.911
	The framework is not very different from other information management frameworks	0.690	3.578
	The framework provides sufficient details	0.753	4.022
	The framework is consistent with other frameworks	0.737	3.844
	ACTIVITY		
	The framework is accurate	0.737	3.844
	The framework can support agricultural advisory information management	0.570	4.244
	Small scale farmers can use the framework to get value of agricultural advisory information.	0.712	4.244
	EVOLUTION		
	The framework can continue to be used even if extension information evolves to formats	0.723	4.022

GOAL

Table 6.3 shows that a mean of 4.334 and a standard deviation of 0.603 respondents agree that the components of the framework as presented in are logical. A mean of 4.400 and a standard deviation of 0.654 of the respondents concur that the components of the framework as presented can support not only agricultural advisory information management but also other information management contexts.

ENVIRONMENT

A mean of 4.334 and a standard deviation of 0.523 respondents agree that the framework is useful to small scale farmers engaged in management of agricultural advisory information in e-agriculture in Uganda. A mean of 4.00 (meaning Agree) and a standard deviation of 0.739 of the respondents agree that the elements of the framework are understandable. A mean of 4.089 and a standard deviation from the mean of 0.701 of the respondents agree that the framework is easy to use (It is easy to see the components of the framework that support information management and follow them). A mean of 4.2 and a standard deviation of 0.588 agree that the framework is useful in management of agricultural advisory information in e-agriculture in Uganda, while a mean of 4.04 and a standard deviation of 0.737 of respondents agree that the framework fits in the context of small-scale farmers engaged in management of agricultural advisory information in e-agriculture.

STRUCTURE

A mean of 3.556 (tending to agree) and a value of standard deviation of 0.725 of the respondents agree that the framework is complete. A mean of 4.022 (Agree) and a standard deviation from the mean of 0.723 of the respondents agree that the framework is simple. A mean value of 3.911 (agree) and a small value of standard deviation of 0.701 agree that the framework is clear. A mean of 3.578 (tending to agree) and a standard deviation of 0.690 of respondents agree that the framework is not very different from other information management frameworks. A mean of 4.022 and a standard deviation of 0.753 of the respondents agree that the framework provides sufficient details. Lastly on this component, a mean of 3.844(tending to agree) and a standard deviation of 0.737 of the respondents agree that the framework is consistent with other frameworks.

ACTIVITY

A mean value of 3.844 agree that *the framework is accurate.* The standard deviation from that mean is a small value of 0.737. A mean of 4.244 and a standard deviation of 0.570 agree that *the framework can support agricultural advisory information management.* A mean of 4.244 and a standard deviation of 0.712 agree that *the small-scale farmers can use the framework to get value of agricultural advisory information.*

EVOLUTION

A mean of 4.022 and a standard deviation of 0.723 agree that *the framework can continue to be used even if agricultural advisory information evolves to other formats.*

6.4. Framework Supporting Management of Agricultural Advisory Information

In the previous section, findings from the questionnaire to the experts and/or practitioners in agricultural advisory information management have been presented. We present the key effects that the findings have caused to the original framework.

1. The name of the framework was adjusted from Farmers Information Management Framework (FIMF) to the framework for managing agricultural advisory information (FMAAI). This decision was reached after detailed discussion with experts in information management. Following this counsel, the researcher adopted the name FMAAI. This name is suitable for this framework because the framework was not only for farmers, although these were key respondents, but for practitioners in agricultural advisory information management.

2. The wording of the factors in the framework was adjusted following the rules of presenting factors or attributes.

3. The framework retained all the elements that it previously had in figure 5.3.

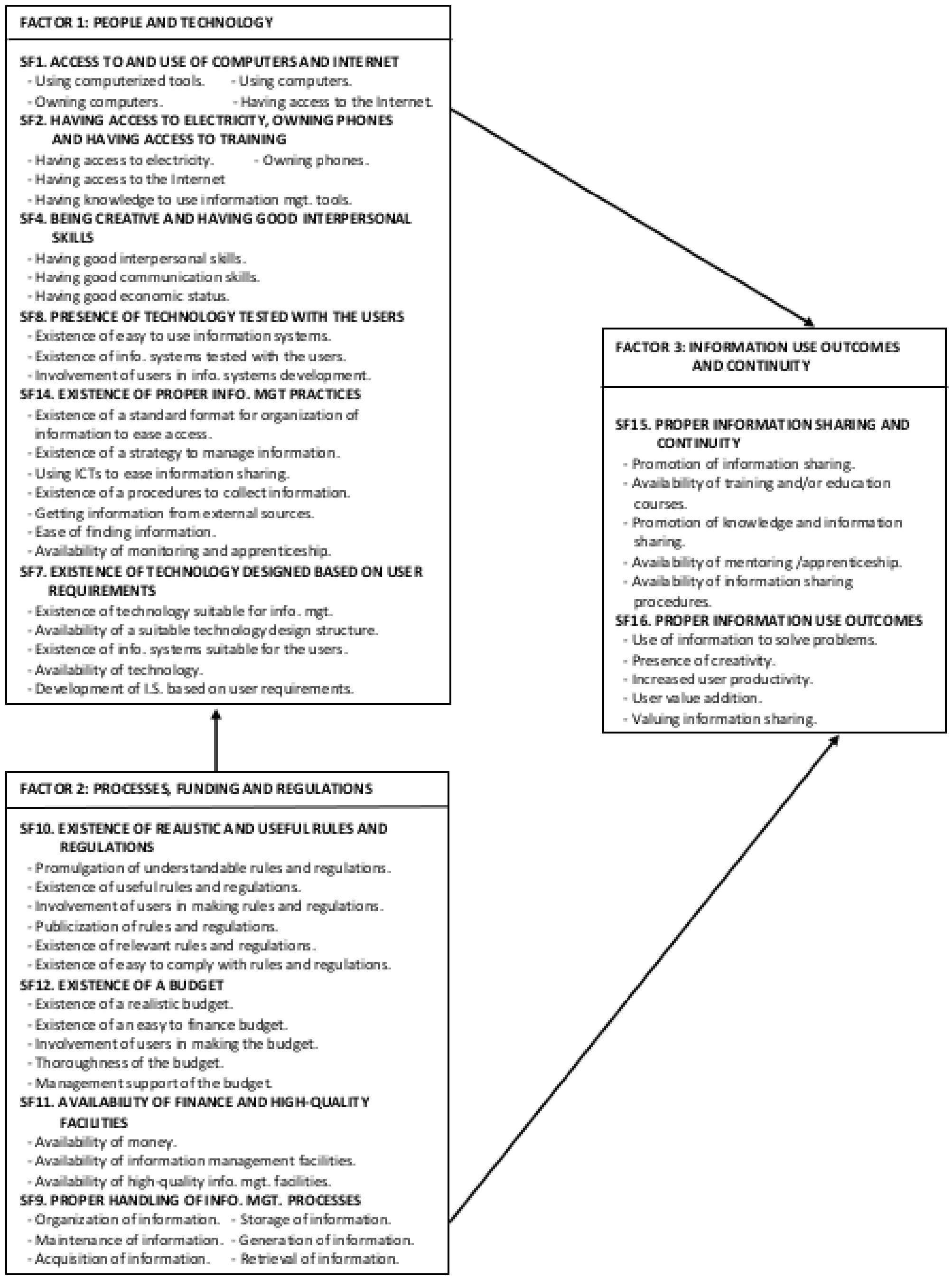

Figure 6. 5: Resultant Framework after evaluation using expert opinion

After those key adjustments, the new framework appears as shown in figure 6.5.

6.5. Evaluation of the Framework Using a Prototype

In the previous section, the FMAAI has been evaluated by experts or/and practitioners in agricultural advisory information management in e-agriculture. The results of the evaluation have shown that the framework is thorough with no significant additions. This section attempts to evaluate the FMAAI using a prototype. In the subsequent section, we provide detail of how this evaluation was done plus the results of the evaluation.

Requirements

Requirements are the services that the system offers to its users. Requirements are a means of stating the pillars on which a contract between the users of the system and the developers is based. The requirements are based on the sub-factors that appear in the CSFs seen in the framework (see table 6.4).

The framework specifies the guidelines/ factors that influence agricultural advisory information management in e-agriculture in e-agriculture. Based on each sub-factor relevant requirements were proposed for example if the sub-factor in the framework stipulates information management budget as an important factor in information management, the corresponding requirement would be derived by asking "What can an IT application do to ensure that an information management budget is available?" The answer would be "The system should help the users to create an information management budget" and thus specifying the relevant requirement. Based on that reasoning, table 6.4 was developed showing all the mega factors in the framework and the corresponding requirement (both functional and non-functional).

Unlike the summarized version of factors in the previous figures of the framework to ease diagraming, in this table, the factors have been written in full sentences to reflect the language of factors.

Table 6. 4: Deriving requirements from the CSFs of the framework

CSF/ FRAMEWORK ITEM	CORRESPONDING FUNCTIONAL REQUIREMENT: The system should be able to:	POSSIBLE CORRESPONDING NON-FUNCTIONAL REQUIREMENT: The system should be:
CRITICAL SUCCESS FACTOR (CSF) 1: PEOPLE AND TECHNOLOGY		
ACCESS TO AND USE OF COMPUTERS AND INTERNET (SFI)	No derivable functional requirement	**Easy to use**
Using computerized tools	No derivable functional requirement	**Available for users to use it**
Owning computers	No derivable functional requirement	No derivable non-functional requirement
Using computers	No derivable functional requirement	**Easy to use**
Having access to Internet	No derivable functional requirement	**Available for users to use it**
HAVING ACCESS TO ELECTRICITY, OWNING PHONES AND HAVING ACCESS TO TRAINING (SF2)	**Train users in IM best practices**	No derivable non-functional requirement
Having access to electricity	No derivable functional requirement	No derivable non-functional requirement
Owning phones	No derivable functional requirement	No derivable non-functional requirement
Having knowledge to use IM tools	No derivable functional requirement	**Easy to use**
BEING CREATIVE AND HAVING GOOD INTERPERSONAL SKILLS (SF4)	**- Enable communication with other stakeholders in IM** **- Enable users exercise creativity**	No derivable non-functional requirement
Having good interpersonal skills	No derivable functional requirement	No derivable non-functional requirement
Having good communication skills	No derivable functional requirement	No derivable non-functional requirement
Having good economic status	No derivable functional requirement	**Loading fast, low cost available, maintainable, flexible, portable**
PRESENCE OF TECHNOLOGY TESTED WITH THE USERS (SF8)	**Enable users participate in testing technologies intended for IM**	
Existence of easy to use I.S.	No derivable functional requirement	**Easy to use**
Existence of I.S. tested with the users	No derivable functional requirement	No derivable non-functional requirement
Involvement of users in I.S.	**Enable users involve in**	No derivable non-functional

development	**developing systems intended for IM**	requirement
EXISTENCE OF PROPER IM PRACTICES (SF14)	**Enable proper IM practices**	No derivable non-functional requirement
Existence of a standard format for organization of information to ease access	No derivable functional requirement	No derivable non-functional requirement
Existence of a strategy to manage information	No derivable functional requirement	No derivable non-functional requirement
Using ICTs to ease information sharing	No derivable functional requirement	No derivable non-functional requirement
Existence of procedures to collect information	No derivable functional requirement	No derivable non-functional requirement
Getting information from external sources	No derivable functional requirement	No derivable non-functional requirement
Ease of finding information	No derivable functional requirement	No derivable non-functional requirement
Availability of monitoring and apprenticeship	No derivable functional requirement	No derivable non-functional requirement
EXISTENCE OF TECHNOLOGY DESIGNED BASED ON USER REQUIREMENTS (SF7)	**Enable participation of users in designing IM systems**	No derivable non-functional requirement
Existence of technology suitable for I.M.	No derivable functional requirement	**Inter-operable with other systems**
Availability of a suitable technology design structure	No derivable functional requirement	**secure,**
Existence of I.S. suitable for users	No derivable functional requirement	**Able to recover after system failure,**
Availability of technology	No derivable functional requirement	**Available for users to use it**
Development of I.S. based on user requirements.	No derivable functional requirement	**With low response time**
CRITICAL SUCCESS FACTOR (CSF) 2: PROCESSES, FUNDING AND REGULATIONS		
EXISTENCE OF REALISTIC AND USEFUL RULES AND REGULATIONS (SF10)	**Enable users participate in creating rules and regulations for IM**	No derivable non-functional requirement
Promulgation of understandable rules and regulations	No derivable functional requirement	No derivable non-functional requirement
Existence of useful rules and regulations	No derivable functional requirement	No derivable non-functional requirement
Involvement of users in making rules and regulations.	No derivable functional requirement	No derivable non-functional requirement
Publicization of rules and regulations.	No derivable functional requirement	No derivable non-functional requirement
Existence of relevant rules and regulations	No derivable functional requirement	No derivable non-functional requirement
Existence of easy to comply with	No derivable functional	No derivable non-functional

rules and regulations.	requirement	requirement
EISTENCE OF A BUDGET (SF12)	**Enable users to create a budget for IM**	No derivable non-functional requirement
Existence of a realistic budget	No derivable functional requirement	No derivable non-functional requirement
Existence of an easy to finance budget	No derivable functional requirement	**Low cost**
Involvement of users in making the budget.	No derivable functional requirement	**Inter-operable**
Thoroughness of the budget	No derivable functional requirement	No derivable non-functional requirement
Management support of the budget	No derivable functional requirement	No derivable non-functional requirement
AVAILABILITY OF FINANCE AND HIGH-QUALITY FACILITIES (SF11)	**Enable users get finance to purchase high quality facilities for IM**	No derivable non-functional requirement
Availability of money	No derivable functional requirement	**Low cost**
Availability of IM facilities	No derivable functional requirement	**Low cost**
Availability of high-quality IM facilities	No derivable functional requirement	**Secure**
PROPER HANDLING OF IM CONSTITUENT PROCESSES (SF9)	**Enable users handle IM constituent processes**	No derivable non-functional requirement
Organization of information	No derivable functional requirement	No derivable non-functional requirement
Maintenance of information	No derivable functional requirement	No derivable non-functional requirement
Acquisition of information	No derivable functional requirement	No derivable non-functional requirement
Storage of information	No derivable functional requirement	No derivable non-functional requirement
Generation of information	No derivable functional requirement	No derivable non-functional requirement
Retrieval of information	No derivable functional requirement	No derivable non-functional requirement

Tale 6.4 shows the relevant requirements both functional and nonfunctional and how these requirements were derived. For those factors from which requirements were not directly derivable, it was rightly assumed that the evaluation of such factors that was done using expert opinion was sufficient.

Functional Requirements for the Prototype

Functional requirements that are directly derivable from the factors highlighted by the FMAAI as clearly indicated in table 6.4, have been presented in the subsequent paragraphs indicating what the prototypes should be able to do in order to support or satisfy the needs of practitioners in agricultural advisory information management in e-agriculture in Uganda:

1. The system should be able to manage information management training,
2. The system should be able to manage participation in information management system development,
3. The system should be able to manage model information management practices,
4. The system should be able to manage information management rules and regulations,
5. The system should be able to manage funding opportunities,
6. The system should be able to manage report generation and
7. The system should be able to manage registration.

The last two requirements (manage report generation and manage registration) were not directly obtained from the CSFs in the framework but were included because they are crucial in the functionality of the prototype to support practitioners in agricultural advisory information management in e-agriculture.

Non-Functional Requirements

Based on what was done to derive non-functional requirements for the prototype that supports agricultural advisory information management in e-agriculture, the following non-functional requirements are presented. These non-functional requirements are the constraints on how the system or prototype should accomplish the functional requirements. The non-functional requirements for the prototype are presented in the paragraphs that follow:

1. The system should be easy to use.
2. The system should be available for users to use it.

3. The system should load fast,
4. The system should be low cost
5. The system should be easy to maintain.
6. The system should be flexible
7. The system should be portable.
8. The system should be inter-operable with other systems.
9. The system should be secure.
10. The system should be able to recover from system failure.

6.6. Design of the Prototype

Design of the system (Prototype) was done to produce a specification of the functionality of the prototype independent of implementation details. This specification (design) is the basis for the implementation of the prototype with implementation tools of one's choice. The design is composed of a category of process models and data models. A process model specifies the processes and the flow of data between the system and different actors. The data model specifies the entities about which data is collected, their attributes and relationships between these entities. To specify the processes in the system, a use case diagram, activity diagrams and interaction diagrams were used and to do data modeling, a class diagram was used.

Use Case Diagram

The use case diagram shows the system boundary plus the external actors that interact with this system to achieve specific user goals. Figure 6.6 shows a use case diagram of the PMAAI.

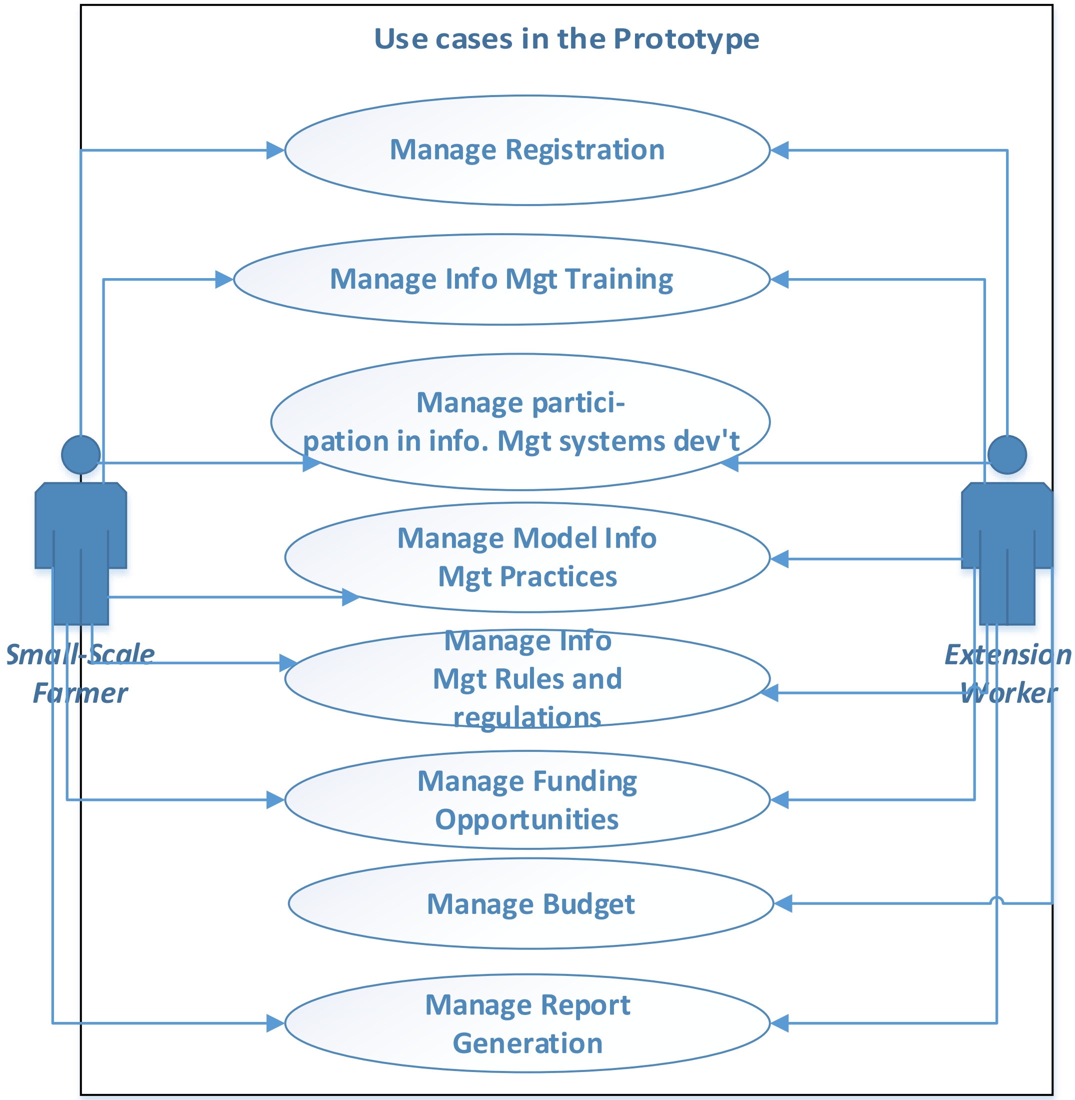

Figure 6. 6: Use case diagram of the Prototype.

From the use case diagram above in figure 6.6 the major external entities of the prototype are the small-scale farmer and the extension worker. Both use the system to manage information management training, to manage participation in information management system development, manage model information management practices, manage information management rules and regulations, manage funding opportunities, manage budget, manage report generation and manage registration.

Class Diagram

A class diagram represents classes (entities), their attributes, behavior and the relationship between classes (entities). The class diagram of the prototype is shown in figure 6.7.

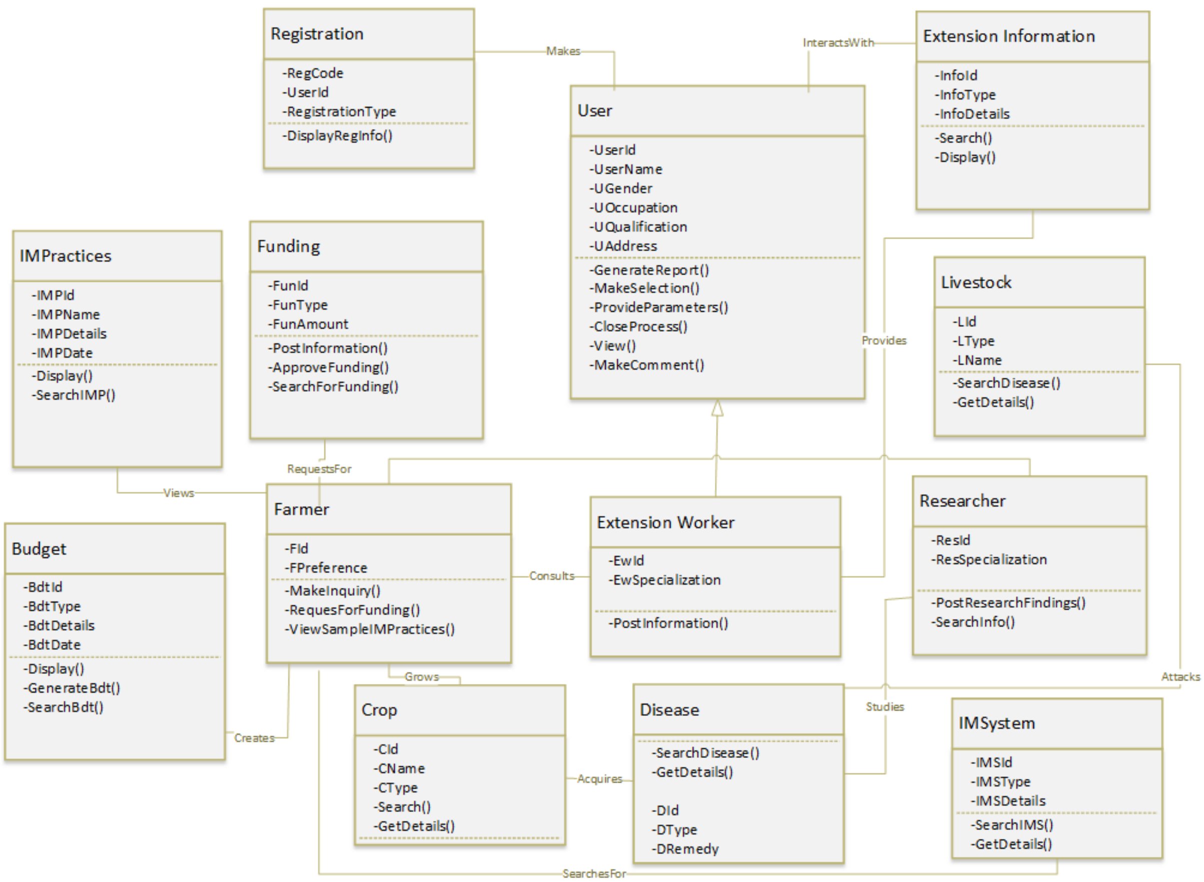

Figure 6.7: Class Diagram for the prototype

The major classes (entities) in the prototype are named as seen in figure 6.7: Farmer, extension worker, Registration, Budget, Information management System, Rules and Regulations, Extension Information, Funding, Information Management Practices, Livestock, Crop, Disease and Researcher.

Activity diagrams

Activity diagrams show a series of activities that take place in order to accomplish a given use case. The major use cases of the Prototype have been represented by activity diagrams. These diagrams are presented in Appendix G (Requirements and design documents). From those diagrams it is shown how the user accomplishes activities required to accomplish the registration use case, the budget management use case, the manage rules and regulations use case, the manage funding use case, the manage sample information management practices, the participate in information management systems development use case and the generate reports use case. All the diagrams for the activities or use cases stated are shown in the Appendix G (Requirements and Design Documents).

Sequence Diagrams

Sequence diagrams show a sequence of activities that are carried out to achieve a given major use case. The sequence diagrams that represent a sequence of activities of the major use cases of the prototype are presented. The sequence diagrams relevant to the prototype are presented in Appendix H (System Prototype Functions). These sequence diagrams are about the interaction that happen between the user and prototype in order to accomplish the registration use case, the manage budget use case, the manage rules and regulations use case, the manage funding use case, the participate in information systems development use case and the generate reports use case.

6.6. Building the Prototype

The prototype was implemented as a web-based system. In order to implement the web version of the prototype, the following technologies were used: HTML, Java script and cascading style sheets were used to implement the user interface. These tools were used because they are easy to use and readily available. These are also technologies commonly used for the development of interfaces of web-based applications. MySQL was used to develop the database component of the prototype.

Scenarios of Use of the Prototype

This section presents different scenarios of use of the prototype. These are sample screens that the user that manages agricultural advisory information in e-agriculture is presented with by the system in the process of accomplishing the use cases relevant to agricultural advisory information management.

Home Screen

The system has a home page that depicts the overall aim of prototype and the major users (Farmers, Extension workers and MAAIF). The page provides links for each of those main users in order to enable them to register, login and thus use the PMAAI successfully. The home page screenshot is shown in the following figure.

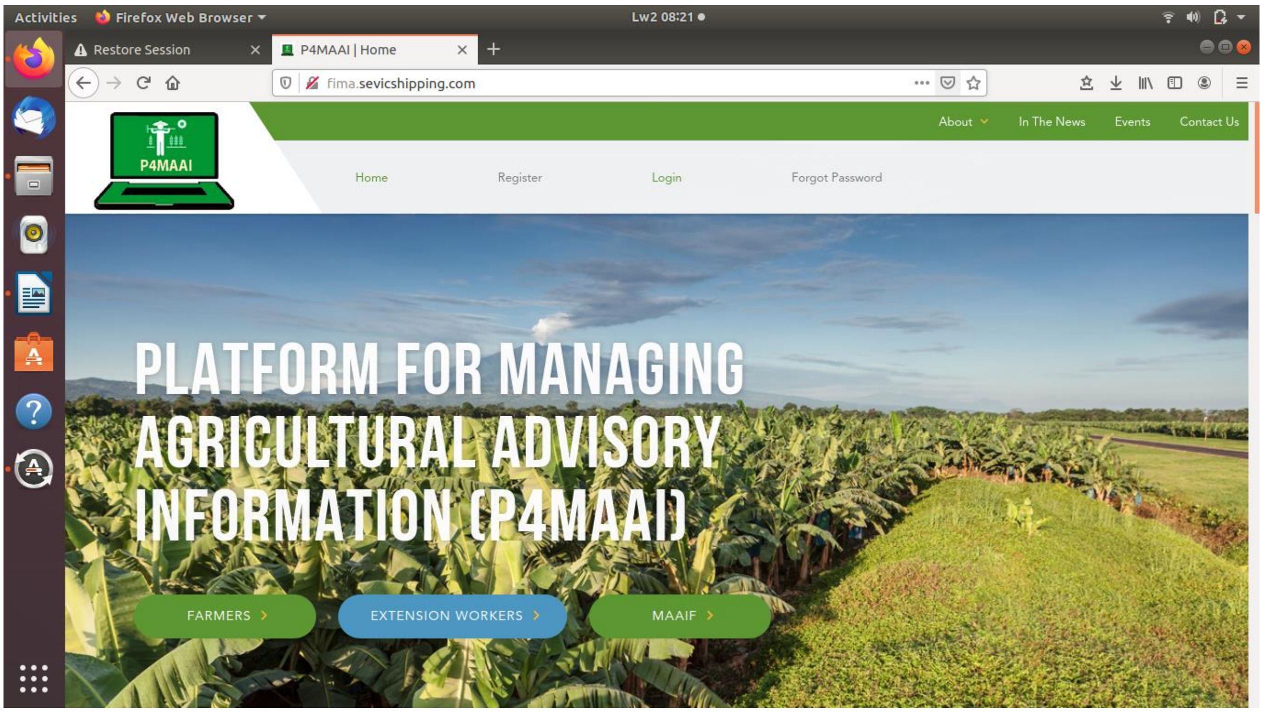

Figure 6.8: Screenshot for the Home Page

Figure 6.8 shows the home page of PMAAI, that is, the page that loads first when the user puts the URL of the platform in a web browser. The page has links to web pages like login, registration and forgot password.

Registration

The system requires the user to provide a username and password in order to use it. When the system is loaded, basic information about agricultural advisory information management is shown to the user including registration. The user, on clicking the registration tab, is provided with the registration form to fill by providing user information including login information. The user enters the user name and password which are later used to login to the system. The screenshot is shown in Appendix H (System Prototype Functionality description) showing the user login interface.

When the user provides a wrong username and/or password, the system denies that user entry and provides a fresh form for username and password entry until the user provides the right username and password. On successful login, the user is presented with a dashboard containing the following tabs: Information Management Training, Participate in Information Management Systems Development, Model Information Management Practices, Information Management Rules and Regulations, Funding Opportunities, Reports, Information Management News and FAQs. Each of these tabs links to other links to ensure that those tasks are completed.

After logging in, the user is provided with different modules relevant to that user. Such modules are Admin, Dashboard, Training Module, and Best practices.

When the user clicks on a module of choice, then the user is directed to that module in order to accomplish tasks relevant to supporting agricultural advisory information management like training, participation in creating information systems to support information management, information management budget creation, view of best practices in information management, view and participation in creating rules and regulations and lastly funding opportunities. Each of those modules have sub modules relevant to each module which the user can navigate in order to accomplish a given use case.

The create budget use case and the relevant tasks that relate to this module are shown diagrammatically in appendix H. The user can add elements of the budget as he/she wishes and then at the end the budget is created for that user. The system also enables users to obtain training about different information management tasks like acquisition, storage, dissemination, processing and use of information. Screenshot in Appendix H illustrate this.

A Screenshot in which a small-scale farmer can get trained in different processes that constitute information management is shown in Appendix H. The user selects the "ask" and then gets training in form of videos, text or cartoons. In addition, a user can have opportunities for funding using the PMAAI as shown in a screenshot in Appendix H. A small-scale farmer can obtain funding from external organizations in form of a loan, donation or grant. The donor uses the donate tab to provide donations to small-scale farmers that have requested for funding (See Appendix H). This is in line with the processes, funding and regulations CSF of the framework.

6.7. Testing the Prototype

The framework as an artifact presents vital pillars in the management of agricultural advisory information by small-scale farmers in e-agriculture. The prototype of the framework is used for experimentation using problem owners. This is done to establish if the prototype represents the framework and it (the prototype) implements the fundamental pillars of the framework. This is founded on Wieringa, (2010) who recommends use of experimentation to evaluate an artifact.

Testing the Functionality of the Prototype

The framework was tested to establish if it enables the user to perform the following functionalities as highlighted by the framework: Get trained in information management practices, access model information management practices, create an information management budget, get access to information management funding opportunities, participate in developing information management systems, registration and participate in making information management rules and regulations. Each of the functionalities was rated by the information management experts using a Likert scale (Strongly agree (SA), Agree (A), Not sure (NS), Disagree (D) and Strongly Disagree (SD). Table 6.5 shows a summary of responses from the experts and selected model farmers that participated in prototype testing.

Table 6.5: Summary of responses from the experts

	Provide information about your level of agreement with the following statements as applied to the platform for managing agricultural advisory information (PMAAI) as a tool for enabling the following functionalities:	***Mean***	***Standard Deviation***
TESF1	PMAAI makes it possible for a user to get trained in information management practices,	0.379	4.833
TESF2	PMAAI makes it possible for a user to get access to model information management practices,	0.626	4.433
TEST3	PMAAI makes it possible for a user to create an information management budget.	0.568	4.567
TESF4	PMAAI makes it possible for a user to participate in developing information management systems useful for information management.	0.556	4.633
TESF5	PMAAI makes it possible for a user to get access to information management funding opportunities.	0.556	4.633
TESF6	PMAAI makes it possible for a user to do registration	0.679	4.567
TESF7	PMAAI makes it possible for a user to participate in making information management rules and regulations.	0.535	4.700

Details of the information are shown in table 6.5 are presented in the subsequent paragraphs.

Interpretation of findings from testing the functionality of the Prototype (PMAAI)

In this section we sum up the respondents' responses as presented in table 6.5 in order to obtain the mean number of respondents that strongly agree (SA) coded as 5, agree (A) coded as 4, are not sure (NS) coded as 3, disagree D coded as 2 and those that strongly disagree (DA) coded as 1. Evaluation of the functionality of the modules in FMAAI indicate whether a given module provides services to a user involved in the management of agricultural advisory information. If a module supports management of agricultural advisory information this means that the factor that this module implements in the PMAAI is key or necessary in the FMAAI that provided the basis for the design of the prototype (PMAAI). The interpretation of findings from the questionnaire representing the key factors that constitute the FMAAI as implemented by PMAAI is presented below based on the coding provided above:

The mean score of 4.833 (tending to strongly agree) was obtained for the assertion that *PMAAI makes it possible for a user to get trained in information management practices.* The standard deviation from the mean for this assertion was a small value of 0.379 meaning that the responses did not diverge greatly from the mean score. This thus confirms that the factor in the FMAAI, which was implemented by this module in PMAAI, is suitable to be part of the FMAAI. In this case, factor **SF2** found in **CSF 1** in the FMAAI is a critical success factor that supports management of agricultural advisory information in e-agriculture in a developing economy like Uganda's.

The mean score of 4.433 (tending to strongly agree) was obtained for the assertion that PMAAI *makes it possible for a user to get access to model information management practices.* The standard deviation from the mean for this assertion was a small value of 0.626 meaning that the responses did not diverge greatly from the mean score. This thus confirms that the factor in the FMAAI, which was implemented by this module in PMAAI, is suitable to be part of the FMAAI. In this case, factor **SF14** found in **CSF 1** in the FMAAI is a critical success factor that supports management of agricultural advisory information in e-agriculture in a developing economy like Uganda's.

The mean score of 4.567 (tending to strongly agree) was obtained for the assertion that *PMAAI makes it possible for a user to create an information management budget.* The standard deviation from the mean for this assertion was a small value of 0.568 meaning that the responses did not diverge greatly from the mean score. This thus confirms that the factor in the FMAAI, which was implemented by this module in PMAAI, is suitable to be part of the FMAAI. In this case, factor **SF12** found in **CSF 2** in the FMAAI is a critical success factor that supports management of agricultural advisory information in e-agriculture.

The mean score of 4.633 (tending to strongly agree) was obtained for the assertion that *PMAAI makes it possible for a user to participate in developing information management systems useful for information management.* The standard deviation from the mean for this assertion was a small value of 0.556 meaning that the responses did not diverge greatly from the mean score. This thus confirms that the factor in the FMAAI, which was implemented by this module in PMAAI, is suitable to be part of the FMAAI. In this case, factor **SF7** found in **CSF 1** in the FMAAI is a critical success factor that supports management of agricultural advisory information in e-agriculture in Uganda.

The mean score of 4.633 (tending to strongly agree) was obtained for the assertion that *PMAAI makes it possible for a user to get access to information management funding opportunities*. The standard deviation from the mean for this assertion was a small value of 0.556 meaning that the responses did not diverge greatly from the mean score. This thus confirms that the factor in the FMAAI, which was implemented by this module in PMAAI, is suitable to be part of the FMAAI. In this case, factor **SF11** found in **CSF 2** in the FMAAI is a critical success factor that supports management of agricultural advisory information in e-agriculture.

The mean score of 4.567 (tending to strongly agree) was obtained for the assertion that *PMAAI makes it possible for a user to do registration*. The standard deviation from the mean for this assertion was a small value of 0.679 meaning that the responses did not diverge greatly from the mean score. Given that this functionality was not motivated by a given factor in FMAAI no conclusion about the FMAAI originates from this module or functionality.

The mean score of 4.700 (tending to strongly agree) was obtained for the assertion that PMAAI *makes it possible for a user to participate in making information management rules and regulations*. The standard deviation from the mean for this assertion was a small value of 0.535 meaning that the responses did not diverge greatly from the mean score. This thus confirms that the factor in the FMAAI, which was implemented by this module in PMAAI, is suitable to be part of the FMAAI. In this case, factor **SF10** found in **CSF 2** in the FMAAI is a critical success factor that supports management of agricultural advisory information in e-agriculture.

In summary, factors SF2, SF4, SF12, SF7, SF11 and SF10 have been confirmed the second time (first, during expert opinion and then here using a prototype). This confirms the suitability of these factors as being key in supporting management of agricultural advisory information in e-agriculture.

Testing the functionality of PMAAI using parameters suggested by Prat t al. (2014)

After testing the suitability of individual elements of PMAAI, it was considered fitting to inspect the system as a whole by seeking respondents' opinion basing on selected criteria as suggested by Prat et al, 2014. The following table 6.6 provides responses from the respondents that were consulted.

Table 6.6: Responses from testing the functionality of PMAAI

Rate how you agree or disagree with the following modules of the PMAAI related to goal of the system	***Mean***	***Standard Deviation***
The modules of the system (PMAAI) as presented are logical in the context of supporting information management	0.626	4.433
The modules of the system (PMAAI) can support not only extension information management but also other information management contexts.	0.507	4/533
Environment		
The system (PMAAI) is useful to small scale farmers engaged in management of agricultural advisory information in e-agriculture.	0.568	4/567
The modules of the system (PMAAI) are understandable	0.479	4.667
It is easy to see the modules in the system (PMAAI) and use them for supporting information management.	0.571	4.533
The system (PMAAI) is useful in management of agricultural advisory information in e-agriculture.	0.556	4.633
The system (PMAAI) fits in the context of small-scale farmers engaged in management of agricultural advisory information.	0.502	4.433
STRUCTURE		
The system (PMAAI) is complete in as far as supporting extension information management is concerned.	0.571	4.533
The system (PMAAI) is simple	0.498	4./600
The system (PMAAI) is clear	0.504	4.400
The system (PMAAI) is not very different from other systems that can be used for information management.	0.671	4.633
The system (PMAAI) provides sufficient details to enable people use it	0.536	4.633
The system (PMAAI) is consistent with other systems.	0.571	4.533
ACTIVITY		
The system (PMAAI) is accurate	0.773	4.233
The system (PMAAI) can support management of agricultural advisory information.	0.629	4.467
Small scale farmers and other users can use the system (PMAAI) to get value out of agricultural advisory information.	0/568	4.567
EVOLUTION		
The system (PMAAI) can continue to be used even if agricultural advisory information evolves to other formats.	0.629	4.533

In the subsequent paragraphs, based on table 6.6, we present a summarized version of how many respondents agreed with the assertions provided and thus the meaning of the agreement. These assertions are categorized again based on the criteria suggested by Prat *et al.,* 2014. In this section we sum up the respondents' responses as presented in table 6.6 in order to obtain the mean number of respondents that strongly agree (SA) coded as 5, agree (A) coded as 4, are not sure (NS) coded as 3, disagree D coded as 2 and those that strongly disagree (DA) coded as 1.

GOAL

A mean score of 4.433 (tending to strongly agree) was obtained when respondents were asked whether the modules of the system (PMAAI) as presented are logical in the context of supporting information management. The standard deviation from the mean for the same question in the evaluation questionnaire was a small value of 0.626. A mean score of 4.533 (tending to strongly agree) was obtained when respondents were asked if the modules of the system (PMAAI) can support not only agricultural advisory information management but also other information management contexts. The standard deviation obtained was a small value of 0.507. This means that the goal of PMAAI which instantiates FMAAI is justified. Since the goal of the PMAAI is justified, ipso facto, the goal of the FMAAI is.

ENVIRONMENT

A mean score of 4.567 (tending to strongly agree) was obtained when respondents were asked if the system (PMAAI) is useful to small scale farmers engaged in management of agricultural advisory information in e-agriculture. The standard deviation was 0.568. A mean score of 4.667 (tending to strongly agree) was obtained when respondents were asked if the modules of the system (PMAAI) are understandable. The standard deviation was 0.479. A mean score of 4.533 (tending to strongly agree) was obtained when respondents were asked if it is easy to see the modules in the system (PMAAI) and use them for supporting information management. The standard deviation was 0.571. A mean score of 4.633 (tending to strongly agree) was obtained when respondents were asked if the system (PMAAI) is useful in management of agricultural advisory information in e-agriculture. The standard deviation was 0.556. A mean score of 4.433 (tending to strongly agree) was obtained when respondents were asked if the system (PMAAI) fits in the context of small-scale farmers engaged in management of agricultural advisory information. The standard deviation was 0.502. This confirms that the structure of PMAAI is appropriate and so does the structure of FMAAI since PMAAI instantiates FMAAI.

STRUCTURE

A mean score of 4.533 (tending to strongly agree) was obtained when respondents were asked if the system (PMAAI) is complete in as far as supporting agricultural advisory information management is concerned. The standard deviation from the mean was a small value of 0.571. A mean score of 4.600 (tending to strongly agree) was obtained when respondents were asked if the system (PMAAI) is simple. The standard deviation from the mean was a small value of 0.498. A mean score of 4.560 (tending to strongly agree) was obtained when respondents were asked if the system (PMAAI) is clear. The standard deviation from the mean was a small value of 0.504. A mean score of 4.400 (tending to strongly agree) was obtained when respondents were asked if the system (PMAAI) is not very different from other systems that can be used for information management. The standard deviation from the mean was a small value of 0.671. The mean score of 4.633 (tending to strongly agree) was obtained when respondents were asked if the system (PMAAI) provides sufficient details to enable people use it. The deviation from the mean as 0.556. The mean score of 4.533 (tending to strongly agree) was obtained when respondents were asked if the system (PMAAI) is consistent with other systems. The standard deviation was 0.571 meaning that the deviation from the mean was a small value. This confirms that the structure of PMAAI is for management of agricultural advisory information in e-agriculture in Uganda implying that the structure of FMAAI is ipso facto suitable for supporting management of agricultural advisory information in e-agriculture.

ACTIVITY

The mean score of 4.233 (agree) was obtained when respondents were asked if t*he system (PMAAI) is accurate.* The standard deviation was 0.773 implying that the scores deviated with a very small value from the mean. The mean score of 4.467 (agree) was obtained when respondents were asked if t*he system (PMAAI) can support management of agricultural advisory information.* The standard deviation was 0.629 implying that the scores deviated with a very small value from the mean. The mean score of 4.567 (tending to strongly agree) was obtained when respondents were asked if the s*mall scale farmers and other users can use the system (PMAAI) to get value out of agricultural advisory information.* The standard deviation was 0.568 implying that the scores deviated with a very small value from the mean. This makes the activity component as suggested by Prat *et al.*, 2014 pass the test in form of PMAAI making it the case also for FMAAI.

EVOLUTION

The mean score of 4.533 (tending to strongly agree) was obtained when respondents were asked if t*he system (PMAAI) can continue to be used even if agricultural advisory information evolves to other formats.* The standard deviation was 0.629 implying that the scores deviated with a very small value from the mean. This implies that the system (PMAAI) can evolve implying the same attribute for the FMAAI.

6.8. The Revised Version of the Framework

After evaluating the FMAAI using expert opinion, changes were implemented in the framework mainly concerning the wording of the elements in the framework plus two other elements suggested to become part of the framework. These two elements were about the information itself which entity was taken as a given in this study. Thus, the version of the framework after modifications that sprung from expert opinion was presented in figure 6.5 After evaluation of the prototype PMAAI, it was noted that this process reaffirmed some of the elements in the FMAAI without suggesting new additions, thus the framework as it appeared in figure 6.4 remained unchanged.

In addition, suggestions from the experts recommended that the naming of the factors be changed or renamed in accordance with their categories instead of remaining with the codes they obtained during EFA. For example, the first category of factors be called Factor 1, then the sub factors in them be named as 1.1 and thus the sub sub factors be named as 1.1.1 in that order. Thus, producing the version of the FMAAI after evaluation as it appears in figure 6.9 below:

FACTOR 1: PEOPLE AND TECHNOLOGY (PAT)

PAT1. ACCESS TO AND USE OF COMPUTERS AND INTERNET

PAT1.1 Using computerized tools. PAT1.3 Using computers.
PAT1.2 Owning computers PAT1.4 Having access to the Internet

PAT2. HAVING ACCESS TO ELECTRICITY, OWNING PHONES AND HAVING ACCESS TO TRAINING

PAT2.1 Having access to electricity. PAT2.4 Owning phones.
PAT2.2 Having access to the Internet
PAT2.3 Having knowledge to use information management tools.

PAT3. BEING CREATIVE AND HAVING GOOD INTERPERSONAL SKILLS

PAT3.1 Having good interpersonal skills.
PAT3.2 Having good communication skills.
PAT3.3 Having good economic status.

PAT4. PRESENCE OF TECHNOLOGY TESTED WITH THE USERS

PAT4.1 Existence of easy to use information systems.
PAT4.2 Existence of info. systems tested with the users.
PAT4.3 Involvement of users in info. systems development.

PAT5. EXISTENCE OF PROPER INFORMATION MANAGEMENT PRACTICES

PAT5.1 Existence of a standard format for organization of information to ease access.
PAT5.2 Existence of a strategy to manage information.
PAT5.3 Using ICTs to ease information sharing.
PAT5.4 Existence of a procedures to collect information.
PAT5.5 Getting information from external sources.
PAT5.6 Ease of finding information.
PAT5.7 Availability of monitoring and apprenticeship.

PAT6. EXISTENCE OF TECHNOLOGY DESIGNED BASED ON USER REQUIREMENTS

PAT6.1 Existence of technology suitable for information management.
PAT6.2 Availability of a suitable technology design structure.
PAT6.3 Existence of information systems suitable for the users.
PAT6.4 Availability of technology.
PAT6.5 Development of information systems based on user requirements.

FACTOR 2: PROCESSES, FUNDING AND REGULATIONS(PFR)

PFR1. EXISTENCE OF REALISTIC AND USEFUL RULES AND REGULATIONS

PFR1.1 Promulgation of understandable rules and regulations.
PFR1.2 Existence of useful rules and regulations.
PFR1.3 Involvement of users in making rules and regulations.
PFR1.4 Publicization of rules and regulations.
PFR1.5 Existence of relevant rules and regulations.
PFR1.6 Existence of easy to comply with rules and regulations.

PFR2. EXISTENCE OF A BUDGET

PFR2.1 Existence of a realistic budget.
PFR2.2 Existence of an easy to finance budget.
PFR2.3 Involvement of users in making the budget.
PFR2.4 Thoroughness of the budget.
PFR2.5 Management support of the budget.

PFR3. AVAILABILITY OF FINANCE AND HIGH-QUALITY FACILITIES

PFR3.1 Availability of money.
PFR3.2 Availability of information management facilities.
PFR3.3 Availability of high-quality information management facilities.

PFR4. PROPER HANDLING OF INFORMATION MANAGEMENT PROCESSES

PFR4.1 Organization of information. PFR4.4 Storage of information.
PFR4.2 Maintenance of information. PFR4.4 Generation of information.
PFR4.3 Acquisition of information. PFR4.5 Retrieval of information.

FACTOR 3: INFORMATION USE OUTCOMES AND CONTINUITY (IUO)

IUO1. PROPER INFORMATION SHARING AND CONTINUITY

IUO1.1 Promotion of information sharing.
IUO1.2- Availability of training and/or education courses.
IUO1.3 Promotion of knowledge and information sharing.
IUO1.4 Availability of mentoring /apprenticeship.
IUO1.5 Availability of information sharing procedures.

IUO2. PROPER INFORMATION USE OUTCOMES

IUO2.1 Use of information to solve problems.
IUO2.2 Presence of creativity.
IUO2.3 Increased user productivity.
IUO2.4 User value addition.
IUO2.5 Valuing information sharing.

This version of the FMAAI after evaluation as shown in figure 6.9 has its naming organized so as to easily show which CSF houses the sub factor plus the sub sub factors:

In addition, reviewers of FMAAI recommended that for each of the factors and sub factors suggestions be made for how the framework element can be made to happen or realized. For example, if the framework element is "training", suggestions should be made of how this can be achieved (for example conduct workshops for training). It was recommended that supporting literature for such realizations of a framework element should be made. Following those recommendations, table 6.7 was generated.

Table 6.7: Framework elements and how they can be realized

CSF/ FRAMEWORK ITEM	Suggestion on how a framework element can be realized
ACCESS TO AND USE OF COMPUTERS AND INTERNET (SFI) - *Using computerized tools* - *Owning computers* - *Using computers* - *Having access to Internet*	*Training stakeholders in using computers and Internet (Nyarko and Kozári, (2021); Vignare, 2013.) *Subsidizing ICT equipment and infrastructure (Harris and Achora, 2018)
HAVING ACCESS TO ELECTRICITY, OWNING PHONES AND HAVING ACCESS TO TRAINING (SF2) - *Having access to electricity* - *Owning phones* - *Having knowledge to use I.M. tools*	*Subsidizing electricity for stakeholders in IM (Reena and Katrina, 2011) *Promoting the use of alternative power sources like batteries, solar, biogas (UCSUSA, (2008)) *Subsidizing phones for stakeholders in IM (Omotilewa et al, 2019; Cater *et al.*, 2014). *Train stakeholders in IM (MAAIF, 2021; Randolph et al 2007) *Ensure that government facilitates training (MAAIF, 2021) *Train trainers (MAAIF, 2021; Randolph et al 2007)
BEING CREATIVE AND HAVING GOOD INTERPERSONAL SKILLS (SF4) - *Having good interpersonal skills* - *Having good communication skills* - *Having good economic status*	* Introduce training quizzes that instill creativity among stakeholders in IM (Find Your Feet, (2012); Foodtank, (2014)) *Introduce simulation games that instill creativity among stakeholders in IM (Shaban, 2012). *Introduce farmer or IM stakeholder meetings that increase communication skills. (Spielman and Birner, 2008; Rivera, 2011; Benson and Jafry, 2013)
PRESENCE OF TECHNOLOGY TESTED WITH THE USERS (SF8) - *Existence of easy to use I.S.* - *Existence of I.S. tested with the users.* - *Involvement of users in I.S. development*	*Avail loans for stakeholders in IM (Reyes *et al.*, 2012; Anang, 2015; Owusu-Antwi, 2010; Finscope, 2010) *Introduce workshops or meetings that involve users in testing IM systems (Lwanga, 2015; MAAIF, 2016) *Employ professional IM systems developers (Lwanga, 2015; MAAIF, 2016)

	*Reward stakeholders that get involved in developing IM systems development (Aker, *et al.,* 2016; GSMA, 2016a; Laureys, 2016; GSMA. 2016B; IICD, (2012).)
EXISTENCE OF PROPER IM PRACTICES (SF14) - *Existence of a standard format for organization of information to ease access* - *Existence of a strategy to manage information* - *Using ICTs to ease information sharing* - *Existence of procedures to collect information* - *Getting information from external sources* - *Ease of finding information* - *Availability of monitoring and apprenticeship*	*Approve a standard IM format and ensure it is followed (Palmieri and Rivas, 2007;). *Draft an IM strategy (Palmieri and Rivas, 2007;) *Create platforms that encourage sharing among stakeholders in IM (Patil and Sidnal, 2016; Patil *et al.,* 2017) *Enact procedures to follow in collecting information (Stefanescu *et al.,* 2013) *Approve credible sources to provide information (MAAIF, 2021) *Prescribe sources that provide information to stakeholders in IM (Stefanescu *et al.,* 2013) *Institute mechanisms for monitoring information (Taye, 2013) *Train people in good IM practices (Chauvat et al. 2016) *Encourage peer to peer learning (Patil and Sidnal, 2016; Patil *et al.,* 2017)
EXISTENCE OF TECHNOLOGY DESIGNED BASED ON USER REQUIREMENTS (SF7) - *Existence of technology suitable for I.M.* - *Availability of a suitable technology design structure* - *Existence of I.S. suitable for users* - *Availability of technology* - *Development of I.S. based on user requirements.*	*Employ developers of IM systems that base on user requirements (Vidanapthirana, 2019) *Donate ICT tools that have been confirmed to be suitable for IM (Akullo and Mulumba, 2016) *Prescribe a specific technology design to be followed by developers of IM systems (DREAMCO Design (2020)) *Train developers to develop IS suitable for users in their specific contexts (DREAMCO Design, 2020) *Avail IM technologies that users can obtain on soft loans (Bank of Uganda, (2020) *Enforce development of I.S that base on user requirements (Leau, *et al.,* 2012; McMurtrey, 2013; Zhang and Li.,2007) *Institute inspectors of developed IM systems (MAAIF, 2021)
EXISTENCE OF REALISTIC AND USEFUL RULES AND REGULATIONS (SF10) - *Promulgation of understandable rules and regulations* - *Existence of useful rules and regulations* - *Involvement of users in making rules and regulations.* - *Publicization of rules and regulations.* - *Existence of relevant rules and regulations.* - *Existence of easy to comply with rules*	*Enact and make known IM rules and regulations e.g. let there be gazated books where such rules are written (MAAIF, 2021) *Update rules and regulations periodically to suite the current needs of stakeholders in IM (MAAIF, 2021) *Support IM stakeholders' debates discussing these rules and regulations plus other themes related to IM (MAAIF, 2021) *Institute mechanisms that enforce the rules and regulations of I.M(MAAIF, 2021)

and regulations.	
EISTENCE OF A BUDGET (SF12) - *Existence of a realistic budget* - *Existence of an easy to finance budget* - *Involvement of users in making the budget.* - *Thoroughness of the budget* - *Management support of the budget*	*Employ inspectors to ensure that IM stakeholders create budgets and follow them (MAAIF, 2021) *Provide funding for IM stakeholders tasks (Omotilewa et al, 2019; MAAIF, 2021) *Introduce seminars and trainings that train IM stakeholders to make good budgets (MAAIF, 2021)
AVAILABILITY OF FINANCE AND HIGH-QUALITY FACILITIES (SF11) - *Availability of money* - *Availability of IM facilities* - *Availability of high-quality IM facilities*	*Construct facilities that are used for I.M(MAAIF, 2021) * Provide loans to construct IM facilities (MAAIF, 2021) *Train users in using and maintaining IM facilities (MAAIF, 2021) *Link IM stakeholders to chances of funding by different organizations (MAAIF, 2021) *Publicize IM practices and their benefits in order to encourage other people to emulate them(MAAIF, 2021)
PROPER HANDLING OF IM CONSTITUENT PROCESSES (SF9) - *Organization of information* - *Maintenance of information* - *Acquisition of information* - *Storage of information* - *Generation of information* - *Retrieval of information*	*Train stakeholders in IM to manage IM processes (MAAIF, 2021) *Avail IM best practices that can be emulated by different IM stakeholders (MAAIF, 2021) *Provide mechanisms to reward best performers in IM practices (MAAIF, 2021) *Introduce and fund agricultural advisory information archives (MAAIF, 2021) *Fund the development of I.S. for storing and disseminating information (MAAIF, 2021)

The practical suggestions as presented in table 6.7 are essential in highlighting the practical suggestions that can be the basis of action in order to support management of agricultural advisory information management in e-agriculture in developing economies like Uganda.

6.9. Summary

Chapter six focused on the evaluation of the framework using two methods: Opinion which we have called expert opinion and field experiment which has been actualized as prototyping. The same criteria were used in the evaluation applying it to these two evaluation methods. Results have been obtained and analyzed in order to provide evidence for the suitability of the artifact (framework) and its constituent factors or variables. This evidence has been a strong element in confirming the final version of the framework.

CHAPTER SEVEN

DISCUSSION OF FINDINGS AND CONCLUSIONS

7.1. Introduction

The overall aim of this study was to develop a framework for supporting management of agricultural advisory information (FMAAI) in e-agriculture. To achieve this aim, three specific objectives were set. The first specific objective was *to establish the critical success factors (CSFs) supporting management of agricultural advisory information in e-agriculture*. In order to achieve this specific objective, a literature review was conducted plus a field study and thereafter, exploratory factor analysis was performed on the data obtained from the field. The second specific objective was *to design the FMAAI*. This was achieved through structural equation modeling (SEM) with path analysis in which we identified how the different critical success factors obtained in objective one relate and how strongly they do so. The third objective was *to evaluate the FMAAI*. This was done by seeking expert opinion and then by instantiating the FMAAI with a prototype called PMAAI. Evidence for achieving the first specific objective (establishment of the CSFs) was presented in chapter four of this thesis. In chapter five, evidence of achieving the second specific objective (design of the FMAAI) was paraded. In chapter six, evidence for achieving the third specific objective (evaluation of the FMAAI) was presented. In this chapter we sum up this study by explaining clearly how each specific objective was achieved, the method for achieving each objective, the result corresponding to each objective, the discussion that springs from attaining each objective and the corresponding conclusion for each specific objective (Maiga, 2021).

7.2. Discussion of Study Findings

Management of agricultural advisory information is essential for increasing agricultural productivity in developing economies like Uganda’s. Challenges exist in management of agricultural advisory information in e-agriculture in Uganda. These challenges are attributed to growth of use of ICTs in the agricultural sector leading to availability of massive information, limited number of extension workers that can reach small scale farmers in their farms, plus limited support to stakeholders in management of agricultural advisory information. Supporting stakeholders in their role of managing agricultural advisory information is key especially for small scale farmers in Uganda since they contribute to the production of food needed to feed the growing population. The aim of this study was to develop a framework for supporting management of agricultural advisory information in e-agriculture. This main objective was divided into three specific objectives: *1. To establish the CSFs that support management of agricultural advisory information in e-agriculture. 2. To design a framework that supports management of agricultural advisory information in e-agriculture. 3. To evaluate the framework that supports management of agricultural advisory information in e-agriculture.* The remainder of this section is dedicated to providing a discussion of the achievement of the three specific objectives. Consequently, section 7.2.1 discusses the CSFs, section 7.2.2 presents the design of the framework and section 7.2.3 is dedicated to the evaluation of this framework.

7.2.1 Discussion of the Critical Success Factors

The first objective of this study was **"*To establish the CSFs that support management of agricultural advisory information in e-agriculture*."** In order to achieve this objective, a literature review was conducted plus a field study and there after exploratory factor analysis was performed on the data obtained from the field study in order to reveal the CSFs. The highlights of these CSFs are presented in the paragraphs that follow. These CSFs are broadly categorized into two: (i) Availability of People and Technology and (ii) Presence of Funding, Processes and Regulations. These two factors influence the third factor: Information use outcomes and continuity.

CSF ONE: Availability of People and Technology

This category of factors is composed of six factors each containing several sub factors. For clarity, these sub-factors have been given codes that differ from the codes they had during exploratory factor analysis. These sub-factors under the critical success factor (CSF) people and technology are: ***PAT1*** *Access to and use of computers and Internet,* ***PAT2*** *Having access to electricity, owning phones and having access to training,* ***PAT3*** *Being creative and having good interpersonal skills,* ***PAT4*** *Presence of technology tested with the users,* ***PAT5*** *Existence of proper information management practices and* ***PAT6*** *Existence of technology designed based on user requirements.* In the subsequent paragraphs we provide a discussion of the different sub-factors under the people and technology factor.

PAT1 Access to and use of computers and Internet. The first sub-factor, under people and technology, that supports management of agricultural advisory information is access to and use of

ICTs like computers and Internet. There is need for computers to be connected to the Internet to enable them (stakeholders in agricultural advisory information management) manage agricultural advisory information properly. So, it is preferable that there is an established Internet or telecommunication infrastructure that enables fast and reliable connection to the Internet. This point was a well highlighted by authors like (Aker and Mbiti, 2010; Zhang *et al.*, 2016; Hailu *et al.*, 2018). In addition, stakeholders in management of agricultural advisory information need to own ICT devices like phones and computers that enables them to acquire, store, process and disseminate information as already articulated by authors like (Zhang *et al.*, 2016). This sub factor under its sub-sub factor (See Figure 6.9), alludes to the need to have knowledge to use these ICT tools.

PAT2 Having access to electricity, owning phones and having access to training. This sub factor clearly asserts the vital-ness of having access to electricity, owning phones and having access to training in supporting management of agricultural advisory information in e-agriculture. This points to the need for funds to buy these technologies (like phones) as well a need for training the users on how to use these tools for improved agricultural advisory information management. People need to be trained on how to handle information management practices through workshops, seminars, radio and television programs and to be presented with a sample of best performers in agricultural advisory information management as a teaching aid for others to emulate. The preeminence of training, for example, was stressed by authors like (FAO, 2019). This is because information becomes obsolete and so there is need for training and having reflesher courses for the stakeholders in agricultural advisory information management like extension workers and farmers. Although it has not been given the due attention it deserves (Bjornlund and Pittock, 2017), training has remained key in supporting management of agricultural advisory information.

PAT3 Being creative and having good interpersonal skills. The third CSF for managing agricultural advisory information, in the category of people and technology, is creativity and good interpersonal skills of people involved in information management. Creativity strengthens the ability of small-scale farmers, plus other stakeholders in agricultural advisory information management, to handle unforeseen challenges they face in information management. Interpersonal skills like communication skills are as well an essential factor in management of agricultural advisory information in e-agriculture. With these skills, stakeholders in agricultural advisory information management can interact, coordinate and cooperate with one another to advance improved management of agricultural advisory information in e-agriculture. The study by Tiwana and Mclean, (2005) highlights the key role of creativity in Information systems development (ISD) and highlights that this attribute remains narrowly studied in I.S literature. Studies have shown that creativity has been seen on one hand as a causal outcome of I.S. use (Marakas and Elam, 1997), on the other hand it has been studied on individual's level yet many ISD projects are carried out in teams (Tiwana and Mclean, 2005). In addition, an unanswered question remains of how expertise in an ISD team translates into creative processes (Tiwana and Mclean, 2005). This attribute is key in supporting agricultural advisory information management and could be instantiated through providing tasks to stakeholders in information management which require creativity of individuals and groups to be performed. These tasks could be supervised or overseen by, for example, MAAIF and other agricultural related organizations dedicated to improving agricultural advisory information management.

PAT4 Presence of technology tested with the users. The fourth CSF for managing agricultural advisory information, in the category of people and technology, is testing technology used for information management with the users. Testing technology with the users is an emphasized activity in the software development life cycle (SDLC) (Font, 2012; Gallaugher, 2012; Leau, *et al.*, 2012; McMurtrey, 2013). When technology is tested with the users, it makes users own this information management technology and makes this technology easy to use. This increases the chance to use this technology by more users thus influencing management of agricultural advisory information. Involving users in the development of software is a key activity in SDLC, as it is also in the development of information management systems that stakeholders in agricultural advisory information management use in their information management processes. In this regard, the PMAAI that instantiated the FMAAI has the potential of enabling users to take part in the development of information management systems before they actually use these systems.

PAT5 Existence of proper information management practices. The fifth CSF for managing agricultural advisory information is existence of proper information management practices. Proper information management practices are shown in practices like ease of information finding, monitoring and apprenticeship, ease of information sharing, ease of acquiring information from external sources and a good strategy for information management. The fact that existence of proper information management practices is an important factor in supporting information management is advanced by authors like (Nguyen *et al.*, 2014; Middleton, 2007). Although this element was stressed in contexts other than agricultural advisory information management, this research has shown that proper information management practices are a CSF in management of agricultural advisory information. The PMAAI implemented a module that has great potential in providing sample best practices in agricultural advisory information management as attested to by practicing stakeholders in agricultural advisory information management.

PAT6 Existence of technology designed based on user requirements. The sixth sub factor for managing agricultural advisory information is designing technology used for information management based on user requirements. Such technology proves to be suitable for information management given that it is based on user requirements. This approach to design of technology for information management improves the overall design structure of such technology (Font, 2012; Gallaugher, 2012; Leau, *et al.*, 2012; McMurtrey, 2013; Zhang and Li., 2007; Zhang, 2012). In order to support stakeholders in agricultural advisory information management, the information systems intended to support stakeholders in information management in agriculture need to be tested with the users. This thus makes these technologies acceptable and useful in supporting information management practices. ICTs that are not tested with the users become inappropriate or unable to address the needs and to fit in the circumstances of the users and thus they end up not being used by the intended users.

CSF TWO: Processes, Funding and Regulations

This category of factors is composed of four sub-factors each containing several sub-sub-factors. For clarity, these sub-factors have been given codes that differ from the codes they had during exploratory factor analysis. These sub-factors under the Critical Success Factor (CSF) Processes, funding and regulations are: ***PFR1*** *Existence of realistic and useful rules and regulations,* ***PFR2*** *Existence of a budget,* ***PFR3*** *Availability of finance and high-quality facilities and* ***PFR4*** *Proper handling of Information Management (IM) constituent processes.* Each of these sub factors has been discussed in the subsequent section of this thesis.

PFR1 Existence of realistic and useful rules and regulations. The first sub factor in the category of processes, funding and regulations (PFR) is promulgation of realistic rules and regulations that govern information management. These rules and regulations need to be understandable, useful, known, relevant and easy to comply with. It is necessary that these rules and regulations are created with the involvement of stakeholders especially small-scale farmers, Ministry of agriculture animal industry and fisheries (MAAIF) and extension workers. These rules and regulations ensure that extension services provided by different stakeholders meet appropriate standards (MAAIF, 2016). These regulations target quality of services provided, self-audit, stakeholders commitment, predefine what clients should expect, support accountability and help in monitoring and evaluation (MAAIF, 2016). These rules are documented in the context of guiding practitioners in agricultural advisory information provision but they are also vital for guiding stakeholders in agricultural advisory information management. These rules and regulations are influential in supporting practitioners in agricultural advisory information management. When there are no such rules and regulations, there cannot be quality of services provided, self-audit, stakeholders commitment, predefining what clients should expect, support accountability and monitoring and evaluation as stipulated by MAAIF, (2016).

PFR2 Existence of a budget. The second sub-factor that supports management of agricultural advisory information is availability of a good budget for information management processes. A budget drafted for information management process should be realistic, easy to finance, thorough (well thought of), easy to be supported and produced with participation of stakeholders in agricultural advisory information management. A budget, among other things, is useful in evaluating the efficiency of a given activity (in this case information management), it provides a basis for a total plan for the process of information management, it is useful in estimating costs and benefits, and it supports applications for credit (PennStateExtension, 2019). If there is a budget for information management then it is considered an important process or practice worthy of support and consideration.

PFR3 Availability of finance and high-quality facilities. The third sub-factor in management of agricultural advisory information is finance and high-quality facilities for information management. There is need for finance or funds to procure information management facilities, as pointed out by (Nick, *et al.*, 2008). These facilities are expected to be of high quality such that they are capable of accommodating or containing information management practices. Information systems or information technology tools can be considered as such facilities in this context since they are the ones that stakeholders in information management use in the dissemination, retrieval, storage and processing of agricultural advisory information.

PFR4 Proper handling of Information Management (IM) constituent processes. The fourth sub-factor in management of agricultural advisory information is proper handling of information management constituent processes. Constituent elements of information management process like information organization, acquisition, storage, generation, retrieval and maintenance should be properly handled since they are the basis or the hinge on which information management rotates (Nguyen *et al.*, 2014; Choo, 2002; Butcher and Rowley, 1998). Therefore, managing these processes of necessity influences management of agricultural advisory information.

7.2.2 Design of the Framework

The second specific objective of this study was ***to design a framework for supporting management of agricultural advisory information in e-agriculture in a developing economy like Uganda's.*** The design of the FMAAI was based on existing frameworks like the one presented by Nguyen et al. (2014) since Design Science supports the design of artifacts based on existing theories (Hevner, 2007). Derivation of critical success factors that later culminated into the FMAAI was obtained from the analysis of frameworks discussed in chapter two of this thesis. These factors were validated in the field study to yield the factors that constitute the framework presented in chapter five. It should be noted that the critical success factors were arrived at after EFA, followed by SEM with path analysis that delivered the FMAAI. The framework (FMAAI) as presented in figure 5.3 depicts the same CSFs discussed in the previous section of this thesis, but in addition, depicts the strength of association between the CSFs. This model was checked for reliability and the results of this assessment are presented in section 5.4 of this thesis. People and Technology CSF influences information use outcomes and continuity by 63%. Processes, Funding and Regulation CSF influences information use outcomes and continuity by 34% bringing the total influence of all factors to 97% leaving 3% to be the contribution of the error term and other factors unspecified in this research. Much of the discussion about this framework has been done already in section 5.2.1 and section 5.2.2.

As it has been already documented in the previous section of this thesis, the first CSF called people and technology (PAT) is composed of the following constructs: These sub-factors under the critical success factor (CSF) people and technology are: ***PAT1*** *Access to and use of computers and Internet,* ***PAT2*** *Having access to electricity, owning phones and having access to training,* ***PAT3*** *Being creative and having good interpersonal skills,* ***PAT4*** *Presence of technology tested with the users,*

PAT5 *Existence of proper information management practices and* ***PAT6*** *Existence of technology designed based on user requirements.* These constructs aggregate to provide an influence of 63% on information use outcomes and continuity.

The second CSFs called processes, funding and regulations (PFR) is composed of the following constructs: ***PFR1*** *Existence of realistic and useful rules and regulations,* ***PFR2*** *Existence of a budget,* ***PFR3*** *Availability of finance and high-quality facilities and* ***PFR4*** *Proper handling of Information Management (IM) constituent processes.* These constructs aggregate to provide an influence of 34% on information use outcomes and continuity.

In the subsequent paragraphs, a discussion of the influence of the different factors, in the two groups (PAT and PFR), is presented.

In the first group of factors, the framework (FMAAI) affirms that ***PAT1*** *Access to and use of computers and Internet,* influences agricultural advisory information use outcomes and continuity. The influence of this factor to information management was prior articulated by Rowley, (1998); Middleton, (2007) and Nguyen et al. (2014). Frameworks documented by these authors wrapped all these tools under technology and information systems. Therefore, our findings that ***PAT1*** *Access to and use of computers and Internet,* influences agricultural advisory information management concurs with those of Rowley, (1998); Middleton, (2007) and Nguyen et al. (2014).

PAT2 *Having access to electricity, owning phones and having access to training* influences agricultural advisory information management. The findings therefore concur with those of Aker, (2011) and Aker and Mbiti, (2010) that assert the influence of phones on information management. In addition, the value of training in influencing information management was articulated by Nyarko and Kozári, (2021); Vignare, (2013); MAAIF, (2021); Randolph et al (2007).

FMAAI points out that ***PAT3*** *Being creative and having good interpersonal skills,* has influence on agricultural advisory information management. The strength of creativity in information management was already articulated by Find Your Feet, (2012); Foodtank, (2014). In addition, Spielman and Birner, (2008); Rivera, (2011); Benson and Jafry, (2013) pointed on the influence that good interpersonal skills have on information management.

PAT4 *Presence of technology tested with the users,* has been pointed out by FMAAI as influencing agricultural advisory information management in e-agriculture. This result is in line with the earlier literature by Lwanga, (2015) and MAAIF, (2016).

In the framework (FMAAI), ***PAT5*** *Existence of proper information management practices* has been pointed out as influencing agricultural advisory information management in e-agriculture. This result is in line with the earlier literature by Stefanescu *et al.*, (2013); Chauvat *et al.*, (2016) and MAAIF, (2021). Among the information management practices suggested in this study are using ICTs to ease information sharing, existence of a standard format for organization of information to ease access, existence of a strategy to manage information, availability of monitoring and apprenticeship, existence of procedures to collect information, getting information from external sources and ease of finding information.

PAT6 *Existence of technology designed based on user requirements* has been found as a significant factor in influencing management of agricultural advisory information in e-agriculture. This factor has already been cited as significant by authors like Leau, *et al.,* (2012); McMurtrey, (2013); Zhang and Li., (2007) and Vidanapthirana, (2019).

In the second group of factors, the framework (FMAAI) affirms that ***PFR1*** *Existence of realistic and useful rules and regulations* influences management of agricultural advisory information management. Rules and regulations have also been emphasized in literature as significant in influencing information management (MAAIF, 2021; Blumenthal, 2009; Chauhan, 2015; Masuku *et al.,* 2017).

PFR2 *Existence of a budget,* has been found to influence management of agricultural advisory information in e-agriculture. This finding has support from literature (Omotilewa et al, 2019; MAAIF, 2021; NSW Government, 2018). This factor stresses that the budget should be realistic, easy to finance, involve users in drafting the budget, that it should be thorough and supported by management.

PFR3 *Availability of finance and high-quality facilities* influences management of agricultural advisory information in e-agriculture. This factor is supported by evidence from existing literature (MAAIF, 2021).

PFR4 *Proper handling of Information Management (IM) constituent processes* influences management of agricultural advisory information in e-agriculture. There is evidence that this factor has support from literature (MAAIF, 2021; Nguyen *et al.,* 2014).

7.2.3. Evaluation of the Framework

The third objective of this study was ***to evaluate the FMAAI. FMAAI*** was evaluated using both expert opinion and prototyping. A detailed explanation of what was done and how it was done was all presented in chapter six of this thesis.

Based on Wieringa, 2010 and Hevner *et al.,* 2004, three categories of evaluation methods were identified: Experimental, Observational and Descriptive methods. This study used Field experiment, which is one of the experimental methods, and Opinion, which is one of the Observational methods. Descriptive methods were not ventured into in this study. This was because the two selected methods (field experiment and Opinion) were considered satisfactory. In addition, the time factor was seen as key in case of using any of the descriptive methods in the evaluation of FMAAI. This study followed a criterion for evaluation that permeated both selected evaluation methods. This criterion is composed of goal, environment, structure, activity and evolution (Prat *et al.*, 2014).

The evaluation results obtained using expert opinion confirm the potential of FMAAI in supporting management of agricultural advisory information. The experts confirmed that all the CSFs that form FMAAI are significant in management of agricultural advisory information and suggested that care should be taken on the attributes of information like recency and timeliness. Since information was taken as a given in this study (see Scope in chapter one) FMAAI was left in the same form as it was in chapter five of this study.

In addition to expert opinion, FMAAI was evaluated using field experiment which was actualized in form of prototyping. This form of evaluation rhymes with relevancy, one of the three cycles of Design Science (Hevner *et al.,* 2004). Relevancy implies that an artifact, in this case FMAAI, is presented to the community of practice to establish if it improves practice or if it addresses the key issues that lead to its development.

The aspects of FMAAI that are implementable in form of an information system or software application were implemented to produce PMAAI. Evaluation of PMAAI confirmed that its modules, which reflect implementable factors of FMAAI, are capable of supporting management of agricultural advisory information. The same criterion, as was used in expert opinion, was used as the basis for testing PMAAI giving results that confirm the potential of FMAAI in supporting management of agricultural advisory information in e-agriculture.

7.3. Research Contributions and Implications

The goal of this research was to develop a framework to support in the management of agricultural advisory information in e-agriculture in a developing economy like Uganda's. This was done by establishing the key factors that influence information management, designing an information management framework to support agricultural advisory information management and evaluating this framework. The contribution of this work to knowledge has been categorized into contribution to theory, contribution to methods and contribution to practice as elaborated upon in the subsequent paragraphs.

Contribution to Theory

This research contributes to theory by extending Nguyen et al. (2014) to derive FMAAI. The different frameworks to support management of information are critical and have been documented in different contexts but none has been developed to support management of agricultural advisory information in e-agriculture. In this sense FMAAI is one of the foundational frameworks to support agricultural advisory information management in e-agriculture.

Contribution to Methods

The use of SEM that allows modelling of several layers simultaneously is a novel approach compared to methods that involve multiple regression done individually. SEM is used to answer several related research questions in a single model. Therefore, this research is evidence that SEM is feasible for use to model framework development processes with utmost success in information systems research.

Contribution to Practice

Proposals arising from the FMAAI are practical suggestions that are as well founded on literature (See table 6.7 in chapter six). These proposals are implementable to ameliorate agricultural advisory information management practices in e-agriculture. In addition, the prototype (PMAAI), since it was tested with the community of practice, can be utilized as an important tool to support the different processes in agricultural advisory information management in e-agriculture.

Practitioners and policy makers in the agricultural sector have been made aware of information management as an important element in enhancing e-agriculture and consequently contributing to increasing agricultural productivity. This is expected because in the preliminary exploratory sessions with the staff of ministry of agriculture animal industry and fisheries (MAAIF) and in the agricultural agencies in Uganda people were less aware of the criticality of information management in their agenda.

7.4. Limitations of the Research

Some of the recent journal articles were not readily accessible especially those from high impact journals. This is because not all of these journals were subscribed to in the University where this research has been conducted due to limited resources.

The researcher obtained responses from 386 respondents in this study meaning that not all the small-scale famers, researchers and other stakeholders in agricultural advisory information management, were contacted in Uganda. Contacting more respondents would probably increase the credibility and reliability of the research results.

COVID 19 struck at a time when interacting with respondents would be best done especially for testing the PMAAI. This pandemic limited physical movement of the researcher implying that some physical interactions with the respondents were not possible thus missing out on the richness that the physical interaction comes with.

The framework supporting management of agricultural advisory information in e-agriculture is new. This means that the researcher did not have a close template on which to base conceptualization of such a framework. The frameworks on which conceptualizations were based were comprehensive but were not in the context of agricultural advisory information management. This explains why it was hard for the researcher to easily conceptualize the framework and to find literature relevant to this study. Nevertheless, the framework by Nguyen *et al.,* 2014 served as a basis for conceptualization of FMAAI.

In this study, an exploratory investigation to establish key challenges faced by stakeholders in agricultural advisory information management was not made, these challenges were obtained from literature. This was due to limited funds. To cover for this, an interview guide seeking for these challenges was taken alongside with the questionnaire, nevertheless this interview guide was not well accepted by respondents. They saw filling the questionnaire as providing enough data that the researcher was seeking for and so the researcher did not force this interview guide on them.

There are researchers who used SEM in information systems for example, Ajigini, (2018) and Arinaitwe, (2021). Nevertheless, using EFA and SEM with path analysis was not very common in information systems research given that this set of integrated methods is novel. Consequently, few statisticians were competent and willing to do data analysis based on these novel methods. These methods were also new to the researcher. It was hard and time consuming to find a competent statistician to do the analysis until Venantious Bbaale, was recommended and competently delivered the quality of results presented in this thesis.

7.5. Future Research

In this research, focus was put on Acquisition, storage, distribution and use of agricultural advisory information. Further research can be conducted involving other processes in information management like organization, processing and archival of information.

In this research, information was taken as a given, thus the investigation did not focus on the type of information or the qualities that agricultural advisory information has. For further research, agricultural advisory information could also be varied in order to ascertain the corresponding influence of this to agricultural advisory information management.

In this research there are no mediating variables, further research could isolate such variables and thus analyze their mediating role in this relationship.

7.6. Recommendations

In this research, questionnaires were used to collect data that was analyzed to get the FMAAI. We recommend the use of both questionnaires and interviews for data collection as the FMAAI is being developed. This can increase dependability of FMAAI.

We recommend the use of other data analysis methods other than exploratory factor analysis. Such method could be like confirmatory factor analysis or any other to see if such research can come up with similar or better results.

We recommend the use of other farmers (that are not small scale) operating in environments other than Uganda's. We also recommend the use of other information other than agricultural advisory information or extension information.

7.7. Conclusion

This study sought to develop a framework for supporting management of agricultural advisory information (FMAAI) in e-agriculture in developing economies like Uganda's. The first specific objective of the study was to establish the CSF for effective management of agricultural advisory information (FMAAI) in e-agriculture. This objective was achieved through the methods of reviewing literature and conducting a field study. Results of the field study were analyzed using EFA and the result of this analysis yielded the CSFs for effective management of agricultural advisory information. These factors are engrossed into people and technology, processes, funding and regulations and information use outcome and continuity. It is concluded therefore that these SCFs fundamental in the management of agricultural advisory information in e-agriculture in developing economies like Uganda.

The second specific objective of the study was to design the framework. The framework was designed using SEM with path analysis conducted on the CSFs that were obtained in research objective one above. The result of SEM with path analysis is a framework (FMAAI) the shows which CSFs influence the others. In this framework, people and technology (CSF 1) influences information use outcomes and continuity. In the same way, the CSF 2 (processes, funding and regulations) influence information use outcomes (CSF 3). It can be concluded therefore that the FMAAI is composed of people and technology (CSF 1) and the CSF 2 (processes, funding and regulations) influencing the influence information use outcomes (CSF 3). Therefore, this provides the design for the FMAAI in e-agriculture in developing economies like Uganda.

The third objective was to evaluate the framework. This was done using prototyping and expert opinion. As the design plus the identification of CSFs were conducted based on Design Science as the overarching method, the evaluation was also motivated by the same method. The results of the evaluation (expert opinion and prototyping) using the community of practice, as required by Design Science, show that the framework is suitable for supporting management of agricultural advisory information in e-agriculture in developing economies like Uganda. Therefore, we can conclude that the framework (FMAAI) is suitable for supporting management of agricultural advisory information in e-agriculture in developing economies like Uganda.

Management of agricultural advisory information is vital and there are factors that are critical to its success. Mechanisms that are dedicated to provide support in the management of agricultural advisory information are however still limited. Consequently, several challenges due to inadequate support to management of agricultural advisory information are documented and evident. In this study, a FMAAI was developed to contribute to the support needed in management of agricultural advisory information in e-agriculture.

This study also actualizes the FMAAI artifact by presenting concrete and practical suggestions on how framework elements or variables can be actualized in real life context of agricultural advisory information management in e-agriculture in a developing economy context like Uganda's. Based on these practical suggestions arising from the framework as presented in table 6.7 in chapter six of this thesis, and based on the evaluation results of FMAAI which involved the development of PMAAI and seeking expert opinion, it is cogent to conclude that stakeholders in agricultural advisory information management are bound to gain from using the support provided by FMAAI to contribute to improved acquisition, storage, distribution and use of agricultural advisory information to increase agricultural productivity in developing economies like Uganda's.

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APPENDICES

Appendix A: Questionnaire (Farmers and Agricultural Extension Staff)

MAKERERE UNIVERSITY

SCHOOL OF COMPUTING AND INFORMATICS TECHNOLOGY

Questionnaire

Improving Information Management in E-Agriculture in Resource Constrained Environments (RCEs).

Preamble

I am **Emmanuel Mugejjera**, a PhD student at Makerere University. I am conducting an Academic/Action Research in the field of E-Agriculture, titled **"Improving Information Management in E-Agriculture in Resource Constrained Environments (RCEs)".** This research is a partial fulfillment of the requirements for the award of a PhD in Information Systems of Makerere University. You have been purposively selected to participate in this survey. The survey should not take more than thirty minutes, please feel free to participate in this survey or not. The information from the questionnaire will be confidential and will be used for the purpose of academic research only.

Best Regards,

Emmanuel Mugejjera (Candidate - +256-703-186705)

<u>Section One:</u> Demographic Information

1.1. State the name of the institution where you work……………………………………………

1.2. State your job title …………………………………………………………………………

1.3. For how long have you been working in the job title selected in (1.2) above?

a) Less than 1 year b) between 2 to 5 years c) between 6 to 10 years d) Over 10 years

1.4. State your highest qualification attained **(Please tick the appropriate):**

a) Secondary level b) Diploma level c) Degree level d) Postgraduate Diploma

e) Masters f) PhD

1.5. State your gender (**Please tick as appropriate**): a) Male b) Female

1.6. State your age group (e.g. Between 15 - 20): ……………………… (years)

1.7. **OPERATIONAL DEFINITIONS**

Information management (IM) is the coordination and control of the generation, acquisition, storage, processing, dissemination and use of information in order to meet information needs of users.

Electronic agriculture (e-agriculture) is the use of information and communications technologies (ICTs) like mobile phones, computers and Internet in agriculture.

Section Two: Resource Constrained Environments and Information Management

Resource Constrained Environments (RCEs) are characterized by scarcity of materials like electricity, equipment, funds, Internet and human resources. Please use codes where **SA= Strongly Agree, A= Agree, NS = Not Sure, D = Disagree, and SD =Strongly Disagree.**

Resource constraints (RC) that hinder information management						
	Rate how these Resource Constraints affect the agricultural information management in your organization	***SA***	***A***	***NS***	***D***	***SD***
RCe1	*I have access to Electricity all the time.*					
RCe2	*I use a telephone to access agricultural information all the time.*					
RCe3	*I use a computer or laptop to access agricultural information all the time.*					
RCe4	*I have access to computerized agricultural equipment.*					
RCe5	*I use computerized agricultural equipment.*					
RCe6	*I am conversant with the use of information management tools to access agricultural information*					
RCe7	*I have all the funds I need to access agricultural information*					
RCe8	*I have access to the Internet to get agricultural information required.*					
RCe9	*The information management personnel are readily available to me.*					

<u>Section Three:</u> Information Management (IM) Factors and E-Agriculture.

3.1. People (PEO) factor

People are very important in the IM environment in the organization where I work. Please rate the importance of the following attributes of people in IM. Please tick as appropriate where SA= Strongly Agree, A= Agree, NS = Not Sure, D = Disagree, and SD =Strongly Disagree

PEOPLE (PE)						
	Rate how these people attributes affect agricultural information management in your organization	***SA***	***A***	***NS***	***D***	***SD***
PEco1	*My economic status (rich or poor) influences the way I seek agricultural information.*					
PEco2	*My political thinking affects the way I seek agricultural information*					
PEco3	*The people I interact with, influence my decision to seek and use agricultural information*					
PEs1	*My interpersonal skills influence my decision to seek and use agricultural information*					
PEs2	*My creativity skills influence my decision to seek and use agricultural information*					
PEs3	*My communication skills influence my decision to seek and use agricultural information*					
PEcu1	*My mother language influences my decision to seek and use agricultural information*					
PEcu2	*My religion influences my decision to seek and use agricultural information*					
	Any other, please specify					

3.2 (a) Technology (TEC) factor

Technology refers to methods, systems, and devices used in an information management environment. Technology has attributes that influence information management in e-agriculture. Please tick as appropriate where SA= Strongly Agree, A= Agree, NS = Not Sure, D = Disagree, and SD =Strongly Disagree

TECHNOLOGY (TEC)						
	Rate how these technology factors affect agricultural information management in your organization	***SA***	***A***	***NS***	***D***	***SD***
TEi1	*The design structure of technology is vital in influencing information storage and use*					
TEs2	*Technology designed for agricultural information management influences its usage*					
TEt1	*Technology tools influence agricultural information management*					
TEC2	*Information systems for agricultural stakeholders influence agricultural information management.*					
TEC3	*Information systems developed based on requirements of agricultural stakeholders influence agricultural information management*					
TEC4	*Information systems tested before their implementation for agricultural use influence agricultural information management.*					
TEC5	*Information systems which are easy to use by agricultural stakeholders influence agricultural information management*					
TEC6	*Information systems developed by involving agricultural stakeholders influence agricultural information management*					
TEC7	*Agricultural information systems which are expensive influence agricultural information management.*					
TEC8	*Agricultural information systems which are cheap to maintain influence agricultural information management.*					

3.2 (b) Technology (TEC) factor

Which of the following ICTs are used in your organization for managing information pertaining to agriculture and why? (Please tick all that apply and provide a reason for using or not using those ICTs)

#	**Do you use these ICTs tools in agriculture?**	**Yes**	**No**	**If no, why not?**
1	Mobile phones			
2	Laptop/Computer			
3	Internet			
4	E-mail			
5	Social media like WhatsApp			
6	Website			
7	Agriculture information system			
8	Radio			

9	Television			
	Any other (Please specify)			

3.3. Processes and Practices (PAP) factor

Processes and practices are all the activities and practices performed during information management (IM) which influence IM. Please tick as appropriate where SA= Strongly Agree, A= Agree, NS = Not Sure, D = Disagree, and SD =Strongly Disagree

PROCESSES AND PRACTICES (PAP)						
	Rate how these Processes and Practices affect agricultural information management in your organization	***SA***	***A***	***NS***	***D***	***SD***
PAP1	*Generation/Creation of information is a critical process in agricultural information management.*					
PAP2	*Acquisition of information is a critical process in agricultural information management*					
PAP3	*Organization of information is a critical process in agricultural information management*					
PAP4	*Maintenance of information is a critical process in agricultural information management*					
PAP5	*Storage of information is a critical process in agricultural information management*					
PAP6	*Distribution of information is a critical process in agricultural information management*					
PAP7	*Use of information is a critical process in agricultural information management*					
PAP8	*Retrieval of information is a critical process in agricultural information management*					
PAP9	*Disposal of information is a critical process in agricultural information management*					
	Any other, please specify					

3.4. Rules and Regulations Factor

In an information management (IM) environment, rules and regulations are vital. These rules and regulations are for example, about confidentiality, integrity and availability of information. **Please tick as appropriate where SA= Strongly Agree, A= Agree, NS = Not Sure, D = Disagree, and SD =Strongly Disagree**

RULES AND REGULATIONS (RAR)						
	Rate how these Rules and Regulations affect agricultural information management in your organization	***SA***	***A***	***NS***	***D***	***SD***
POL1	*Rules and regulations that are easy for information managers to comply with are vital in agricultural information management*					
POL2	*Rules and regulations that are relevant to information managers' practices are vital in agricultural information management*					
POL3	*Rules and regulations that are useful to information managers in their information management practice are vital in agricultural information management*					
POL4	*Rules and regulations that are understandable to information managers are vital in agricultural information management*					
POL5	*Rules and regulations that information managers get involved in making, are vital in agricultural information management.*					
POL6	*Rules and regulations that are known to information managers are vital in agricultural information management.*					
	Any other, please specify					

3.5. Facilities and Facilitation Factor

Facilities and facilitation are important factors in an IM environment. The following are attributes of facilities and facilitation that are important in an IM environment. **Please tick as appropriate where SA= Strongly Agree, A= Agree, NS = Not Sure, D = Disagree, and SD =Strongly Disagree**

FACILITIES AND FACILITATION (FAF)						
	Rate how facilities and facilitation affect agricultural information management in your organization	***SA***	***A***	***NS***	***D***	***SD***
FAF1	*Availability of money for agricultural information management needs is vital for its success*					
FAF2	*Availability of facilities to generate, acquire, store, process, disseminate and use information is vital for agricultural information management*					
FAF3	*Quality of facilities used is vital for the success of agricultural information management.*					
	Any other, please specify.					

3.6. Budget (BUD) factor

Budget is an estimate of income and expenditure for a set period of time. In an information management environment in the organization where I work, budget drafted or estimated for information management is vital. Please tick as appropriate where SA= Strongly Agree, A= Agree, NS = Not Sure, D = Disagree, and SD =Strongly Disagree

BUDGET (BUD)						
	Rate how program/project budget affect agricultural information management in your organization	***SA***	***A***	***NS***	***D***	***SD***
BUD1	*A realistic budget to information managers is vital for the success of agricultural information management*					
BUD2	*The ease with which the budget can be financed is vital for the success of agricultural information management*					
BUD3	*Stakeholder participation in drafting the budget is vital for the success of agricultural information management.*					
BUD4	*Thoroughness in the budget process is vital for the success of agricultural information management*					
BUD5	*Management support to the budget is vital for the success of agricultural information management*					
	Any other, please specify.					

3.7. Leadership (LEA) factor

Leadership is an important factor in IM. In an IM environment in the organization where I work, there are attributes of leadership that are vital in IM. Please tick as appropriate where **SA= Strongly** Agree, A= Agree, NS = Not Sure, D = Disagree, and SD =Strongly Disagree

LEADERSHIP (LEA)						
	Rate how your leadership skills affect agricultural information management in your organization	***SA***	***A***	***NS***	***D***	***SD***
LEA1	*Control and coordination efforts in order to achieve a specified goal, is vital for the success of agricultural information management*					
LEA2	*Identification and use of skills relevant to agricultural information management is vital to its success.*					
LEA3	*Leadership that stresses clear organization and arrangement of entities is vital for the success of agricultural information management.*					
LEA4	*Leadership that enforces prioritization is vital for the success of agricultural information management.*					
	Any other, please specify					

<u>SECTION Four</u>: Information Management Practices (IMP)

INFORMATION MANAGEMENT PRACTICES						
	Rate how the following information management practices fare as applied at your organization	***SA***	***A***	***NS***	***D***	***SD***
IMP1	*My organization has a formal policy or strategy for managing knowledge and information.*					
IMP2	*My organization has formal procedures to collect knowledge.*					
IMP3	*My organization has formal procedures to share knowledge.*					
IMP4	*My organization identifies and obtains knowledge from outside sources (e.g. industry partners, governments, universities).*					
IMP5	*Knowledge and information in my organization is available and organized to make it easy to find what I need.*					
IMP6	*Information about good work practices, lessons learned, and knowledgeable persons is easy to find in my organization.*					
IMP7	*My organization makes use of information technology to facilitate knowledge and information sharing.*					
IMP8	*My organization has a culture intended to promote knowledge and information sharing.*					
IMP9	*My work unit encourages experienced workers to communicate their knowledge to new or less experienced workers.*					
IMP10	*My organization encourages workers to attend training and/or education courses.*					
IMP11	*My organization has formal mentoring programs and/or apprenticeships.*					
IMP12	*My work unit has a culture intended to promote knowledge and information sharing.*					
IMP13	*Any other, please specify.*					

SECTION Five Information Use Outcomes (IUO)

INFORMATION USE OUTCOMES						
	Rate how your information use outcomes affect agricultural information management in your organization	***SA***	***A***	***NS***	***D***	***SD***
IUO1	*I can quickly recognize the complexities in a situation and find a way of solving problems.*					
IUO2	*My work tasks demand new, creative ideas and solutions.*					
IUO3	*My work benefits my organization.*					
IUO4	*I have influence over what happens within my work unit.*					
IUO5	*Sharing information is critical to my being able to do my job.*					

END

Appendix B: Interview Guide

MAKERERE UNIVERSITY

SCHOOL OF COMPUTING AND INFORMATICS TECHNOLOGY

Interview Guide (Farmers and Agricultural Extension Staff)

Improving Information Management in E-Agriculture in Resource Constrained Environments (RCEs).

Preamble

I am **Emmanuel Mugejjera**, a PhD student at Makerere University. I am conducting an Academic/Action Research in the field of information management in the context of E-Agriculture, titled **"Improving Information Management in E-Agriculture in Resource Constrained Environments (RCEs)*".*** This research is a partial fulfillment of the requirements for the award of a PhD in Information Systems of Makerere University. You have been purposively selected to participate in this interview. The interview should not take more than thirty minutes, please feel free to participate in this interview or not. The information you provide in this interview will be confidential, and will be used for the purpose of academic research only.

Best Regards,

Emmanuel Mugejjera (Candidate - +256 -703-186705)

INTERVIEW QUESTIONS FOR THE QUALITATIVE RESEARCH

1. State your name (Optional)……………………………………………………………..

2. State our phone number (Optional) ……………………………………………………

3. State the name of the institution where you work………………………………………..

4. State your title ………………………………………………………………………….

5. For how long have you been working in the job title above?................................. years

6. State your highest qualification attained**:** a) Primary level b) Secondary level C) Diploma level d) Degree level e) Postgraduate Diploma f) Masters g) PhD

7. State your gender: a) Male b) Female

8. State your age ……………………… (years)

9. What is information management, in your own understanding?

10. During information management, a farmer generates, acquires, stores, processes, uses and disseminates information. Do you agree that information management involves the above **processes**?

11. What are the other processes that the farmer does during information management?

12. Is a **farmer** important in his/her information management practices?

13. Are there certain characteristics a farmer should have in order to manage information easily?

14. If yes to question 13, state those characteristics.

15. What are the commonest **ICTs** that a farmer uses to do information management?

16. How do these ICTs help the farmer during information management?

17. Are there any **guidelines, rules or regulations** that a farmer follows during information management? If yes, which ones?

18. Why are those guidelines, rules or regulations important in the farmers' information management practices?

19. Does a farmer need **facilities or facilitation** in order to do information management?

20. If yes to question 19 above, state some of these faculties and facilitation.

21. How do these facilities and facilitation help the farmer in information management?

22. Does a farmer need a **budget** for information management?

23. How does this budget help the farmer in information management?

24. Does a farmer need **leadership** skills to do information management? Why?

25. We have seen that Information management involves generation, acquisition, storage, processing, use and dissemination of information. What else?

26. We have seen also that People (farmer), ICTs, regulations, budget, facilities and leadership are required by the farmer during information management. What else do you think is required?

27. In general, what are some of the **challenges** that the farmer faces in his/her information management practices?

28. What are some of your suggestions for addressing the challenges in 27 above?

END

Thank you for completing this interview.

Appendix C: Distribution of job titles among the respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agric. Farm Manager	1	.3	.3	.3
	Agriculture Extension Officer	2	.5	.5	.8
	Agriculture Officer	6	1.6	1.6	2.3
	Asst. Agriculture officer	1	.3	.3	2.6
	Builder and farmer	1	.3	.3	2.8
	District Production & Manager	2	.5	.5	3.4
	Farmer	354	91.7	91.7	95.1
	Farmer Trainer	1	.3	.3	95.3
	IT Officer	1	.3	.3	95.6
	Municipality agricultural officer	1	.3	.3	95.9
	Operation Wealth Creation Officer	1	.3	.3	96.1
	Senior Officer	1	.3	.3	96.4
	Sub County Extension Officer	1	.3	.3	96.6
	Tutor/Farmer	1	.3	.3	96.9
	Vermin Control Officer	1	.3	.3	97.2
	Agronomy advisor	1	.3	.3	97.4
	Animal husbandry officer	1	.3	.3	97.7
	Community based Facilitator	1	.3	.3	97.9
	District Agric. Officer	1	.3	.3	98.2
	Fisheries Officer	1	.3	.3	98.4
	Modal Farmer	1	.3	.3	98.7
	Poultry and Agriculture Officer	1	.3	.3	99.0
	Principal Agricultural Officer	1	.3	.3	99.2
	Production & Marketing Officer	1	.3	.3	99.5
	Records Manager	1	.3	.3	99.7
	Senior Agricultural Engineer	1	.3	.3	100.0
	Total	386	100.0	100.0	

Appendix D: System specification

SYSTEM SPECIFICATION (PLATFORM FOR SUPPORTING MANAGEMENT OF AGRICULTURAL ADVISORY INFORMATION MANAGEMENT (PMAAI))

1. Click System icon

2. System loads

See home page.

- Login

- Username

- Password

3. If username or password is not correct

See error message.

Prompt to login again

Login

-Username

-Password

4. If username or password is not correct

Go to number 3

5. If username and password are right

See the following.

(A) Registration

(B) Training Module

(C) IM System Development

(D) IM Budget

(E) Model IM Practices

(F) Rules and Regulations

(G) Funding Opportunities

(A) REGISTRATION

- Fill Registration Form
- Submit Form
- End

(B) TRAINING MODULE

- See themes for training
    - Information Acquisition
    - Information Storage
    - Information Dissemination
    - Information Retrieval
    - Information Processing

For each theme,

Select one theme.

See training materials (Videos, Words, Cartoons) for that theme.

Make an inquiry about the training materials selected.

Make a comment about the training.

View comments by other people

End

(B) PARTICIPATION IN IM SYSTEM DEV'T

- See Title of the system under development
- See a list of main users of the system
- Select from the list (Farmer, Extension worker)
    - Select Farmer Option
    - Get info about the system under Development and what you are required to do
    - See a form with a template of requirements from which you select the appropriate for you
    - The section includes the "Other " option
    - Summit your selection
        - Other users will also submit theirs
    - Each user will see the summary of requirements with scores (How many selected what)

- Print, view, Edit, Convert to PDF, send by email

- End

(C) CREATE BUDGET

- See boxes with labels: per day, per month, per year.

- There are items: data, airtime, phone or computer repair and maintenance, transport to IM training, miscellaneous ......

- Select any item and choose whether you spend on it per day, per month, per year.

- Enter the amount you spend on the selected item per day, per month, per year

[- When you enter per day or per month, the system calculates for you the per year amount]

- Do that for all items, there is an option for other, type the other

- See the total amount of money to spend generated by the system

- Print, view, Convert to PDF, send by email

- End

(D) MODEL INFORMATION MANAGEMENT PRACTICES

- See themes where model tasks are shown:

- Information Acquisition

- Information Storage

- Information Dissemination

- Information Retrieval

- Information Processing

For each theme,

- Select one theme

- See model materials (Videos, Words, Cartoons) for that theme as practiced by different people

- Make an inquiry about how the model farmer or extension worker does this

- Make a comment about the things you have seen

- View comments by other people

- END

(E) RULES AND REGULATIONS

- View rules and regulations relating to:

- Information Acquisition
- Information Storage
- Information Dissemination
- Information Retrieval
- Information Processing

For each theme,

- Select one theme
- See rules and regulations
- Make an inquiry about rules and regulations
- Make a comment about rules and regulations
- View comments by other people
- END

- Participate in making rules and regulations relating to:
    - Information Acquisition
    - Information Storage
    - Information Dissemination
    - Information Retrieval
    - Information Processing
- For each theme,
    - View description of rules and regulations under consideration
    - From a drop own menu, select all rules and regulations that you agree with
    - The drop down includes an option of other where you type what you think was omitted
    - View the passed rules and regulations (later ... after all have participated)
    - Extension worker adds rules and regulations to the existing ones
    - View comments by other people
    - END

(F) FUNDING OPPORTUNITIES

- View different options:
- Search

- Comment

- Ask for

- Testimony

- Other ...

Specify area of funding:

- Loan

- Grants

- Donations

- Other ...

- Assume you select Grant:

    - Enter details to apply

    - Edit

    - Submit

        - Check for status of the application later

        - Comment

        - View prior grants awarded and testimonies

    - Do all the above for applying for a loan and applying for a donation

    - END

All those scenarios were for the side of the farmer. the extension worker also has his scenarios which we can infer from those of the farmer. e.g., if a farmer receives feedback of a given query, the extensionist must have posted it ....

Appendix E: Evaluation Questionnaire for the Prototype

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Evaluation Questionnaire (Testing the Platform for Supporting management of agricultural advisory information (PMAAI))

In this study, information management is understood as the control and coordination of information: Its acquisition, storage, processing, dissemination and use. An information management framework is a frame/skeleton that provides pillars (critical success factors) that support information management. In this research we sought to develop an information management framework (IMF) that can support small scale farmers, engaged in e-agriculture, in the management of agricultural advisory information in Uganda. Such a framework was developed because of the inadequacy of the existing IMFs in supporting small scale farmers' management of agricultural advisory information. The developed IMF was based on lessons learnt from existing information management frameworks that were not intended for management of agricultural advisory information. Results of the study show that the developed framework consisting of the following pillars or critical success factors: (i) People and Technology, (ii) Processes, funding and regulations, and (iii) Information use outcomes and continuity. The following questionnaire seeks your view on whether the PMAAI has implemented functionalities reflected by the IMF consisting of critical success factors that support a small-scale farmer in management of agricultural advisory information.

Section One: **Demographic Information**

1.1. State the name of the institution where you work……………………………………

1.2. State your job title ………………………………………………………………...

1.3. For how long have you been working in that capacity mentioned in 1.2 above?

a) Less than 1 year (b) between 2 to 5 years (c) between 6 to 10 years (d) Over 10 years

1.4. State your highest qualification attained **(Please tick the appropriate):**

(a) Degree level (b) Postgraduate Diploma (c) Masters (d) PhD

1.5. State your gender (**Please tick as appropriate**): (a) Male (b) Female

<u>Section Two:</u> Critical success factors that support agricultural advisory information management.

Present your level of agreement or disagreement with the following assertions in relation to modules that make up the PMAAI as a prototype for an information management framework that supports small-scale farmers in the management of agricultural advisory information in e-agriculture in Uganda. This questionnaire should be filled after using the PMAAI.

2A. FUNCTIONALITY TESTING OF PMAAI

Use strongly agree (SA), agree (A) not sure (NS) disagree (D) and Strongly disagree (SD) to agree or disagree with the assertions presented in the tables bellow.

2A. FUNCTIONALITY TESTING OF PMAAI						
	Provide information about your level of agreement with the following statements as applied to the farmers information management application (PMAAI) as a tool for enabling the following functionalities:	***SA***	***A***	***NS***	***D***	***SD***
TESF1	PMAAI enables a farmer to get trained in information management practices,					
TESF2	PMAAI makes it possible for a farmer to get access to model information management practices,					
TEST3	PMAAI enables a farmer to create an information management budget.					
TESF4	PMAAI makes it possible for a farmer to participate in developing information management systems useful for information management.					
TESF5	PMAAI enables a farmer to get access to information management funding opportunities.					
TESF6	PMAAI makes it possible for a farmer to register as a user.					
TESF7	PMAAI makes it possible for a farmer to participate in making information management rules and regulations.					

2B. GOAL OF THE ARTIFACT

2B. GOAL OF THE ARTIFACT						
	Rate how you agree or disagree with the following modules of PMAAI related to goal of the system/application.	***SA***	***A***	***NS***	***D***	***SD***
	*The modules of the system (PMAAI) as presented in section **2A** are logical in the context of supporting information management*					
	The modules of the system (PMAAI) can support not only agricultural advisory information management but also other information management contexts.					

	Environment					
	The system (PMAAI) is useful to small scale farmers in management of agricultural advisory information in e-agriculture in Uganda.					
	The modules of the system (PMAAI) are understandable.					
	It is easy to see the modules in the system (PMAAI) and use them to support information management.					
	The system (PMAAI) is useful in management of agricultural advisory information by small scale farmers engaged in e-agriculture in Uganda.					
	The system (PMAAI) fits in the context of small-scale farmers engaged in management of agricultural advisory information in Uganda.					
	STRUCTURE					
	The system (PMAAI) is complete in as far as supporting management of agricultural advisory information is concerned.					
	The system (PMAAI) is simple.					
	The system (PMAAI) is clear.					
	The system (PMAAI) is similar to other systems that can be used for information management.					
	The system (PMAAI) provides sufficient details to enable people use it.					
	The system (PMAAI) is consistent with other systems.					
	ACTIVITY					
	The system (PMAAI) is accurate.					
	The system (PMAAI) supports agricultural advisory information management.					
	Small scale farmers can use the system (PMAAI) to get value out of agricultural advisory information.					
	EVOLUTION					
	The system (PMAAI) can continue to be used even if agricultural advisory information evolves to other formats.					

END

Thanks for filling this questionnaire.

Appendix F: Evaluation Questionnaire for Specialists in Information Management

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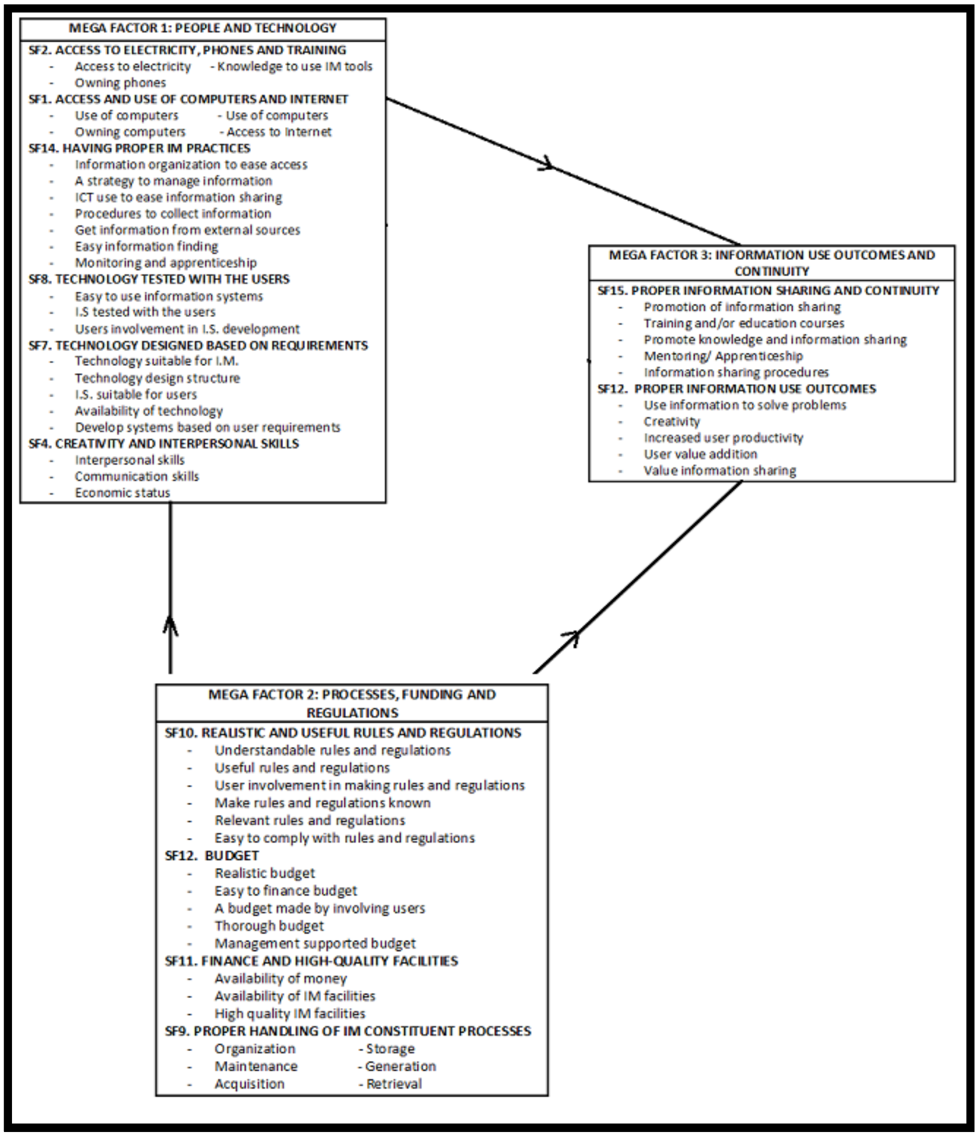
Evaluation Questionnaire (Specialists in Information Management)

Farmers' Information Management Framework

In this study, information management is understood as the control and coordination of information: Its acquisition, storage, processing, dissemination and use. An information management framework is a frame/skeleton that provides pillars (critical success factors) that support information management. In this research we sought to develop an information management framework (IMF) that can support small scale farmers in the management of agricultural advisory information in Uganda. Such a framework was developed because of the inadequacy of the existing IMF in supporting small scale farmers' management of agricultural advisory information. To inform the development of this IMF, the researcher based on literature about information management frameworks in various contexts and field study. Results of the study show the developed IMF consisting of the following pillars or critical success factors: (i) Availability of People and Technology, (ii) Availability of regulations, funding and management of Information Management (IM) Processes, and (iii) Existence of Information use outcomes and continuity. The framework shows that (i) and (ii) support (iii) as diagrammatically shown in the IMF below:



The following questionnaire seeks your view on these critical success factors as being suitable for supporting management of agricultural advisory information by small scale farmers engaged in e-agriculture in Uganda.

<u>Section One:</u> Demographic Information

1.6. State the name of the institution where you work……………………………………

1.7. State your job title ………………………………………………………………...

1.8. For how long have you been working in that capacity mentioned in 1.2 above?

b) Less than 1 year (b) between 2 to 5 years (c) between 6 to 10 years (d) Over 10 years

1.9. State your highest qualification attained **(Please tick the appropriate):**

(b) Diploma and below (b) Bachelor's Degree level (c) Masters Degree (d) PhD

1.10. State your gender (**Please tick as appropriate**): (a) Male (b) Female

<u>Section Two:</u> Critical success factors that influence information management

Present your level of agreement or disagreement with the following assertions in relation to the critical success factors that support management of agricultural advisory information by small scale famers engaged in e-agriculture in Uganda. Use strongly agree (SA), agree (A) not sure (NS) disagree (D) and Strongly disagree (SD).

The section 2A

2A. PEOPLE AND TECHNOLOGY						
	Indicate whether the following critical success factors (as they appear in the IMF diagrammatically presented above) are relevant in supporting management of agricultural advisory information.	***SA***	***A***	***NS***	***D***	***SD***
SF2	*Access to electricity, owning phones and having access to information management training should be in place.*					
SF1	*Access to and use of ICTs like computers and Internet should be emphasized.*					
SF14	*There should be proper information management practices.*					
SF8	*There should be technology, for information management, tested with the users.*					
SF7	*Technology used for information management should be designed based on user requirements.*					
SF4	*People involved in information management should be creative and with good interpersonal skills.*					
	Any other, please specify					

The section 2B

2B. FUNDING, PROCESSES AND REGULATIONS						
	Rate whether these funding, processes and regulations factors support management of agricultural advisory information by small scale farmers engaged in e-agriculture in Uganda.	***SA***	***A***	***NS***	***D***	***SD***
SF10	*There should be realistic rules and regulations that govern information management.*					
SF12	*There should be a budget for information management.*					
SF11	*Finance and high-quality facilities for information management should be available.*					
SF9	*Information management constituent processes like acquisition and storage of information should be properly handled.*					
	Any other, please specify					

Section Three

This section seeks your view on the artifact (FIMF) as a whole

3A. GOAL OF THE ARTIFACT						
	Rate how you agree or disagree with the following factors related to goal of the Framework	***SA***	***A***	***NS***	***D***	***SD***
	I think the factors, as presented in section 2A and 2B, are logical.					
	I think the factors, as presented in section 2A and 2B, can support not only agricultural advisory information management but also other information management contexts.					
	Environment					
	The factors identified in 2A and 2B are useful to small scale farmers engaged in management of agricultural advisory information in e-agriculture in Uganda.					
	The elements of the framework (i.e. critical success factors) are understandable					
	It is easy to see the components of the framework (i.e. critical success factors) that support information management and follow them.					
	The framework (composed of critical success factors) is useful in management of agricultural advisory information by small scale farmers engaged in e-agriculture in Uganda.					
	The framework fits in the context of small-scale farmers engaged in management of agricultural advisory information in Uganda.					
	STRUCTURE					
	The framework is complete.					
	The framework is simple.					
	The framework is clear.					
	The framework is similar to other information management frameworks.					
	The framework provides sufficient details.					
	The framework is consistent with other frameworks.					
	ACTIVITY					
	The framework is accurate.					
	The framework can support agricultural advisory information management.					
	Small scale farmers can use the framework to get value of agricultural advisory information.					
	EVOLUTION					
	The framework can continue to be used even if agricultural advisory information evolves to different formats.					
	The end					

Thank you for your time

Appendix G: Letters Used During Data Collection

MAKERERE UNIVERSITY

P.O Box 7062 Kampala- Uganda
URL: www.cit.mak.ac.ug
URL: http://www.cis.mak.ac.ug

Tel: +256-392-000-180
Twitter: @cocismak
Facebook: www.facebook.com/cocismak

COLLEGE OF COMPUTING AND INFORMATION SCIENCES
SCHOOL OF COMPUTING AND INFORMATICS TECHNOLOGY

1st August, 2019

To: Chief Administrative Officer (CAO)

..MASAKA................................

Dear Sir/Madam,

RE: Introduction of Mugejjera Emmanuel Undertaking Research on "Improving Information Management in E-agriculture in Resource Constrained Environments (RCEs)"

Mugejjera Emmanuel is a PhD Candidate in Information Systems at the School of Computing and Informatics Technology (at Makerere University). His research involves developing a model that will guide information managers in E-agriculture in RCEs. To achieve the research goal, he needs to conduct an exploratory survey at your district in the department of Agricultural extension involving key personnel that are responsible for information management. Specific information that will be required during the survey includes:

1. Current practices in information management in e-agriculture
2. Challenges in the current practices.
3. Key factors that influence information management in e-agriculture.

The purpose of this letter is to kindly request your organization to participate in the survey by availing the above information to the candidate. The exploratory survey will involve a questionnaire, interviews, and focus group discussions with key personnel in information management. Attached is a detailed template that highlights the required information from your organization. Study findings shall be compiled in a position paper that will be submitted to your organization. More details regarding this research can be obtained by contacting the candidate using: emugejjera@gmail.com or emugejjera@cis.mak.ac.ug, mobile: +256-772-959183 or 256-703-186705

Any assistance rendered to Emmanuel will be highly appreciated.

Sincerely,

Assoc. Prof. Gilbert Maiga (PhD)
Dean, School of Computing and Information Sciences

MASAKA DISTRICT
16 AUG 2019
FOR:
CHIEF ADMINISTRATIVE OFFICER

The Production Coordinator
Please avail the researcher the information required for his study.
16-8-2019
For CAO

National Crops Resources Research Institute
28 AUG 2019
RECEIVED

MAKERERE UNIVERSITY

P.O Box 7062 Kampala- Uganda
URL: www.cit.mak.ac.ug
URL: http://www.cis.mak.ac.ug

Tel: +256-392-000-180
Twitter: @cocismak
Facebook: www.facebook.com/cocismak

COLLEGE OF COMPUTING AND INFORMATION SCIENCES
SCHOOL OF COMPUTING AND INFORMATICS TECHNOLOGY

1st August, 2019

Director General,
Namulonge Agricultural and Animal Production Research Institute (NAARI)
Kampala, Uganda

Dear Sir/Madam,

RE: Introduction of Mugejjera Emmanuel Undertaking Research on "Improving Information Management in E-agriculture in Resource Constrained Environments (RCEs)"

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Any assistance rendered to Emmanuel will be highly appreciated.

Sincerely,

Assoc. Prof. Gilbert Maiga (PhD)
Dean, School of Computing and Information Sciences

II. DCO- Winnie

Kindly study this request and advise on information we can provide and how this may be sourced/structured.

28/8

DPO The student is allowed to collect data. Please give the necessary support 15/8/2019

MAKERERE UNIVERSITY

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COLLEGE OF COMPUTING AND INFORMATION SCIENCES
SCHOOL OF COMPUTING AND INFORMATICS TECHNOLOGY

OFFICE OF CHIEF ADMIN. OFFICER NTUNGAMO DISTRICT
15 AUG 2019
RECEIVED
SIGNATURE:

1st August, 2019

To: Chief Administrative Officer (CAO)
NTUNGAMO

Dear Sir/Madam,

RE: Introduction of Mugejjera Emmanuel Undertaking Research on "Improving Information Management in E-agriculture in Resource Constrained Environments (RCEs)"

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Any assistance rendered to Emmanuel will be highly appreciated.

Sincerely,

Assoc. Prof. Gilbert Maiga (PhD)
Dean, School of Computing and Information Sciences

ZARDIS
1. Mbarara ZARDI
2. NGETTA ZARDI
3. BULINDI ZARDI
4. Mukono ZARDI

19/8

MAKERERE UNIVERSITY

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COLLEGE OF COMPUTING AND INFORMATION SCIENCES
SCHOOL OF COMPUTING AND INFORMATICS TECHNOLOGY

EXECUTIVE DIRECTOR'S OFFICE
19 AUG 2019
RECEIVED

1st August, 2019

Director General,
National Agricultural Advisory Services (NAADS)
Kampala, Uganda

Dear Sir/Madam,

RE: Introduction of Mugejjera Emmanuel Undertaking Research on "Improving Information Management in E-agriculture in Resource Constrained Environments (RCEs)"

Mugejjera Emmanuel is a PhD Candidate in Information Systems at the School of Computing and Informatics Technology (at Makerere University). His research involves developing a model that will guide information managers in E-agriculture in RCEs. To achieve the research goal, he needs to conduct an exploratory survey at National Agricultural Advisory Services (NAADS) in the department of Agricultural extension involving key personnel that are responsible for information management. Specific information that will be required during the survey includes:

1. Current practices in information management in e-agriculture
2. Challenges in the current practices.
3. Key factors that influence information management in e-agriculture.

The purpose of this letter is to kindly request your organization to participate in the survey by availing the above information to the candidate. The exploratory survey will involve a questionnaire, interviews, and focus group discussions with key personnel in information management. Attached is a detailed template that highlights the required information from your organization. Study findings shall be compiled in a position paper that will be submitted to your organization. More details regarding this research can be obtained by contacting the candidate using: emugejjera@gmail.com or emugejjera@cis.mak.ac.ug, mobile: +256-772-959183 or 256-703-186705

Any assistance rendered to Emmanuel will be highly appreciated.

Sincerely,

Assoc. Prof. Gilbert Maiga (PhD)
Dean, School of Computing and Information Sciences

ED NAADS 0312178305

1. Bugiyanya East
Mr. Yiga Dennis
0782-306333

2. Mukono ZARDI
Alice Nakiganda
0772-579517
Dr. Isneka
0701-705639

MAKERERE UNIVERSITY

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Facebook: www.facebook.com/cocismak

National Crops Resources Research Institute
28 AUG 2019
RECEIVED

COLLEGE OF COMPUTING AND INFORMATION SCIENCES
SCHOOL OF COMPUTING AND INFORMATICS TECHNOLOGY

1st August, 2019

Director General,
Namulonge Agricultural and Animal Production Research Institute (NAARI)
Kampala, Uganda

Dear Sir/Madam,

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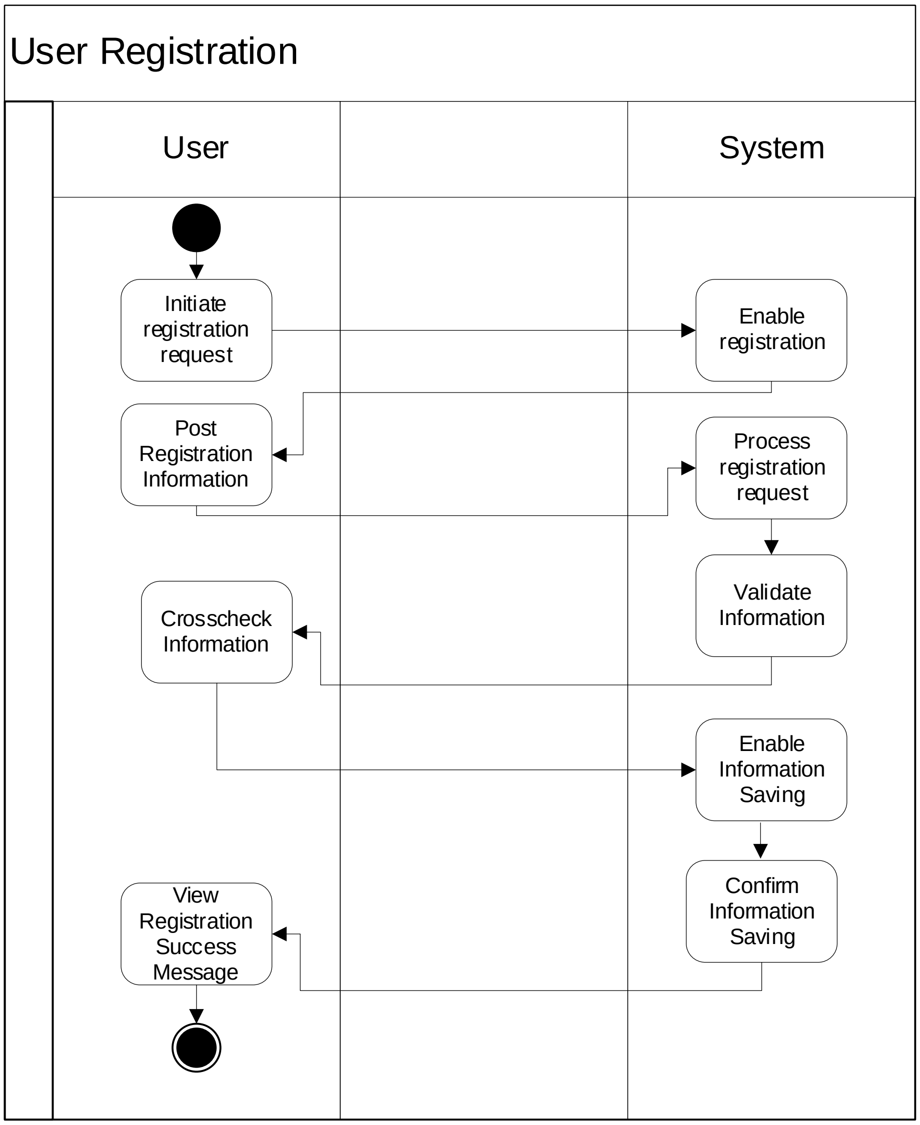
Any assistance rendered to Emmanuel will be highly appreciated.

Sincerely,

Assoc. Prof. Gilbert Maiga (PhD)
Dean, School of Computing and Information Sciences

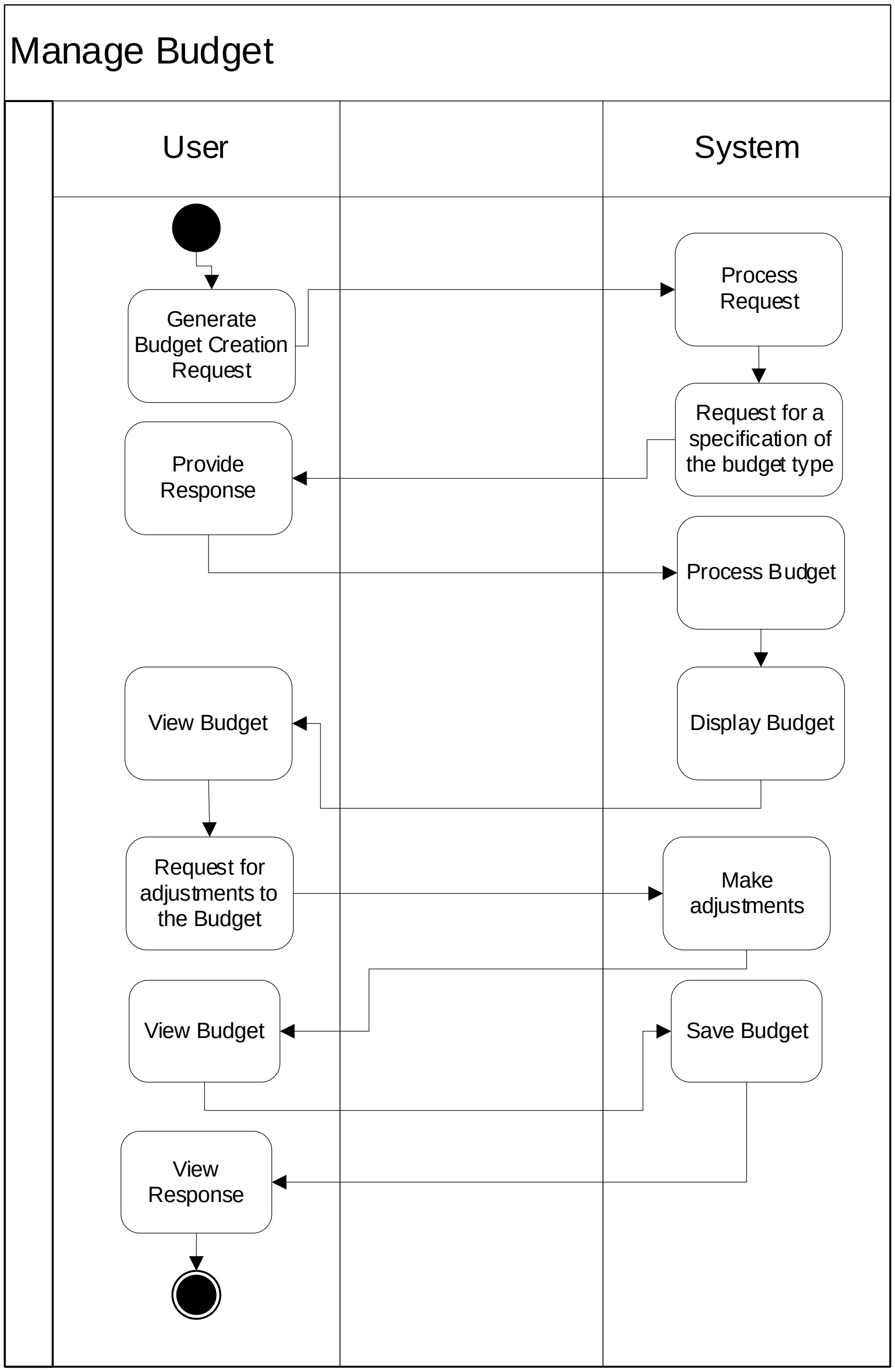
Appendix 1: Requirements and Design Documents

The user completes a registration use case by carrying out the activities highlighted in the figure below until the registration use case is completed and the user satisfied.



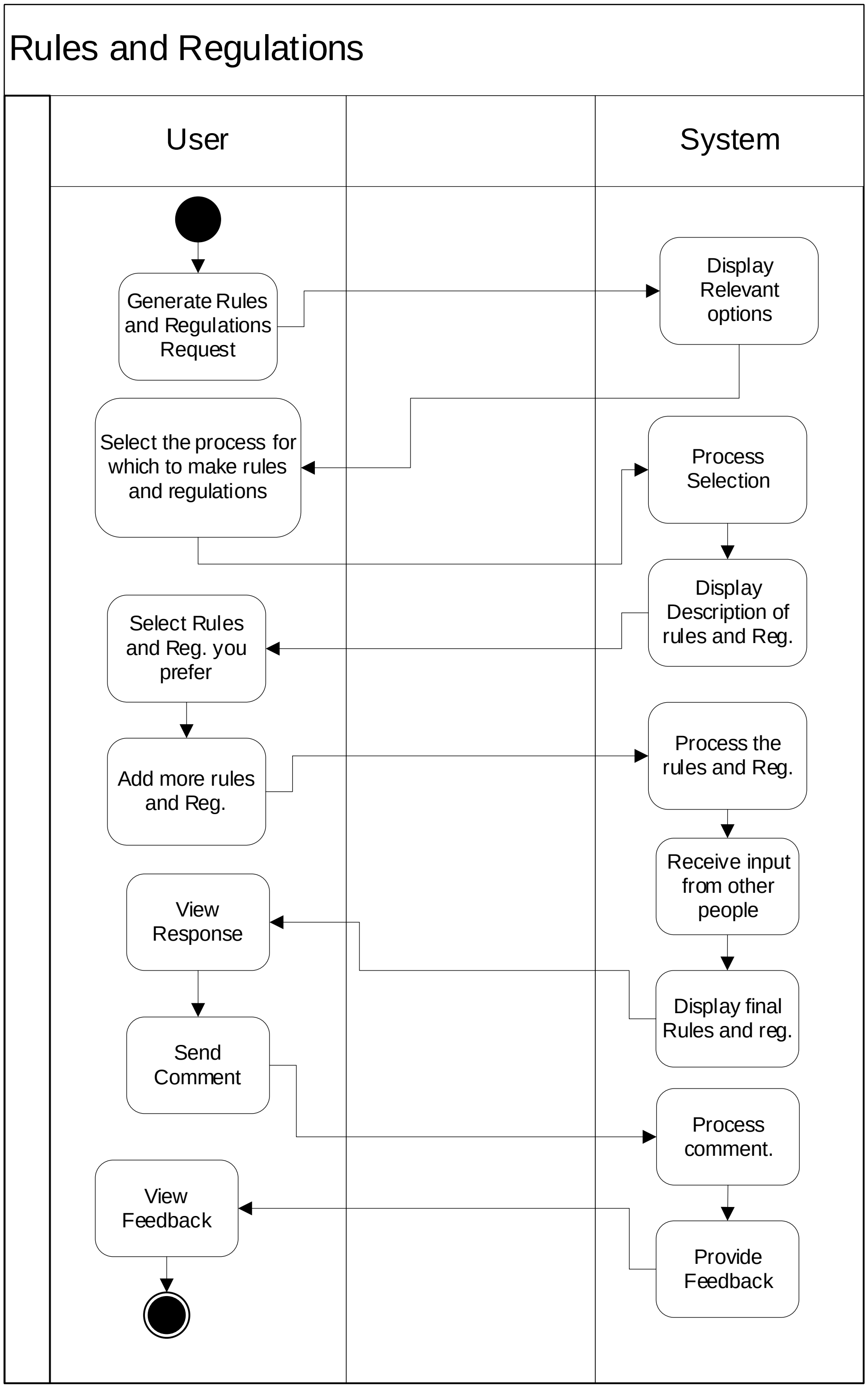
Activity diagram for registration

The user completes a budget management use case by carrying out the activities highlighted in figure below until the budget is created.



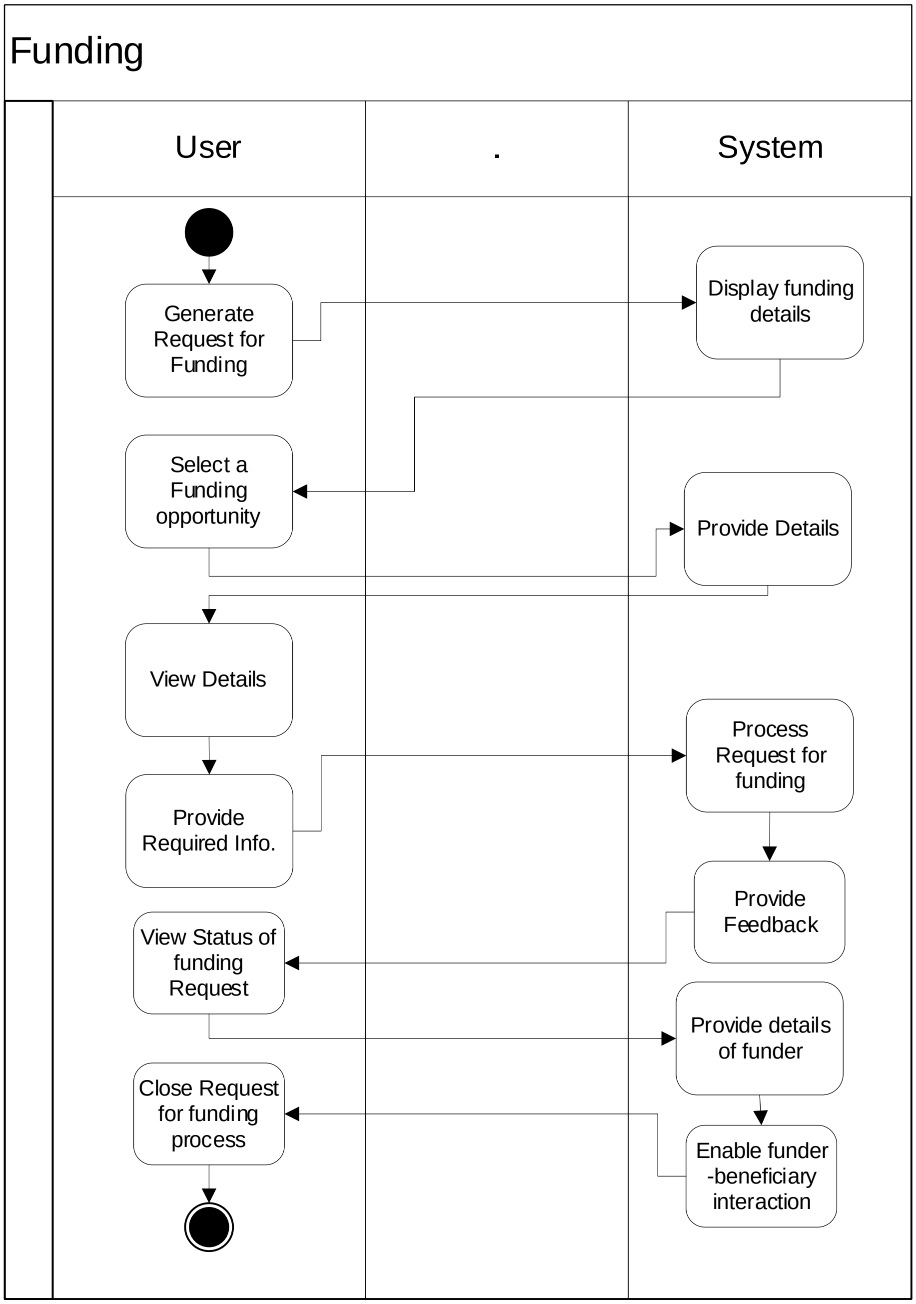
Activity diagram for budget management

The user completes by carrying out the activities highlighted in the figure below until the use case is completed.



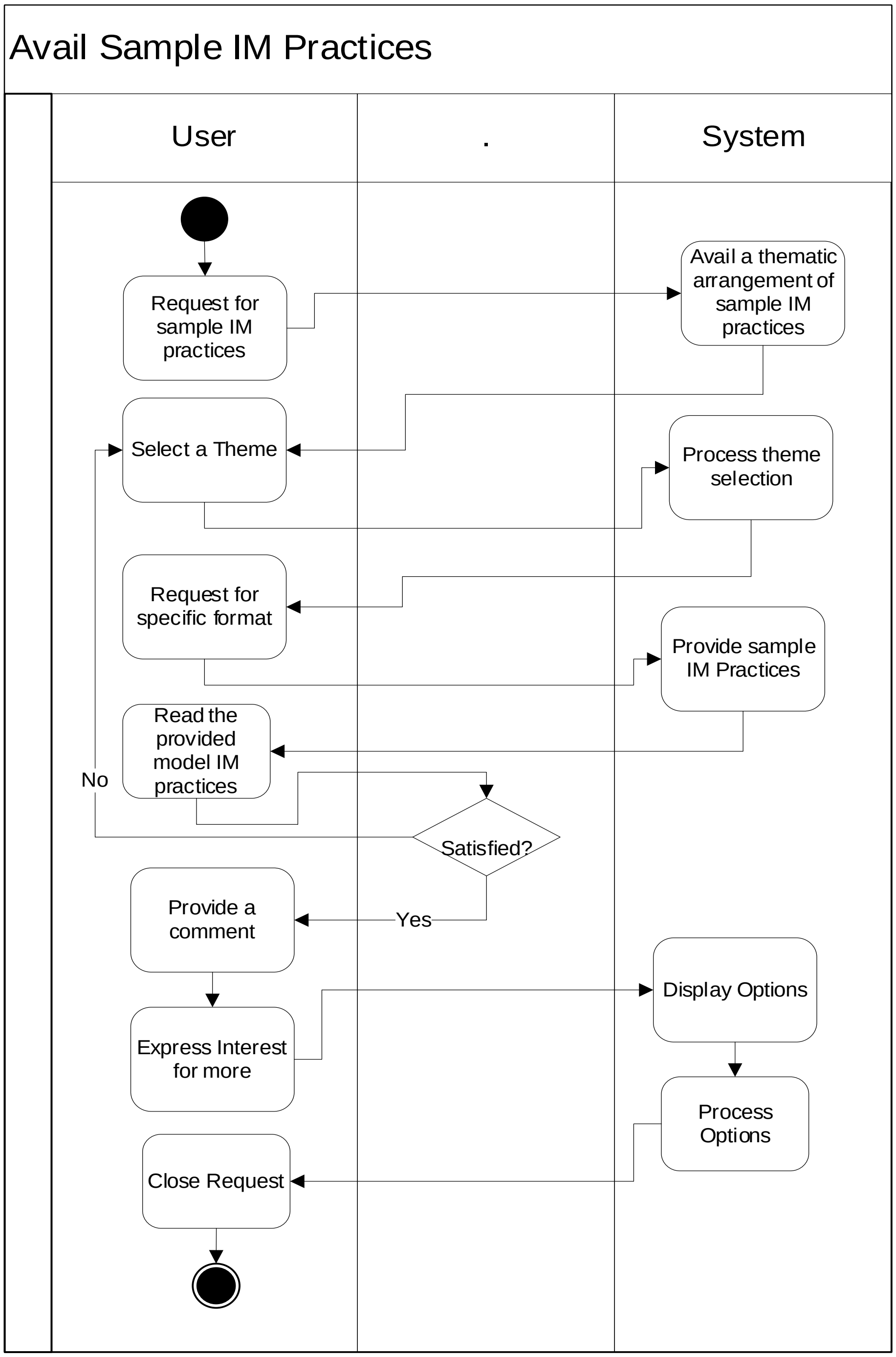
Activity diagram for Rules and Regulations management

The user executes the manage funding use case by carrying out the activities highlighted in the figure below until the use case is completed and the user is satisfied.



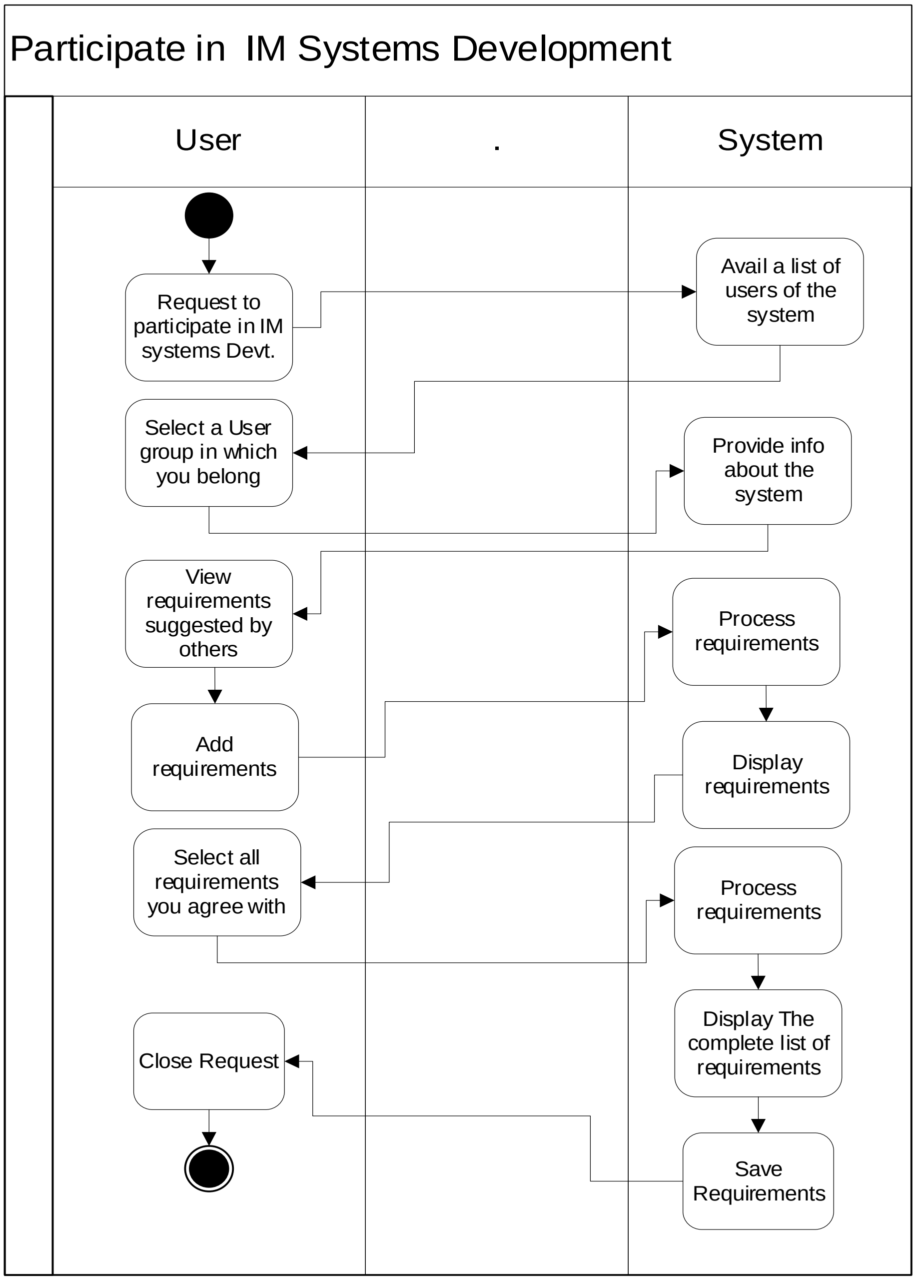
Activity diagram for the manage funding use case.

The user executes a manage sample information management practices use case by carrying out the activities highlighted in the figure below until the use case is completed and the user is satisfied.



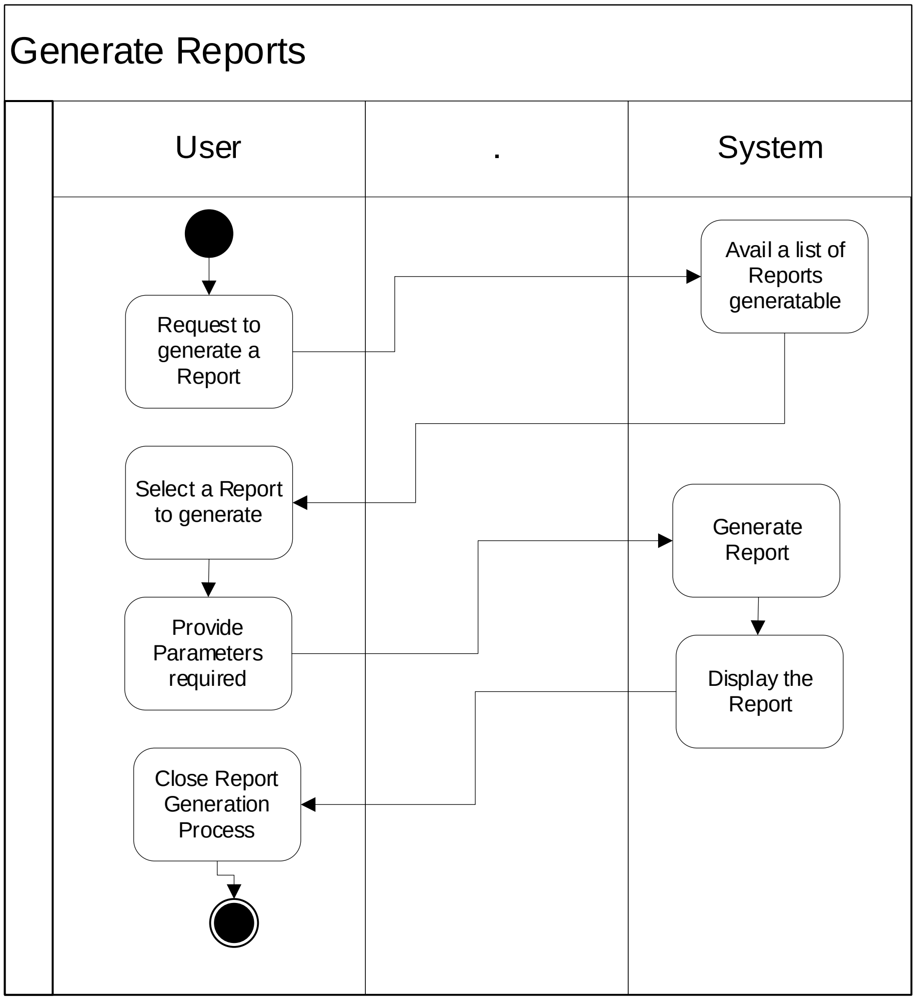
Activity diagram for the for the manage sample information management practices use case

The user executes a participate in information management systems development use case by carrying out the activities highlighted in the figure below until the use case is completed and the user is satisfied.



The activity diagram for the participate in information management systems development use case.

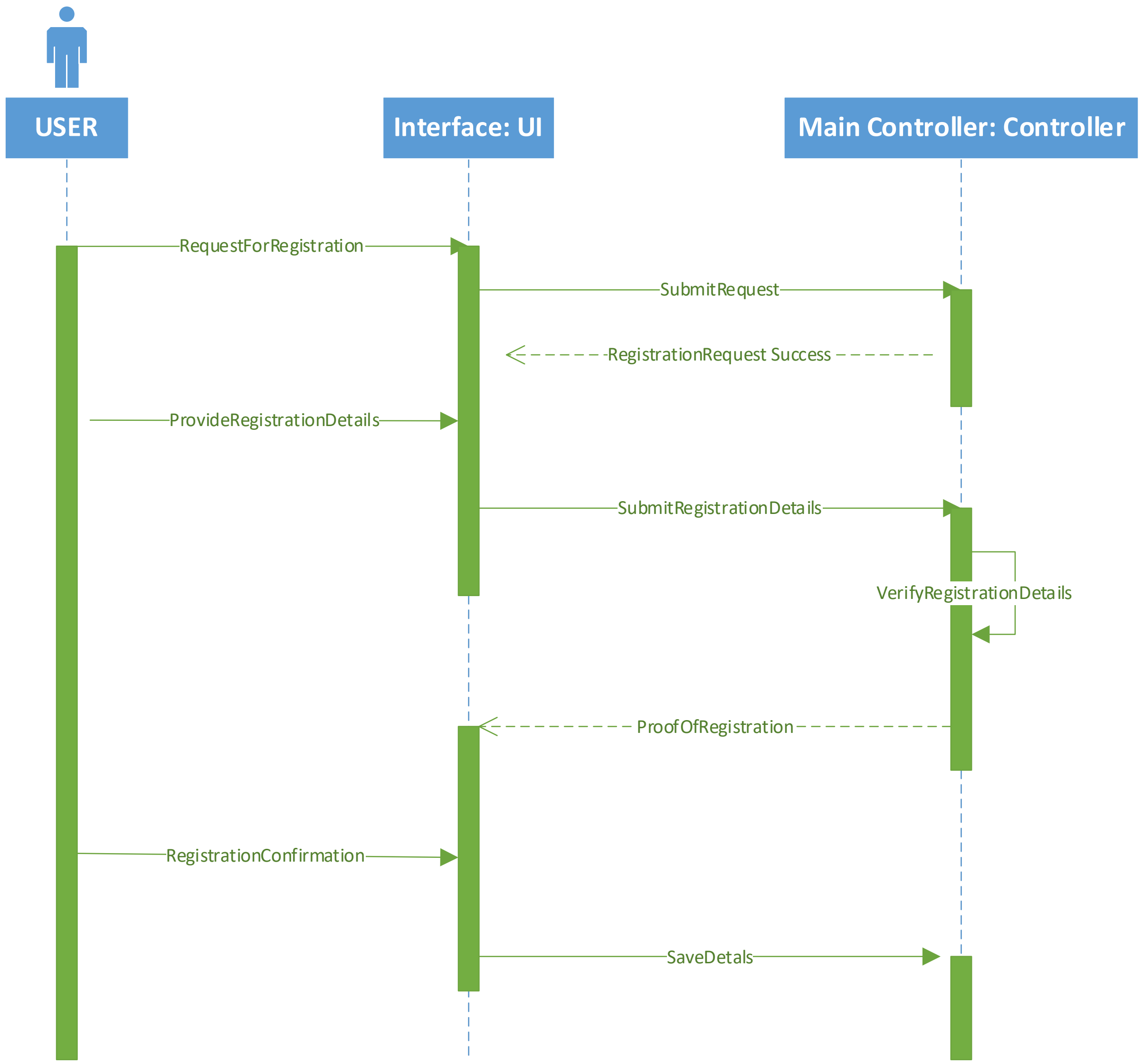
The user generates reports by carrying out the activities highlighted in the figure below until the user is satisfied.



Activity diagram for the generate report use case

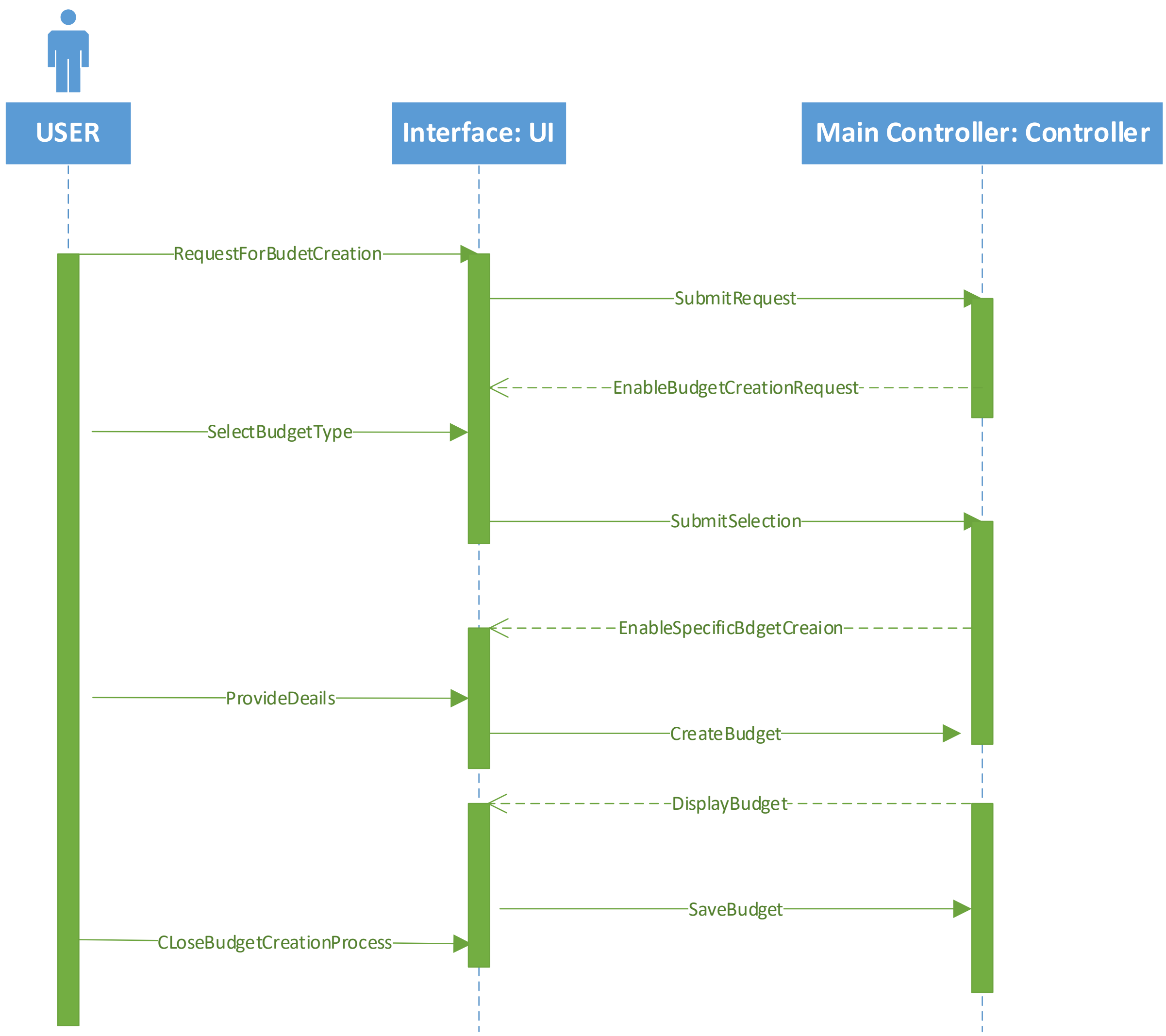
Appendix H: System Prototype Functions

The diagram below shows the sequence of events that happen between the user and prototype in order to accomplish the registration use case.



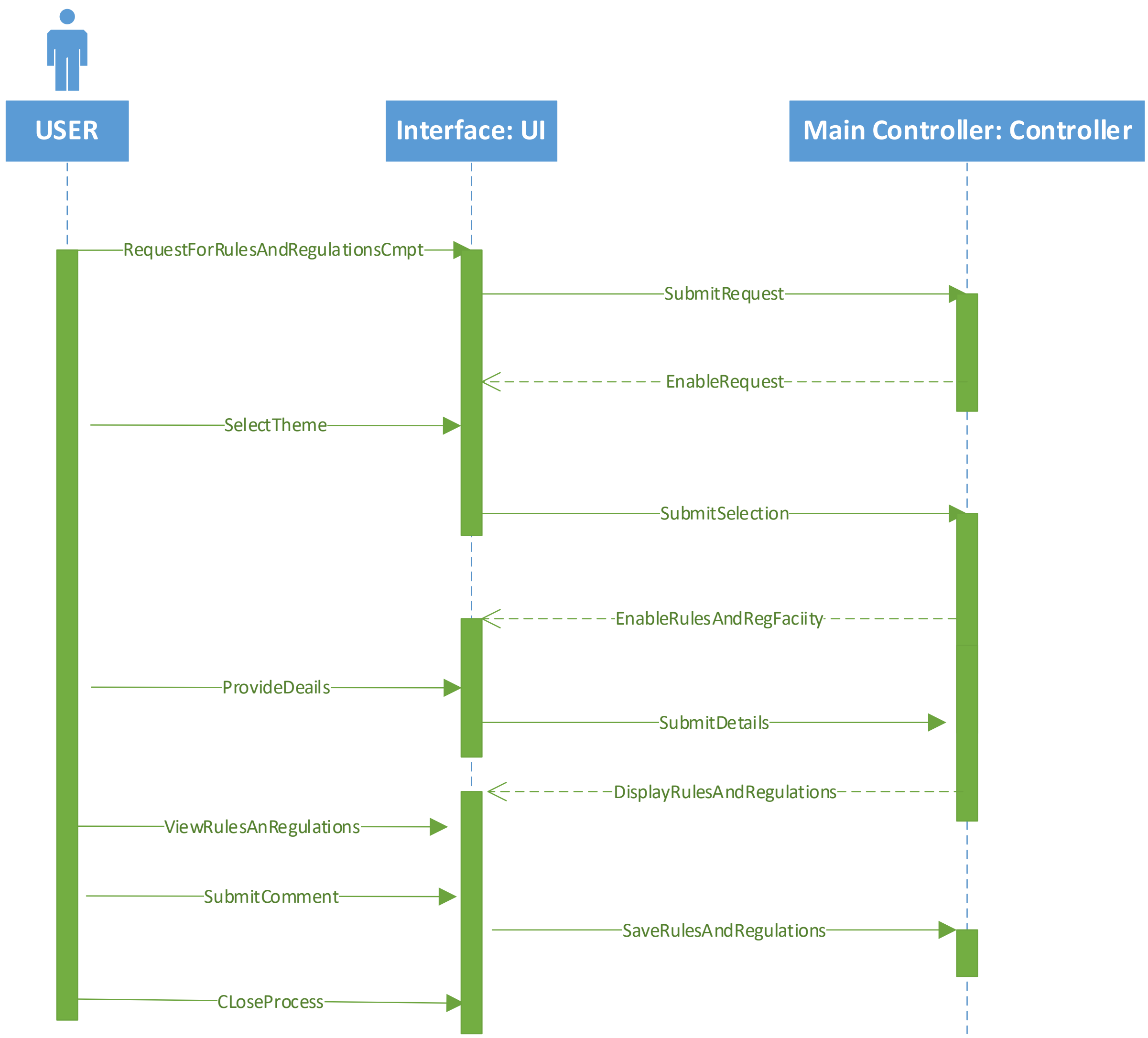
Sequence diagram for the registration use case.

The sequence diagram in the figure below shows a sequence of events that happen between the user and the prototype in order to accomplish the manage budget use case.



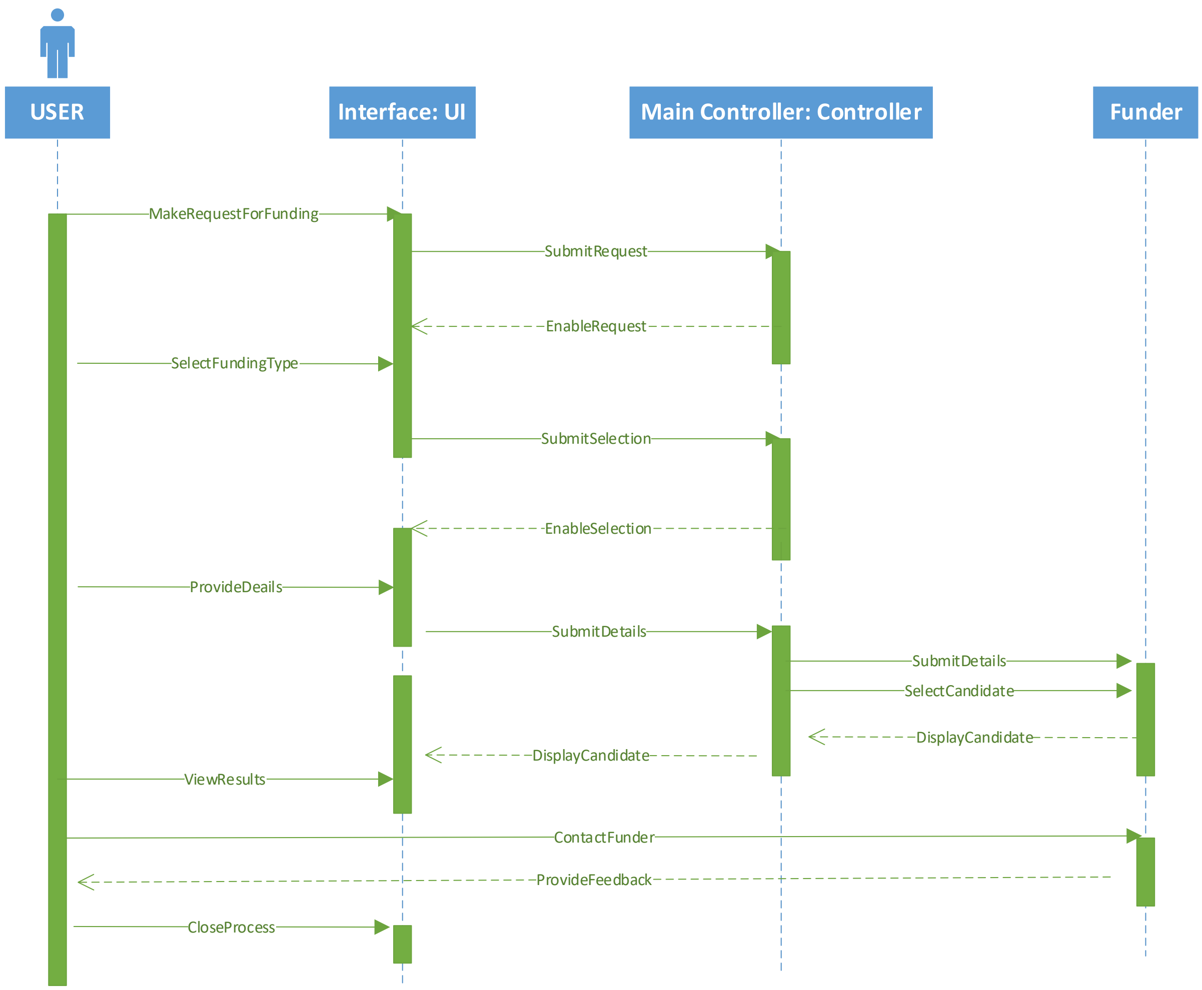
Sequence diagram for the manage budget use case.

The sequence diagram in the figure below shows a sequence of events that happen between the user and the prototype in order to accomplish the manage rules and regulations use case.



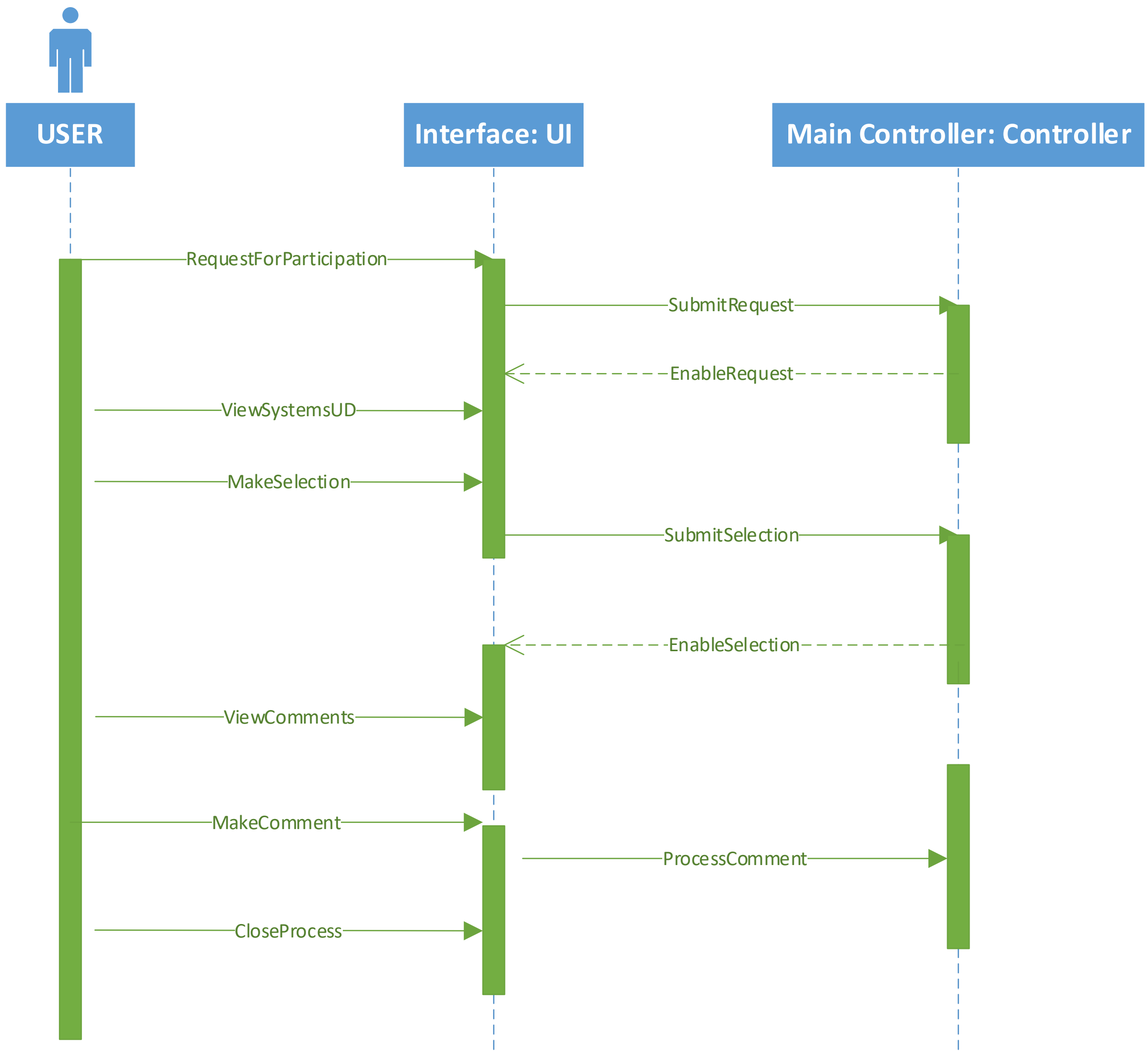
Sequence diagram for the manage rules and regulations use case.

The sequence diagram in the figure below shows a sequence of events that happen between the user and the prototype in order to accomplish the manage funding use case.



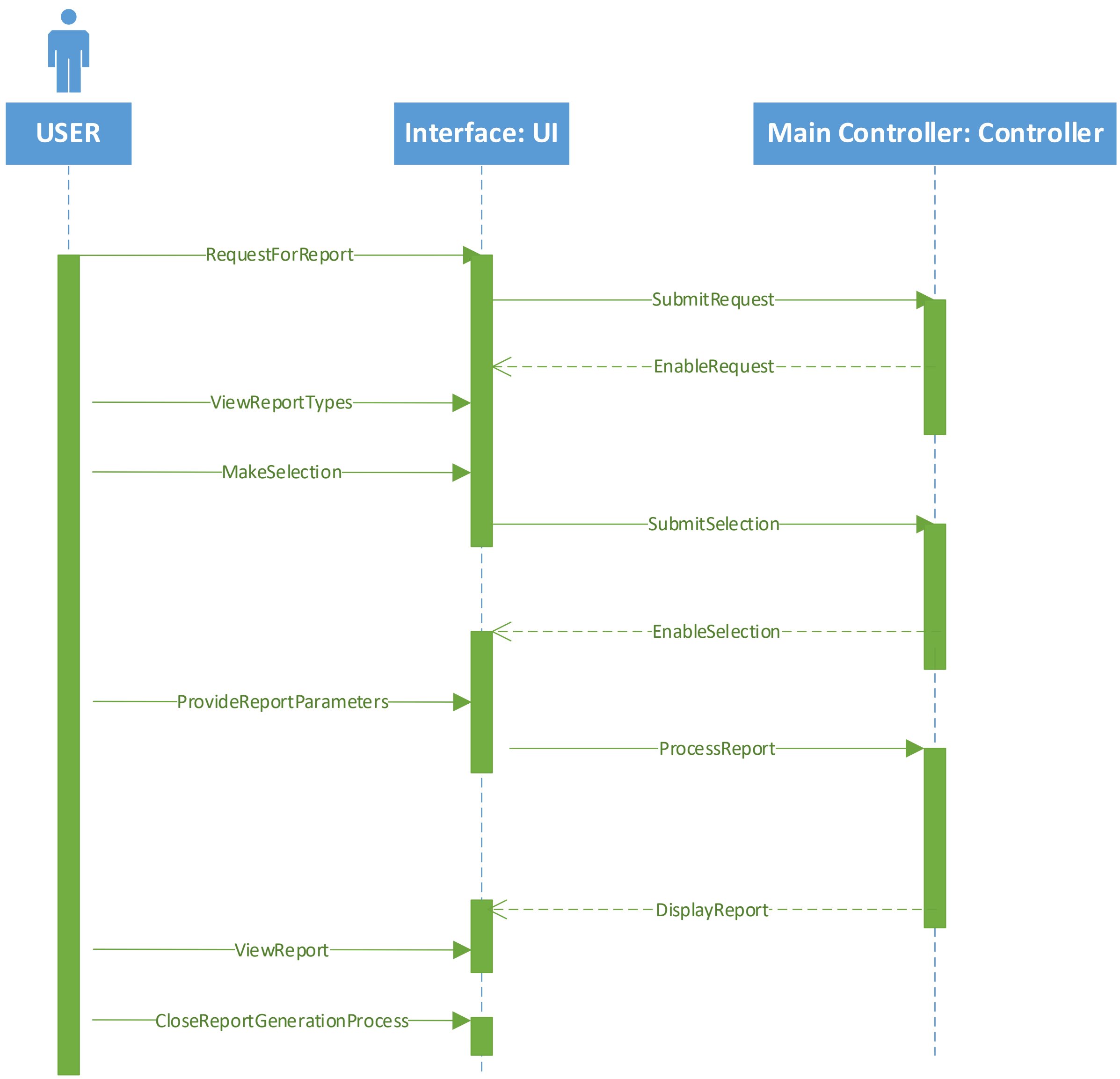
Sequence diagram for the manage funding use case.

The sequence diagram in the figure below shows a sequence of events that happen between the user and the prototype in order to accomplish the participate in information systems development use case.



Sequence diagram for the participate in information systems development use case.

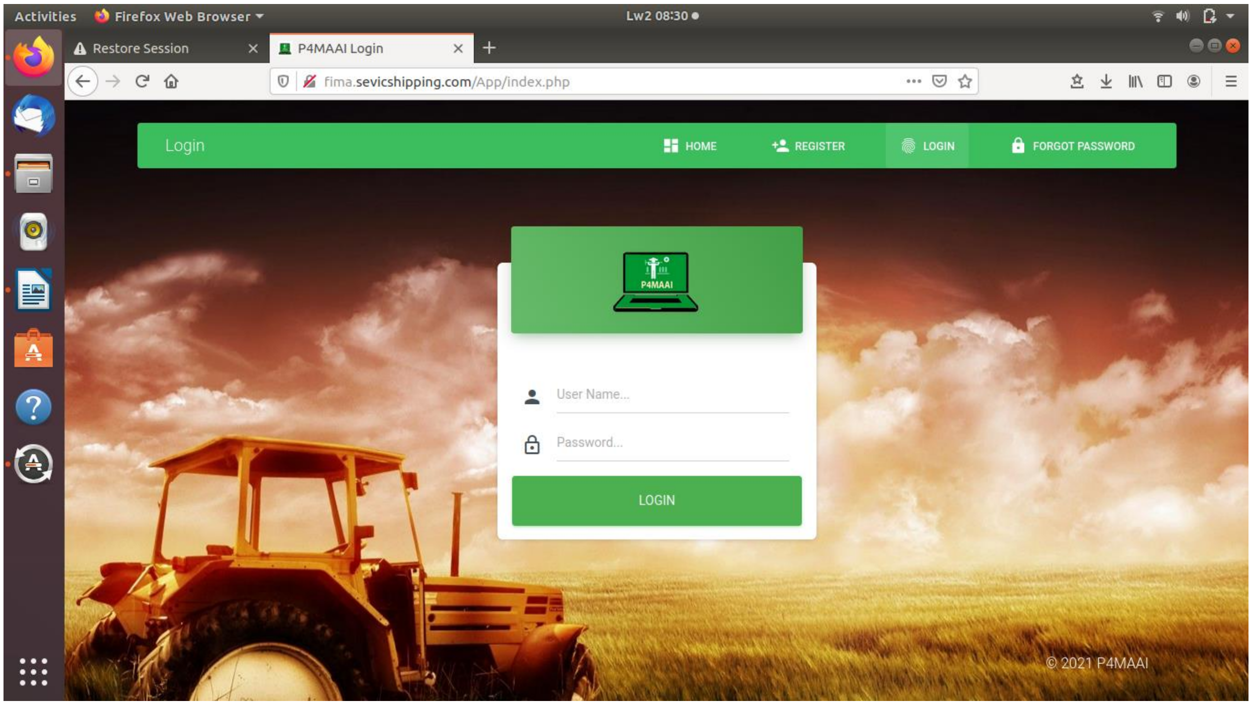
The sequence diagram in the figure below shows a sequence of events that happen between the user and the prototype in order to accomplish the generate reports use case.



Sequence diagram for the generate reports use case.

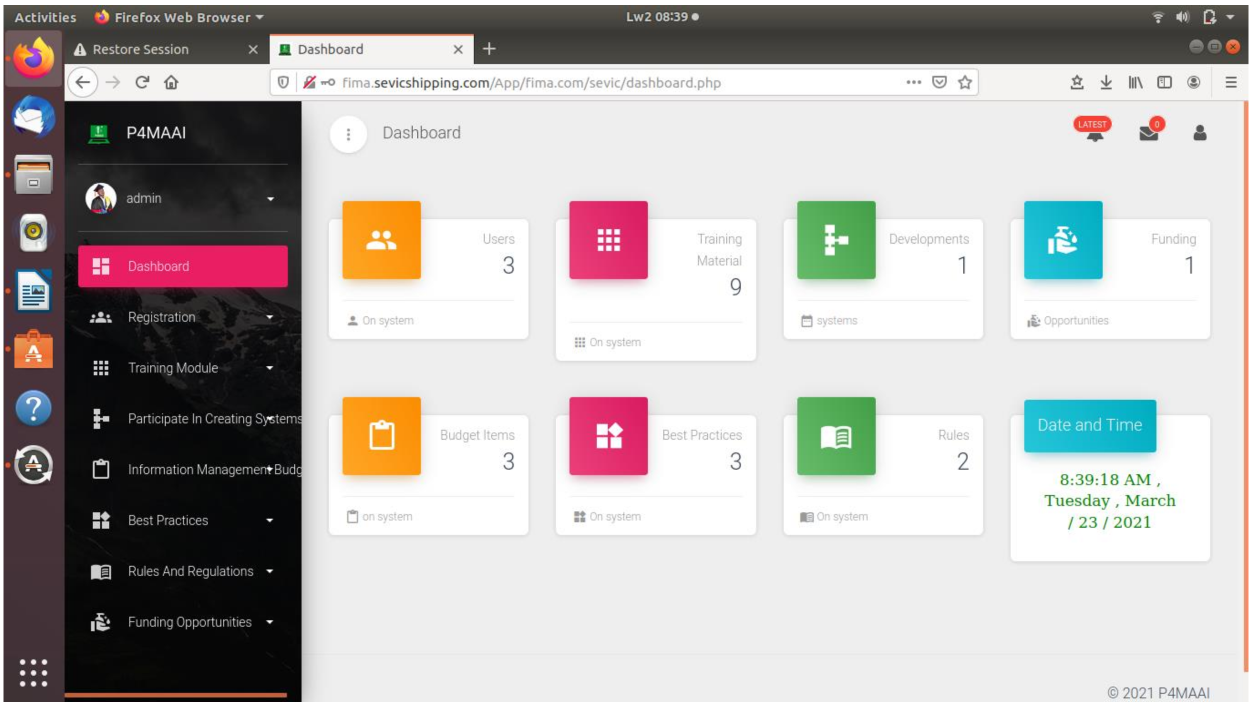
Appendix 2: System Prototype Functionality Description

The user logs in by providing a user name and password.



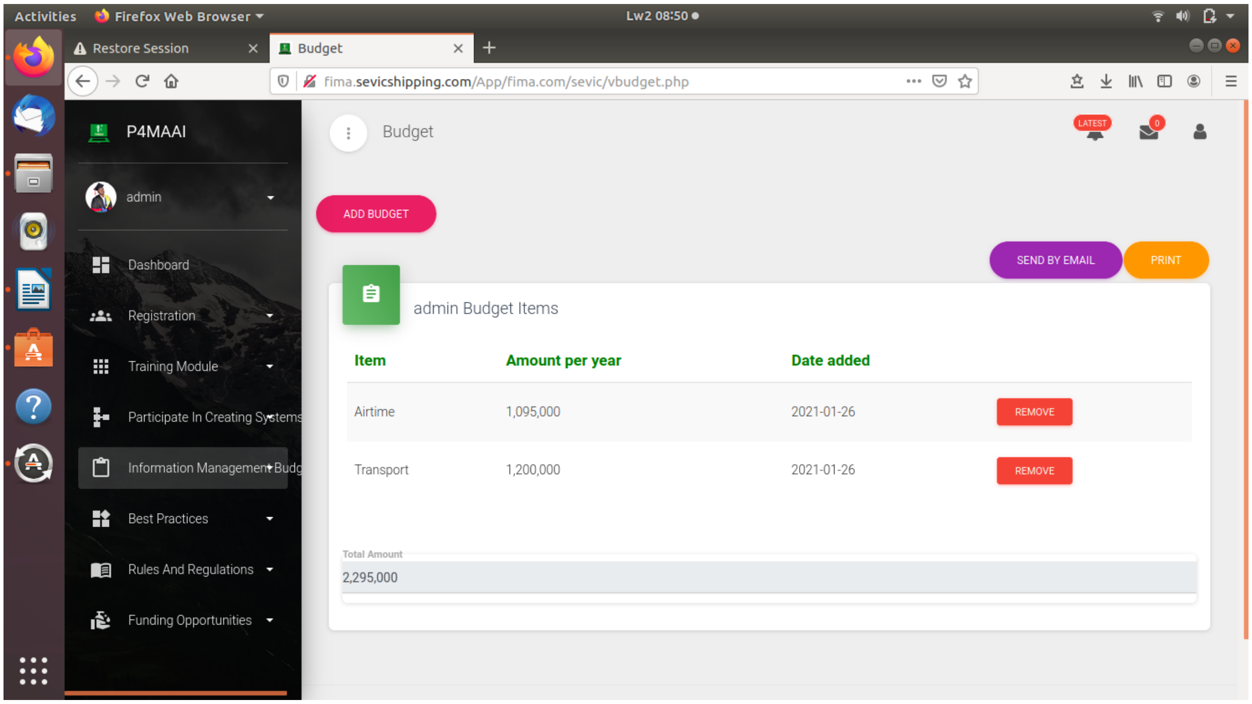
Screenshot for User Login

After logging in, the user is provided with the different module relevant to that user. Such modules are Admin, Dashboard, Training Module, and Best practices are shown



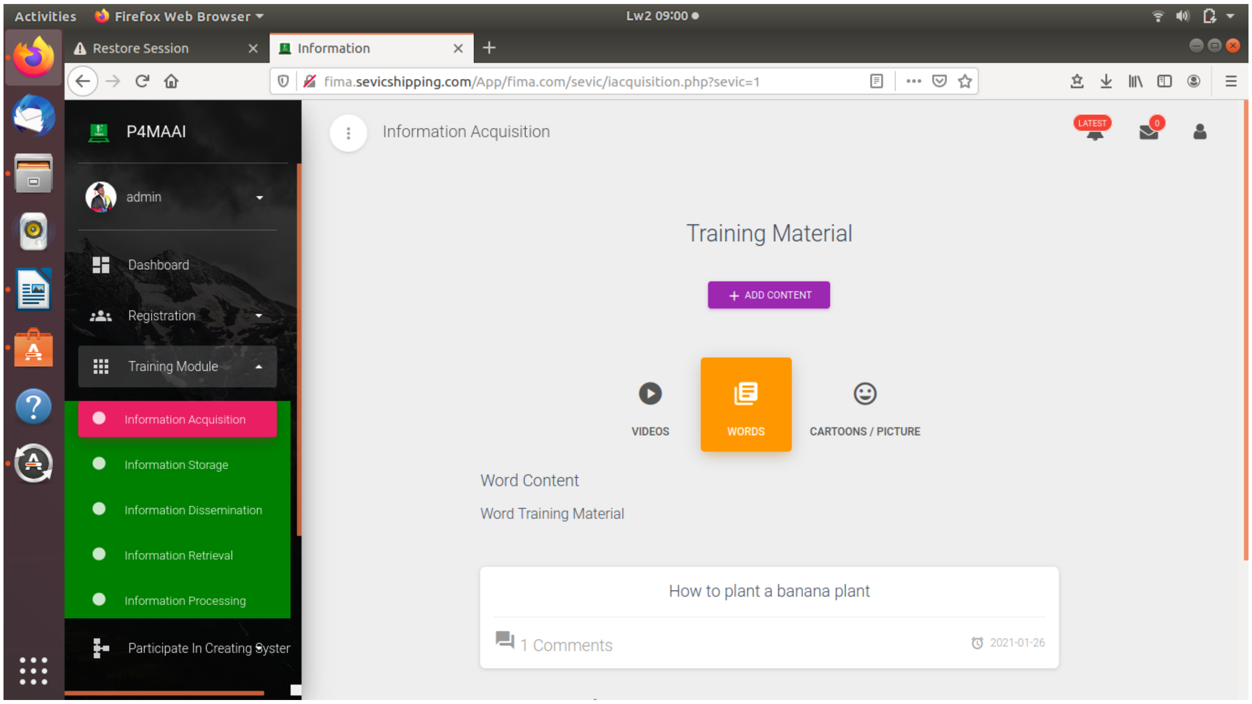
Screenshot for available modules in PMAAI

A sample budget is shown in the figure below



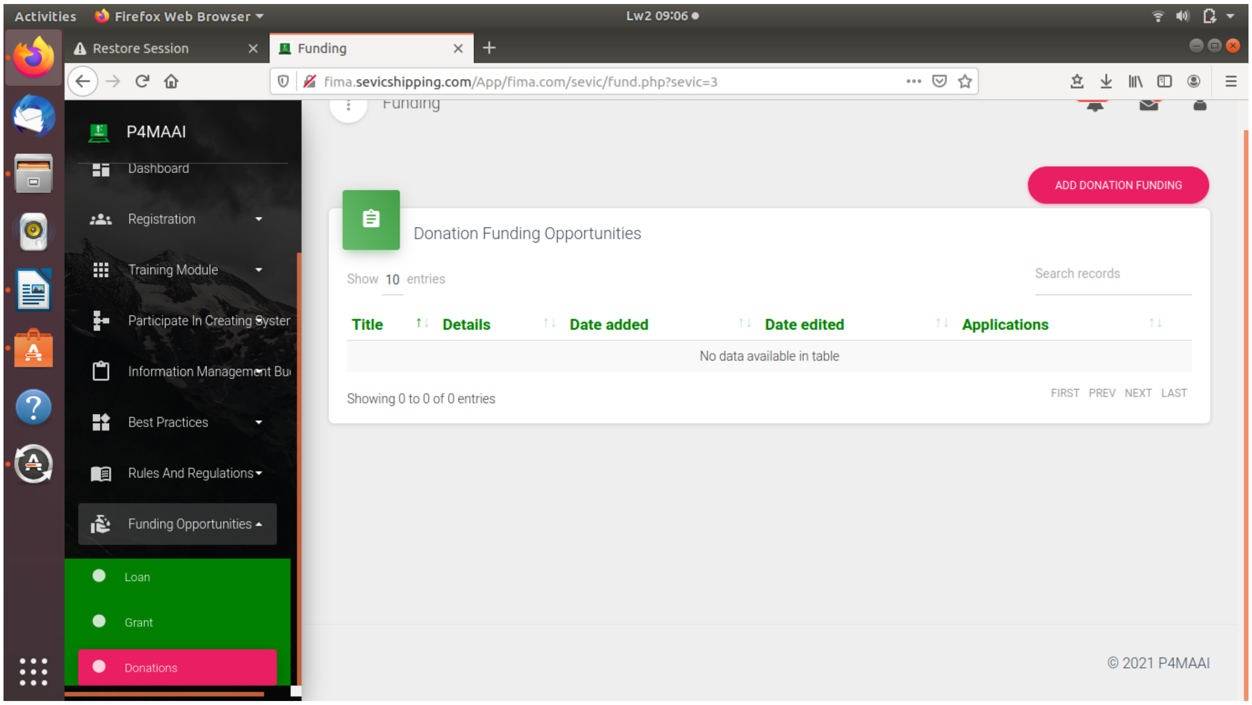
Screenshot for Information management budget

The system enables users to obtain training about different information management tasks like acquisition, storage, dissemination, processing and use of information.



Screenshot for Training

Figure below shows a screen shot of the search for funding use case.



Screenshot for Funding