UNIVERSITY OF NAIROBI

SCHOOL OF COMPUTING AND INFORMATICS

AN ICT MODEL FOR INCREASED ADOPTION OF AGRICULTURAL INPUT INFORMATION BY CEREAL FARMERS IN DEVELOPING COUNTRIES: A CASE IN SIKASSO, MALI

BY

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DECLARATION

I hereby declare that this project is my own work and has, to the best of my knowledge, not been submitted to any other institution of higher learning.

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This project has been submitted as the fulfilment of requirements for the PhD in Information Systems of the University of Nairobi with my approval as the University supervisor.

Prof Robert Oboko

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DEDICATION

To my father Professor Nianguiry KANTE who devoted himself to my education scarifying his own life to mine.

To my dear mother Niakale Kebe whose love and support was never lacking.

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Many people have supported me during this journey. I would like to speak about some of them here.

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ABSTRACT

Use of agricultural inputs by small-scale cereal farmers constitutes the basis for an improvement of their agricultural productivity. Such use is related to the adoption of agricultural input information disseminated by Information and Communication Technologies (ICTs).

ICT services have been set up in developing countries to disseminate agricultural input information. We can cite the ICT services Senekela and MyAgro in Mali; Nokia Life in India, Indonesia, Nigeria and China; MFarm in Kenya; IFFCO (Indian Farmers Fertilizer Cooperative Limited) Airtel Initiative and E-choupal in India; TigoKilimo in Tanzania; Ukisaan and Kissan in Pakistan. Hence, farmers have been exposed to ICT on agricultural input information in developing countries.

Despite the availability of these different ICTs channels in the agricultural input information sector, adoption of agricultural input information remains a problem for small-scale cereal farmers. That problem is linked to the low use of these ICT services by small-scale cereal farmers. Furthermore, the low use was restrained by certain factors. Therefore, an investigation needed to be conducted into these factors affecting small-scale cereal farmers' use of ICT on agricultural input information and their relationships to inform the design and delivery of this information service in developing countries using the case of Sikasso in Mali to gather data.

The specific objectives are:
The broad objective of this study is to propose an ICT model for increased adoption of agricultural input information.
The specific objectives are:

1. To establish farmers' perception of ICT on agricultural input information and to identify the effects of this perception on the use of these ICTs.
2. To establish farmers' influence on each other in the use of ICT on agricultural input information and to identify the effects of this influence on the use of these ICTs.
3. To establish the challenges faced by farmers in the use of ICT on agricultural input information and to identify the effects of these challenges in the use of these ICTs.
4. To propose an ICT model for increased adoption of agricultural input information.

This study was conducted in Sikasso, Mali through quantitative methods. A positivist philosophical point of view was adopted for this research. A pilot study was conducted to validate the research instrument and the proposed model. Its results were very useful in confirming the proposed model based on the literature review in the field of use of ICT by small-scale cereal farmers to adopt (access and use) agricultural input information in developing countries. However, some items were dropped to enhance the instrument

reliability and validity. The main study was cross-sectional. Data was collected from 222 respondents against a target of 200.

The model was analysed using Partial Least Square Structural Equation Model (PLS-SEM) following the guidelines available in the field of Information Systems Research. The study proposed a model for small-scale cereal farmers that was highly predictive and explicative of use of ICT by small-scale cereal farmers in developing countries.

This research has made a theoretical contribution: It has proposed a new model in the study of ICT adoption/use. Methodological contributions were also made by proposing an updated guideline for the use of PLS in Information System research for an exploratory study, by developing a method to translate a survey instrument from English into French and Bambara (Nko), by contributing to the debate of how to establish the discriminant validity. The research made a practical and managerial contribution by proposing to the ICT services managers a model that they should take into account before deploying any such service to cereal farmers. We pointed out where further inquiries could be taken from this research.

RÉSUMÉ

L'utilisation des intrants agricoles par les petits exploitants producteurs de céréales est la condition d'une meilleure rentabilité agricole. Une telle utilisation est liée à l'adoption de l'information agricole sur ces intrants agricoles qui peut être diffusée par les technologies de l'information et de la communication (Tics).

Dans cette optique de diffusion de l'information agricole sur les intrants agricoles, les Tics ont été développés et déployés dans les pays en voie de développement. On peut citer Senekela et MyAgro au Mali ; Nokia Life en Inde, Indonésie, Nigeria et en China ; MFarm au Kenya ; IFFCO (Indian Farmers Fertilizer Cooperative Limited) Airtel Initiative et E-choupal en Inde ; TigoKilimo en Tanzanie ; Ukisaan and Kissan au Pakistan. Par conséquent, les petits producteurs de céréales ont été expose aux Tics sur les intrants agricoles dans les pays en voie de développement.

Malgré l'exposition à ces différents Tics dans le secteur de l'information agricole relative aux intrants, l'adoption de cette information est toujours problématique pour les petits producteurs de céréales. Le déficit d'adoption de l'information agricole relative aux intrants est réfréné par une utilisation insuffisante des TICs dans le domaine de l'information agricole sur les intrants. Par conséquent, une recherche devrait être conduite pour déterminer les facteurs qui affectent l'utilisation de ces TICs et les relations entre ces différents facteurs (un modèle) dans les pays en voie de développement utilisant le cas de Sikasso au Mali pour collecter les données.

Le principal objectif de cette recherche était de proposer un modèle Tics pour une adoption accrue de l'information agricole sur les intrants.
Les objectifs spécifiques sont :

1. Etablir la perception des Tics par les paysans et identifier son effet sur l'utilisation de ces Tics
2. Etablir l'influence que les paysans ont sur les uns et les autres et identifier son effet sur l'utilisation de ces Tics
3. Etablir les défis que font faces les paysans dans l'utilisation des Tics et identifier ses effets sur l'utilisation de ces Tics.
4. Proposer un modèle Tics pour une adoption accrue de l'information agricole sur les intrants.

Cette étude a été conduite dans la région de Sikasso, Mali à travers des méthodes quantitatives. Du point de vue épistémologique, une approche positiviste a été adoptée. Une étude préliminaire a été conduite pour tester et valider le questionnaire et le proposé modèle conceptuel. Ces résultats ont été très utiles dans la confirmation du proposé modèle qui était base sur les données de la littérature dans le domaine de l'adoption et l'utilisation des Tics par les paysans dans les pays en voie de développement. En plus, les résultats ont permis the

valider le questionnaire. Néanmoins, quelques questions ont été retirées de celui-ci. L'étude proprement dite a été ainsi conduite dans la région de Sikasso. Les données ont été collectées à partir de 222 répondants contre un objectif de 200.

Le model a été analyse en utilisant le Modèle d'Equation Structurelle et plus précisément Moindres Carres Partiels. L'étude a proposé un modèle qui était extrêmement prédictif et explicatif de l'utilisation des Tics par les producteurs de céréales dans les pays en voie de développement. Cette recherche a fait des contributions théorétiques : elle a proposé un modèle nouveau et unique, pour l'étude de l'adoption/utilisation des Tics ; Enrichie la littérature existante. Des contributions méthodologiques ont aussi été faites en proposant un guide mis à jour pour l'utilisation des Moindre Carrés Partiels dans le domaine des systèmes d'information et dans un environnement exploratoire ; en développant une méthode de traduction de questionnaire de l'anglais vers le français et Nko ; en contribuant au débat sur comment valider une analyse discriminante. La recherche a fait des contributions pratiques et managerielles en proposant au monde des Tics un model qu'ils doivent prendre en compte avant de développer ou déployer tout service Tics en direction des paysans dans les pays en voie de développement. Nous avons formulé des recommandations pour les futures recherches à partir de la nôtre.

Table of Contents

PUBLICATIONS

The following papers have been published during this research. These contributed to enhancing knowledge on adoption/use of ICT by small-scale cereal farmers in the context of agricultural input information in developing countries.

Papers

1. Kante, M., Oboko, R. & Chepken, C., 2016. Factors affecting the use of ICTs on agricultural input information by farmers in developing countries. *AIMS Agriculture and Food*, 1(3), pp.315–329. Available at: http://www.aimspress.com/article/10.3934/agrfood.2016.3.315

2. Kante, M., Oboko, R. & Chepken, C., 2017. Influence of Perception and quality of ICT-based agricultural input information on the use of ICTs by farmers in developing countries: Case of Sikasso in Mali. *Electronic Journal of Information Systems in Developing Countries, 83(9), 1–21.* doi: 10.1002/j.1681-4835.2017.tb00617.x

3. Kante, M., Chepken, C. & Oboko, R,. 2017. Revisitant les facteurs affectant l'utilisation des Tics sur l'information relative aux intrants agricoles par les paysans dans les pays en voie de développement. *Journal of Information Systems and Technology Management, 14(2), pp. 169–189. doi: 10.4301/S1807-17752017000200003*

Proceedings

1. Kante, M., Chepken, C. & Oboko, R., 2017. The influence of quality of ICT-based agricultural input information on use of ICTs by cereal farmers in developing countries: Case of Sikasso, Mali. In *ICT adoption for Africa development*. Douala: ICT4AD'17, pp. 72–84.

2. Kante, M. et al., 2017. Farmers' Perceptions of ICTs and its Effects on Access and Use of Agricultural Input Information in Developing Countries : Case of Sikasso, Mali. In P. C. and M. Cunningham, ed. *IST-Africa Week 2017*. Windhoek: IIMC International Information Management Corporation, pp. 1–8. Available at: www.IST-Africa.org/Conference2017.

3. Kante, M., Chepken, C., & Oboko, R. 2017. Methods for translating ICTs' survey questionnaire into French and Bambara, Egerton University, Njoro, 29th – 31st March 2017.

4. Kante, M., Chepken, C. and Oboko, R. (2017). Partial Least Square Structural Equation Modelling ' use in Information Systems : an updated guideline of practices in exploratory settings, in University, K. (ed.) Research, Innovation and Knowledge Translation for Community Transformation. Nakuru, p. 41.

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LIST OF ABBREVIATIONS

AMRTP: Autorite Malienne de Regulation des Telecommunications/TIC et des Postes
(Malian Regulatory Authority of Telecommunications /ICT and Post)

AI: Agricultural inputs

AII: Agricultural Input Information

AVE: Average Variance Extracted

CP: Compatibility

DIKDAR Model: Data delivery, Information, Decision Action and Results Model

DOI: Diffusion of Innovation Theory

IDI: ICT Development Indices

ICT: Information and Communication Technologies

ICT4D: Information and Communication Technology for Development

IS: Information System

IT: Information Technologies

ITU: International Telecommunication Union

IQ: Information Quality

OB: Observability

OMA: Agricultural Market Observatory

RA: Relative Advantage

SEM: Structural Equation Modelling

SI: Social Influence

SIMP: Simplicity

PLS-SEM: Partial Least Squares Structural Equation Modelling

TAM: Technology Acceptance Model

TIC: Technologies de l'Information et de la Communication

UTAUT: Unified Theory of Acceptance and Use of Technology

USAID: United States Aid

USSD: Unstructured Supplementary Service Data

CHAPTER ONE

INTRODUCTION

1.1. STUDY AREA BACKGROUND

Mali is a semi-arid country with a population of approximately 18.75 million as at 2015 (United Nations Population Division, 2015) and a surface area of 1, 242, 248 km^2. The rural population in Mali represents 73% of the population that works in the agriculture sector (Traoré et al., 2011). The literacy rate is approximately 33.1% for adults (15 years and above). However, in the rural area, this rate is about 24.4% (INSTAT, 2015). The Malian agriculture, dominated by small-scale farmers (68%), grew by 7.7% in 2010 and contributed 37% to the country's Gross Domestic Product in 2008 (FAO, 2013). Cereals such as millet, sorghum, maize, rice and fonio constitute the main part of the agricultural production of the country (Aparisi & Balie, 2013).

The agricultural activities are marked by low productivity (AGRA, 2014). Nevertheless, there is broad agreement that agricultural productivity in many developing countries needs to improve (Batchelor et al., 2014) for better food security levels. Such objective cannot be achieved without a greater adoption (use) of inputs, which permit the increase of the yield (International Development Fertilizer Centre, 2004). Also, Staatz & Temé (2015) emphasise that one of the sources of productivity increase is technological improvements through access to improved technologies (agricultural inputs). Moreover, Dey, Prendergast and Newman (2008) argue that lack of use of technology (farm inputs) in the production leads to lack of productivity of farmers.

Agricultural inputs utilisation depends largely on agricultural input information' adoption. That is emphasised by Msoffe & Ngulube (2016) who argue that farmers' decision to adopt input is greatly influenced by the amount of information that is available. Also, the experience of some rapidly growing economies such as China in achieving agricultural transformation was due to an improvement of information services (Siyao, 2012). Therefore, Information and Communication Technologies (ICT) services play a key role in the dissemination of Agricultural Input Information (AII). Hence, well-informed farmers make wise decisions, which in turn are responsible for improving agricultural productivity.

Developing countries have seen an incredible growth of ICT especially mobile phones. For instance, Aker et al. (2016) report that between 1999 and 2014, the percentage of the population with access to mobile phone coverage grew from 10% to 90%. The growth of the worldwide subscriber base is fastest in developing countries, with four out of five new connections being made in the developing world, and 880 million unique developing-market subscribers estimated to register new accounts by 2020 (GSMA, 2012). In Mali, ICT (mobile phone) rate of penetration moves from 7.14% in 2005 to 90.27% in 2012 (Diallo, 2013).

1.2. ICT USE IN THE AGRICULTURAL INPUT INFORMATION SECTOR

ICT on agricultural input information is any ICT resource that allows farmers to adopt (access, send and utilise) information on agricultural inputs. Agricultural input information is defined as any information on weather, best practices, crop planting, buy/use of fertiliser and seed. This is emphasised by Dangi & Singh (2010) who argue that use of ICT adopt agricultural input information enable farmers to access the latest local and global information on weather, scientific farming practices as well as market prices of agricultural inputs, facilitate the sale and buying of farm inputs. In addition, Aker (2011) suggests that agricultural input information through an ICT service are on crop planning (better information on higher yield crop, seeds varieties), on buying seeds (identify the best time to plant, buying inputs like fertiliser), on planting (use better fertiliser and apply better techniques).

1.2.1. Availability of ICT on agricultural input information in developing countries

ICT services have been set up in developing countries to disseminate agricultural input information. These services include telecentres and mobile phones mainly. For instance, more than 60 telecentres have been created in Mali (MAIGA, 2009). The telecentres have been set up in many other developing countries such as India, Tanzania, Uganda and Zambia (Kameswari et al., 2011; Kaddu, 2011; Souter, 2010). Nevertheless, Churi *et al.*, 2012 argue that the mobile phones are becoming the popular method for disseminating agricultural (input) information.

The mobile phone is considered to be the most widely ICT used channel to disseminate agricultural input information in developing countries. This is emphasised by Aker (2011) who argues that there has been a proliferation of mobile phone information services towards farmers. Also, Scott et al. (2004) highlight the benefits of ICT (mobile phone), which include market accessibility, the risk from disasters. They further argue that mobile phones empower societies by enabling them to access information. Mobile applications have been used to disseminate agricultural input information towards farmers. Examples include the ICT services Senekela and Myagro in Mali; Nokia Life in India, Indonesia, Nigeria and China; IFFCO (Indian Farmers Fertilizer Cooperative Limited) Airtel Initiative and E-choupal in India; TigoKilimo in Tanzania; Ukisaan and Kissan in Pakistan (Sukhpal, 2004; Siraj, 2010; Pshenichnaya and Clause, 2013; Palmer, 2014; Chung, 2015; de la Rive Box *et al.*, 2015; Singh *et al.*, 2016).

1.2.2. Agricultural input information adoption and Use of ICT on agricultural input information in developing countries

Despite the availability of different ICT services to disseminate agricultural input information, adoption of agricultural input information remains a problem for cereal farmers. For instance, KTM (2013) concluded that in Kenya, still, an improvement is necessary since a large number of smallholder farmers (3.5 million) work without basic farm inputs. Also, it is estimated that more than 45% of the cultivated areas are not fertilised in Mali (Ouedrago, 2008). The input utilisation rates have always been low in Sub-Saharan Africa in general, and in Mali, Burkina Faso and Ghana (Traoré *et al.*, 2011). Thus, Wulystan and Andrew (2013) argue that the Tanzanian agricultural sector has not gained benefit from ICT on agricultural (input) information. Therefore, ICT on agricultural input information has not been able to increase the adoption (access and use) of agricultural input information by cereal farmers.

The aforementioned non-increased adoption of agricultural input information is linked to the low use of ICT on agricultural input information is due to less use of these ICTs. For instance in Mali Senekela has 177,817 users (GSMA, 2015). This number is very small compared to the potential users in the country where 73% of the population worked in the agricultural sector, and the operator (Orange Mali) has two-thirds of customers in the country. Another ICT service Myagro serves only 3,500 farmers in Mali and Senegal (de la Rive Box et al., 2015). These limited users in Mali and Senegal were similar to Tanzania where Chung (2015) reports that Tigokilimo had reached (only) 6% of its addressable market. These facts provide evidence that the adoption (use) of the service by small-scale cereal farmers to access and use agricultural input information is very low.

The low use of ICTs-based agricultural input information is due to certain factors. These factors are farmers' perception (Dey, Prendergast and Newman, 2008; Amin and Li, 2014), farmers influence on each other (Palmer, 2015; Sathye *et al.*, 2015), information quality (Mittal and Mehar, 2012; Barakabitze, Fue and Sanga, 2017) and high cost of ICTs' services (Williams, 2013; Chung, 2015; Sousa, Nicolay and Home, 2016).

1.2.2.1. Farmers' perception of ICT and use of ICT on agricultural input information

In developing countries, studies picked out that perception of ICT services by cereal farmers affect their use of ICT for adopting agricultural input information. For instance, in Mali Palmer (2014) argues that the use of the ICT on agricultural (input) information was perceived as difficult by (cereal) farmers. In addition, in Benin, Adegbidi et al. (2012) conclude that the use of ICT needs positive outlook from the actors (farmers).

Rogers (1983) emphasised that the rate of innovation' (ICT) adoption is affected by the perception of the receivers. Therefore, the farmers' perception of ICT is a factor in the use of ICT on agricultural input information and this study will identify its effects on the use of these ICTs by farmers.

1.2.2.2. Farmers sharing information on ICT on agricultural input information and its use

Farmers are known to share information among themselves and therefore influences each other. For instance, Lwoga (2010) findings demonstrated that the principal origin of information for farmers was preponderantly local (neighbours, friends and family). Also, Midline (2015) reports that almost all users interviewed in his study on the use of a mobile application on agricultural input information in Mali said that other farmers come to them every month for farming advice. Dey, Prendergast and Newman (2008) conclude that the use of mobile telephony (ICT) could only be effective where the technology was consistent with the social processes and farmers' lifestyles. Therefore, there is a need to investigate the influence of farmers on each other (farmers' peer influence) and its effect on use of ICT on agricultural input information, which has to be done by this study.

1.2.2.3. Information quality and use of ICT on agricultural input information

The information delivered to farmers is important to them. For instance, Mittal & Mehar (2012) report that farmers call for an improvement of the ICT delivered information quality. In Mali, the incomplete content (incomplete information) was a barrier to the uptake of Senekela (GSMA, 2015). Therefore, there is a need to improve the quality of the provided information so that farmers can keep or start using ICT on agricultural input information.

Information is a valuable and useful tool to people in their attempts to cope with life, but the value of information depends on many conditions including accessibility, relevance, accuracy and currency (Chilimo and Sanga, 2006). In addition, Heeks & Molla (2009) emphasised that the information should be complete, accurate, relevant, opportune, and appropriate. Moreover, Msoffe & Ngulube (2016) argued that it is crucial for ICT services (information providers) to disseminate information that satisfies farmers' need and is appropriate to their farming practices. Therefore, the Information Quality constitutes a challenge in the use of ICT, and this study will identify its effect on the use of ICT on agricultural input information by farmers.

1.2.2.4. ICT service cost and use of ICT on agricultural input information

Another challenge faced by farmers in the use of ICT on agricultural input information is the high cost of ICT' services. For instance in Tanzania, mobile phone services' cost, excluded many farmers from accessing TigoKilimo[1] (Chung, 2015). In Mali, 95% of SENEKELA[2] users find that the cost is prohibitive (Palmer, 2014). Moreover, Batchelor et al. (2014) argue that even though there is plenty of evidence that access to information can increase profits, small (scale

[1] TigoKilimo is a value added service in Tanzania, disseminating information (on agricultural inputs) towards farmers.

[2] SENEKELA is a value added service in Mali, disseminating information (on agricultural inputs) towards farmers.

cereal) farmers may not be willing to pay for information services (ICT). Therefore, Cost is a factor in the use of ICT on agricultural input information and this study will identify its effect on the use of these ICTs.

1.3. STATEMENT OF THE PROBLEM

Information is the secret to a knowledge base. The knowledge base is important as it enables individuals to decide on what they are doing. Use of ICT on agricultural input information should lead to a better adoption of agricultural input information. That was noticed by Aker, Ghosh and Burrell (2016) who argue that ICT services such as mobile phones affect agricultural (inputs) adoption and production via the agricultural (input) information provision. Therefore, the use of ICT on agricultural input information leads to the adoption of agricultural input information, which in turn will result in the use of farm inputs. Moreover, Lwoga, Stilwell and Ngulube (2011) argue that the link between use of ICT and agricultural productivity is positive.

Nevertheless, despite the availableness of diverse ICT on agricultural input information services, adoption of agricultural input information by cereal farmers in developing countries, particularly Mali, is still a challenge. Many studies emphasise that there is a lack of adoption of agricultural input information (Richardson, 2005; Heeks, Gao and Ospina, 2010; Kameswari, Kishore and Gupta, 2011; Chung, 2015; GSMA, 2015).

The aforementioned lack of adoption of agricultural input information has resulted in a low productivity due to the non-use of agricultural inputs. That point was highlighted by Dey, Prendergast and Newman (2008) conclude that lack of use of technology (ICT) in the production (by farmers) leads to lack of productivity of the farmers. Thus, the main challenge faced by many (small-scale cereal) farmers in Mali is access to selected seeds and fertilisers (de la Rive Box *et al.*, 2015), which is related to the adoption of agricultural input information (Msoffe and Ngulube, 2016). Therefore, farmers access to services and information need to be improved on traditional crops (Wollni and Qaim, 2014), so too on ICT on agricultural input information services.

Other information services for farmers are better developed in developing countries compared to agricultural input information services. For instance, even if Mali and Burkina Faso have a well-established phytosanitary system, a lot remains to be done in the fertiliser and seed sector (IFDC, 2004).

Previous studies (Maumbe and Okello, 2010; Rezaei-Moghaddam and Salehi, 2010; Aker, 2011; Sanga, Kalungwizi and Msuya, 2013; AGRA, 2014; Msoffe and Ngulube, 2016) concur that use of ICT on agricultural input information would be applicable to farmers in developing countries if certain conditions were met. These conditions (factors) need to be established and find a way to overcome them. Then more use of ICT services can be realised and therefore an increased adoption of agricultural input information. That can then be the basis for increasing the productivity of cereal crops. Hence, an investigation needs to be conducted into these factors affecting farmers' use of CT on agricultural input information and their relationships to inform the design and delivery of these ICTs to small-scale cereal farmers in developing countries.

1.4. RESEARCH OBJECTIVES

The broad objective of this study is to propose an ICT model for increased adoption of agricultural input information.

The specific objectives are:

1. To establish farmers' perception of ICT on agricultural input information and to identify the effect of that perception on the use of these ICTs.
2. To establish farmers' influence on each other in the use of ICT on agricultural input information and to identify the effect of that influence on the use of these ICTs.
3. To establish the challenges faced by farmers in the use of ICT on agricultural input information and to identify the effects of these challenges in the use of these ICTs.
4. To propose an ICT model for increased adoption of agricultural input information in developing countries using a case in Sikasso, Mali.

1.5. JUSTIFICATION

Farmers' adoption of agricultural input information is still limited. This adoption is restrained by the low use of ICT on agricultural input information. Therefore, use of these ICTs needs to be improved to enable farmers to adopt agricultural input information in developing countries by proposing a model. Discernment of the drivers and barriers related to the use of ICTs allows the developing of schemes to boost ICT adoption and step up the effectiveness and efficiency of accessing and using agricultural information (Adegbidi *et al.*, 2012) and agricultural input information.

Models of ICT adoption/use have been proposed in developing countries in many fields such as health, education, e-government, agriculture. However, few studies have proposed a model in the context of agricultural input information in developing countries for cereal farmers. Even the few proposed models have shortcomings. For instance, Adegbidi et al. (2012) proposed a model for rice farmers in Benin. This model did not take into accounts the most cereal crops that are millet, sorghum, maize (with wheat and rice increasing in importance) in developing country, particularly African countries as suggested by Wood & Cowie (2001). Moreover, this model did not take into accounts the factors Cost, Social Influence and Information Quality that were identified as affecting use of ICT on agricultural input information. More details of these models are discussed below in the literature review section (section 2.6). Therefore, this study is justified in developing countries and aims at proposing an ICT model for increased adoption of agricultural input information by small-scale cereal farmers.

1.6. SCOPE

The overall scope of this study was to propose an ICT model for increased adoption of agricultural input information by small-scale cereal farmers in developing countries. The study was conducted in Sikasso (Mali) with small-scale cereal farmers.

1.7. SIGNIFICANCE

The outcomes of this research should be beneficial for many stakeholders. Academicians, ICT services designers, policymakers, farmers' organisations and farmers and development partners.

This work will be relevant to scholars especially those undertaking studies focusing on ICT adoption/use especially in Mali. It would be specifically relevant for scholars working on ICT and agricultural input information in developing countries.

The model would inform the ICT on agricultural input information designers about what would lead to more the use of these ICT services in agricultural input information sector.

Government policymakers have the responsibility to create relevant policies for the ICT-based agricultural (input) information sector. Therefore, they need empirical evidence and appropriate information for policy framework craftiness.

Farmers' organisations would find this work useful whilst providing guidance for cereal farmers and developing their guidelines. Development partners interested in enhancing farm inputs' use for more productivity would find this work useful.

1.8. OPERATIONAL DEFINITION

This section introduces some of the key concepts used in this study.

1.8.1. ICT

An ICT (Information and Communication Technology) is any device, tool or application that permits the exchange or collection of data through interaction or transmission (World Bank, 2011). Wulystan & Andrew (2013) quoting Shetto (2008) argued that computers, radio, television, the internet, CD-ROMs and telecommunication networks constitute ICTs in agriculture. Aker (2011) distinguishes two ICTs: the traditional ICTs (radio and television) and the new ICTs (mobile phone, computer). The scholar further argues that in developing countries, many ICTs initiative have moved away from traditional to the use of mobile phones, including SMS and the Internet-based services.

In this study, ICT services include mobile phone applications and services on agricultural input information and telecentres that permit farmers to access and use agricultural input information.

1.8.2. Household Head

The head of the household is an individual in one family setting who supplies actual support and maintenance to one or more individuals who are connected to him/her (Advameg, 2016). Domestic units are barely limited to the nuclear family in 'collectivist societies' that characterise most societies of developing countries (Sathye *et al.*, 2015; Advameg, 2016). In such societies, the family consists of an extended patrilineal family (father, his brothers and their wife/ves and children, his wife (ves), his sons, their wives and children, and unmarried daughters). The household head in this study is anyone who is leading the agricultural activities of the family and using ICT on agricultural input information, i.e. headed mother, headed son, headed wife, headed small brother.

1.8.3. Cereal

Maize, sorghum and millet are the important cereal crops in Africa (Wood and Cowie, 2001). The authors further report that wheat and rice are increasing in importance. This study refers to cereals as millet, sorghum, maize and fonio.

1.8.4. Agricultural Input Information

Table 1.1 defines agricultural input information as used in this study. Access is defined as a way of reaching something and in this case a way of reaching information on agricultural inputs. Use of agricultural input information is to act according to that information. This study refers to adoption as that access and use of agricultural input information.

Table 1.1. Agricultural input information

Stage	Information
Crop planning	▪ Information on yield ▪ Information on crops ▪ Information on seed
Buying seeds	▪ Information on best time to plant ▪ Information on inputs (e.g. fertilisers)
Planting	▪ Information on how to use fertiliser ▪ Information on how to plant a specific seed ▪ Information on the best technique for a seed, fertiliser….

Source: adapted from Aker (2011)

1.8.5. Innovation, Use, Adoption and Diffusion

Innovation can be defined in many ways. Bui (2015) argues that there is a lack of consistency across research regarding the constructs such as 'innovation' or 'innovatinness'. Therefore, for any study using such terms, there is a need to define them regarding the undergoing study.

Scholars recognise innovation as a new way of conducting or carrying out activities, whether in the form of new ideas, new productions combinations, or new technological process (Bui, 2015). In the studies of Information Technology and Individuals, the term innovation is used as Information and Communication Technologies (ICT) use or adoption by individuals (Lim *et al.*, 2009). Therefore, ICT use or adoption is considered as an innovation. That applies to a case whereby the study is looking at the factors that affect the using of ICT on agricultural input information.

Use is defined in this study as the decision to start using ICT. In this study, Adoption and Use are used to specify that decision. Diffusion refers to adoption in innovation research (Simin and Janković, 2014). In conclusion, Diffusion of Innovation is used as Technology (ICT on agricultural input information) acceptance or adoption by individuals. That was noticed by

(Bui, 2015) who argues that examples of innovation studies include technology acceptance or appropriateness. Diffusion of Innovation Theory (IDT/DOI) refers to use of ICT. The Use is defined in the DOI at the persuasion level, which is Behavioural Intention (BI) in other technology acceptance models/theories such as UTAUT or TAM. Therefore, Use of DOI refers to BI. The DOI is more discussed in chapter 2 (section 2.4.3).

1.9. ASSUMPTIONS

This study has some assumptions. An assumption is any significant fact presumed to be true but not verified (Gay, 1976). It does not need testing, unlike the hypothesis. This study assumes that:

1. The use of agricultural inputs will increase the agricultural productivity.
2. There exist other factors not covered in this work, which can affect the agricultural productivity.
3. Other factors affect the adoption of agricultural input information.

The figure below gives an overview of the ICT on agricultural input information value chain.

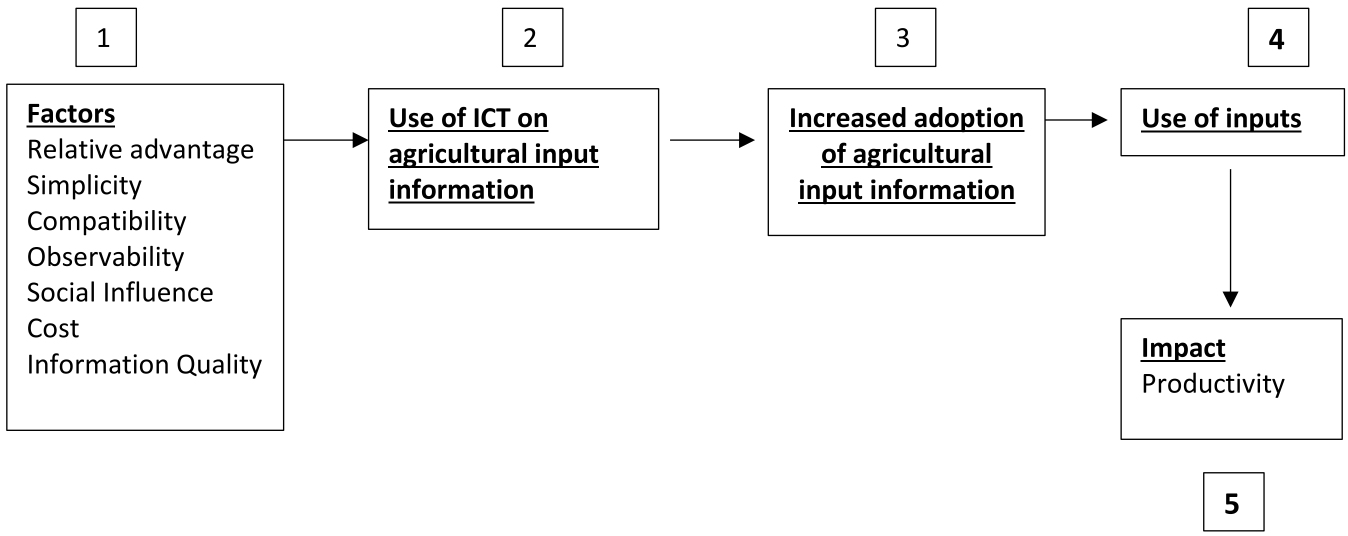


Figure 1.1 ICT on agricultural input information value chain

Source: Adapted from Heeks & Alemayehu Molla (2009)

This study is focussed on stage 1, 2 and 3. It identified the factors (stage 1) that have an effect on Use of ICT on agricultural input information (stage 2) for an increased adoption of agricultural input information (stage 3). As stated in the scope above, this study does not cover the stage 4 (use of agricultural inputs) and 5 (productivity). In addition, other factors are a source of increased adoption of agricultural input information. For instance, agricultural extension officers can disseminate agricultural input information.

1.10. THESIS STRUCTURE

This thesis comprises five chapters. Chapter 1 introduces the problem under investigation, i.e. the lack of adoption of agricultural input information due to the low use of ICT on agricultural input information focussing on Mali. The chapter links:

- agricultural productivity to use of agricultural inputs
- use of farm inputs to the adoption of agricultural input information
- adoption of agricultural input information to the use of ICT on agricultural input information

Afterwards, Chapter 1 defines the research problem, objective, justification, scope, significance, the operational definition of the keys terms, assumptions and structure of this thesis.

Chapter 2 deals with the literature that relates to the context of this study. It reviews the theories and models in the field of Information and Communication Technologies (ICT) use or adoption by individuals. Chapter two goes on by extracting the empirical constructs in accordance with the research objectives using the Grounded Theory as suggested by Urquhart and Fernández (2013) from related studies in developing the country in general and particularly in Mali. The framework of Müller-Bloch and Kranz (2015) was followed in the chapter to find out the empirical and theoretical gaps. These resulted in a conceptual framework with hypotheses related to the objectives. The results of this chapter were validated through a peer review publication.

Chapter 3 focusses on the study's methodology. It starts with the research paradigm that underlines the philosophical point of view of this study. It continuous by presenting the study design, the study area, sampling method and procedure, the data collection and the data analysis. In addition, the research instrument formulation, translation and validation are presented in chapter two.

Chapter 4 reports the results of the main study. Descriptive statistics are reported using SPSS v 20. It goes on by presenting the model (measurement and structural) assessment achieved by following the steps of the Partial Least Squares Structural Equation Modelling (PLS-SEM). The chapter first reports and discusses the descriptive statistics. It then presents the assessments of the two model of the PLS-SEM by research. This chapter also compares the findings with the current literature.

Finally, chapter 5 discusses the achievements, contributions and implications, limitations, conclusion and recommendation of this research.

CHAPTER TWO

LITERATURE REVIEW

This chapter reviews the literature on ICT on agricultural input information' use by small-scale cereal farmers. The first section starts by linking the low agricultural productivity to the lack of adoption of agricultural input information, which can be disseminated by ICT.

To show that ICT on agricultural input information services have been deployed in developing countries, we reviewed experiences from India, Indonesia, Tanzania, Kenya, Pakistan, China and Mali. That is done under section 2 of the chapter. Section 3 presents the observations from these experiences. The chapter goes on by reviewing in section 4 the theoretical literature. The next section that is section 5 discusses the empirical literature. Section 6 presents the identified Gaps. The chapter finishes by drawing the conceptual framework and hypotheses in section 7.

2.1. INTRODUCTION

Agriculture constitutes the backbone of the economy many developing countries. For instance, Bwalya (2009) argues that agriculture is the mainstay of the Ethiopian economy. Also, in Mali, it contributed to 37% of the country's Gross Domestic Product in 2008 (Angelucci *et al.*, 2013). Furthermore, Siyao (2012) argues that the Tanzanian economy's mainstay has been the agricultural sector. Moreover, Agriculture is the key sector of the Indian economy (Kameswari, Kishore and Gupta, 2011).

Small-scale farmers dominate the agricultural activities in developing countries. For instance, the Tanzanian agricultural activities are dominated by small-scale farmers (Siyao, 2012). Also, these farmers predominate the agricultural production in India (Kameswari, Kishore and Gupta, 2011). Furthermore, in Mali, the agriculture sector is dominated by small family farms (68%) (Angelucci *et al.*, 2013).

Cereals such as millet, maize, rice, sorghum and fonio constitute the main agricultural production in these countries. For instance, in Mali, cereals constitute the main part of the agricultural production (Aparisi and Balie, 2013). Also, in Ethiopia, in the year 2010/11, over 96 percent of cereals were produced by smallholder farmers (Bwalya, Asenso-Okyere and Tefera, 2012). Cereal crops are essential for better food security in Africa (Murage *et al.*, 2013). Maize is Ghana's most important cereal crop (Doss, 2006).

However, studies argue that these agricultural activities are marked by low productivity (Traoré *et al.*, 2011; Murage *et al.*, 2013; AGRA, 2014). Agricultural inputs such as seeds, fertiliser and advice are essential to increase yields and hence production. The International Development Fertilizer Centre (2004) concludes that a sustainable agricultural intensification cannot be achieved without the greater adoption of appropriate inputs, which permit an increase of the yield. That was also confirmed by Kinyangi (2014) who argues that the use of agricultural technologies affects the rate of growth in agricultural output. In general, farmers should be able to accomplish higher yields if they use good practices, have access to inputs and use them.

How can farmers have access to these inputs? They should have information on agricultural inputs and use that information. As it is right for most sectors, information is one of the key inputs in agriculture (Kameswari, Kishore and Gupta, 2011). In addition, the experience from China shows that the agricultural transformation of this rapidly growing economy is due to an improvement of its information services (Siyao, 2012). That was emphasised by Lwoga et al. (2011), who argue that an improved agricultural (input) information is the key element to ameliorate the agricultural production of small-scale agricultural. Lio & Liu (2006) argue that ICT especially mobile phones helped raise farm output prices and lower input prices through the mechanism of information diffusion. Therefore, ICT play a core function in disseminating agricultural input information for more access and use of these agricultural inputs, which in turn will increase productivity and hence production.

ICT services have been set up in developing countries in the agricultural field. That was noticed by Aker, Ghosh and Burrell (2016) who argue that numerous ICT initiatives have been designed and disseminated in developing countries. More than 140 ICT services have been deployed in developing countries as per 2015 (Aker, 2011; Nakasone, Torero and Minten, 2014). Therefore, farmers have been exposed to ICT on agricultural input information in developing countries, and developing countries' access to ICT has increased considerably in the last decade.

Despite that growth and farmers' exposition, the adoption of agricultural input information is restrained by ICT on agricultural input information due to certain factors. For instance, Aker et al. (2016) argue that many factors mediated the potential impacts (increased adoption of agricultural information) of information technology in the agricultural sector. The question that can be asked now is Have ICT on agricultural input information increased the adoption of agricultural input information. If yes, to what extent? If no, what can be done? The next section discusses ICT on agricultural input information services deployed in this sector in developing countries to answer these questions (gaps) and address them (conceptual framework and hypotheses).

2.2. SELECTED ICT ON AGRICULTURAL INPUT INFORMATION IN DEVELOPING COUNTRIES

This section reviews some ICT on agricultural input information deployed some developing countries. The mode of access (technology used), the model of business and the description of each one of these reviewed ICT on agricultural input information is presented. The aim is to show that developing countries have set up ICT services to disseminate agricultural input information. Experiences from eight developing countries are reviewed. Nevertheless, more than fifteen developing countries are covered in this work.

2.2.1. Experiences from India

ICT services are important in the dissemination of agricultural input information. Information and communication technology is expected to play a central role in improving the farm's operations, facilitating inputs procurement transactions, overcoming the low rural agricultural production (Mittal and Mehar, 2012). An increase in convenience and cost savings were reported by farmers with their mobile phones to look for farm inputs' information (ibid.). In India, various ICT services are used to provide agricultural (input) information to farmers (Kameswari, Kishore and Gupta, 2011). Some of them are presented below.

2.2.1.1. E-choupal

Technology used: Mobile Phone, Personal Computer, information systems

Model: Subscription based (consumers pay)

Description: The ITC (Indian Tobacco Company) Limited's e-choupal project is an ICT-based project, which aims at building effective farmer-agribusiness linkages. The model has been designed to tackle the problems of fragmented farms, weak infrastructure and a large number of intermediaries in the Indian farming sector (Sukhpal, 2004). The system permits:

- Delivery of current and appropriate information that help farmers to ameliorate their decision-making on farm inputs and hence better productivity.
- Aggregation of demand at the village level for accessing higher quality inputs and knowledge at lower costs.

Agricultural input information: weather information, advice on the activities in the farming life cycle, agricultural best practices organised by crop type and buying inputs such as seeds, fertiliser and pesticides in local languages (Dangi and Singh, 2010).

2.2.1.2. IFFCO Airtel

Technology used: Mobile Phone (Siraj, 2010)

Model: Subscription based (consumers pay)

Description: Indian Farmers Fertiliser Cooperative Limited (IFFCO) and Airtel[3] launched a service for Indian farmers on agricultural input information in 2008 (Singh et al., 2016). Farmers can buy a mobile phone that is already registered for the initiative and look for agricultural input information through SMS (Short Message Service) or a call centre.

[3]Airtel is a telecom operator in India

IFFCO Airtel provides the best time to plan, the weather information, prices of farm inputs (fertilisers and seeds) as agricultural input information to farmers in all local languages (Singh et al., 2016).

2.2.2. Experiences from Indonesia

Like the previous developing country, some experiences in the dissemination of agricultural input information to farmers have been set up in Indonesia.

2.2.2.1. Nokia life:

Technology used: Nokia Mobile Phones

Model of business: Subscription based (consumers pay)

Description: Nokia life suite is an information service through mobile phone (Nokia) launched in India in 2009 and scaled the same year in Indonesia, and currently used in Nigeria and China. In the four countries, the service is cheaper in Indonesia than the others. In a report on Nokia Life, Pshenichnaya & Clause (2013) found that the service cost is: 5 Chinese Yuan (0.76 US$) in China per month, 60 Indian Rupee (0.88 US$) in India per month, 500 Indonesian Rupiah (0.03 US$) in Indonesia per month and 250 Nigerian Naira (1.25 US$) in Nigeria per month. In Indonesia, Nokia heads the ranking as reported by Ueno & Yoshida (2012). The Indonesian experience on this service is therefore different from the three other countries in terms of cost of the service. Thus we have chosen to review Indonesian experience of that ICT service. Nokia Life delivers Education, Health, Agriculture and infotainment services to address the information gap and enable consumers in emerging societies to be better informed and to improve their livelihoods (Pshenichnaya and Clause, 2013). The service delivers information on agricultural inputs via SMS.

Agricultural input information: crop tips, agriculture news, market prices, weather information and advisory.

2.2.3. Experiences from Tanzania

2.2.3.1. TigoKilimo

Technology used: Mobile phone

Model of business: Subscription base (consumers pay)

Description: this agricultural value-added service (Agri VAS) in Tanzania provides relevant, timely and actionable information on farm inputs and market intelligence. Farmers can use Unstructured Supplementary Service Data (USSD), Interactive Voice Response (IVR) and helpline to access Content (Chung, 2015). The services are available in Kiswahili and English (http://www.tigo.co.tz). Moreover, as a result, respondents (88%) reported that they were making changes thanks to TigoKilimo information. These changes occur in realising for farmers higher yield that was auctioned by more access and use of farming practices (37%), and current and relevant weather (23%)(Chung, 2015).

Some farmers gave their testimonial on this ICT. For instance, '*previously I used to weed the field, remove all grasses, and take them away from the field. However, through TigoKilimo, I obtained knowledge that I should not collect the weeds away from the field but to leave them there.so, now I do as they advised me to.*' (Chung, 2015).

Agricultural input information: farm input prices, weather forecasts, agronomy advice

2.2.3.2. Z-Kilimo

Technology used: Mobile phones

Model of business: Subscription based (consumers pay)

Description: Z-Kilimo is an SMS-based application in Tanzania, utilising mobile phone capability and ubiquity to provide access to comprehensive farming methods operated by Zantel (a network provider in Tanzania).

Agricultural input information: daily weather forecast, details on soil management, pest control methods and information on livestock knowledge and bird flu (Zantel, 2013).

2.2.4. Experiences from Kenya

The Kenyan Markets Trust (2013) reports that Kenya made substantial steps in improving agricultural productivity with agricultural inputs by farmers. We review below some of the ICT services set up in the country to disseminate agricultural (input) information to farmers.

2.2.4.1.M-FARM

Technology used: Mobile phone and web platform

Model of Business: Subscription based (consumers pay)

Description: M-farm is a mobile service and a web platform that aims to improve Kenya's agricultural sector by connecting farmers with one another because peer-to-peer collaboration can improve market information (World Bank, 2011). The service assists farmers to know when to plant and connect to sell as reported by mfarm (2016).

Agricultural input information: farm inputs prices, where to buy farm inputs, weather forecasts, the best time to plant.

2.2.5. Experiences from Pakistan

In the recent years, Pakistan made tremendous strides in improving ICT services for masses (Siraj, 2010). In the field of agricultural input information dissemination, some ICT services have been set up in the country.

2.2.5.1. Ukisaan

Technology used: Mobile phones, web portal

Model of Business: Subscription based (consumers pay)

Description: Ukisaan is an agricultural value-added service launched by Ufone[4] towards farmers. It provides information on a call made by the peasants. It is only available for the users of this telecom operator.

Agricultural input information: agricultural crops, livestock farming, non-conventional crops, poultry and fruit farming, weather alerts, in regional languages.

[4]Ufone is an operator telecom in Pakistan

2.2.6. Experiences from China

ICT brought a new chance for two-way information flow between farmers and service providers (Sylvester, 2013). Asian examples of ICT services are becoming a primary source of information for farmers by providing them information and advice, and giving them the option to speak to an agricultural expert (ibid.). Some of this agricultural VAS are reviewed below.

2.2.6.1. NOVA

Technology used: Mobile phones, web portal

Model of Business: Subscription based (consumers pay)

Description: The agricultural information dissemination is done by NOVA (agriculture and production information system (CICC, 2003). It is a web-based agricultural service. Some farmers achieved significant productivity thanks to the use of information on agricultural products including farm inputs. Some farmers even claimed that they could no longer work without the system. Farmers on site, proving that it gives the assistance required, generally accept the system. In particular, the system of installing a help centre, which provides the same services on the telephone as online in environments without PC access was highly assessed, as was the function of achieving immediate results of exploring new sales channels to farmers (CICC, 2003).

Agricultural input information: weather forecasts, best practices, farm inputs prices, where to buy inputs (seeds, fertilisers)

2.2.6.2. SOUNOUNG

Technology used: Mobile phones, web portal

Model of business: Subscription based (consumers pay)

Description: SOUNOUNG disseminates agricultural input in China. Harrod & Jamsen (2010) argued that the project provide an aggregated information from a search engine to farmers. They further reported that in 2009, 1276 households were using the website and by 2010, that figure doubled indicating an indisputable success for the project. What is the source of this achievement? The project works with farmers' organisations as partners that are well structured and functional. Farmer organisations' members can access information from the service using their computers, mobile phones and personal digital assistants (PDAs). Farmers can access agricultural input information according to their farm characteristics. Farmers of the organisation who may not have computers, mobile phones or PDAs, the farmers' organisation (cooperative) can also print information and recommended actions (Harrod and Jamsen, 2010). The cell phone was found to be the most ICT service used in China because of its timeliness and convenience (Harrod and Jamsen, 2010).

Agricultural input information: weather forecasts, best practices, farm inputs prices, where to buy inputs (seeds, fertilisers).

2.2.7. Experiences from Mali

The most ICT-based agricultural input information tool in Mali and elsewhere is the mobile phone. It was brought in Mali in the 1990s with only one network provider. The use of that ICT has arisen since then in terms of the number of network providers, coverage, subscriptions and services offered. For instance, in 1999, there were 6,375 mobile phone subscribers, 4.5 million subscribers in 2009 and 10.3 million in 2014 (Issa FOFANA, 2010; GSMA, 2015).

The mobile phone based agricultural input information can be traced to 2011. A private extension service Myagro (N'gasene) started to disseminate farm inputs information towards farmers around the district of Bamako (Kante, Oboko and Chepken, 2017). Thereafter, Myagro launched its services in Sikasso, considered as the granary of Mali (DRPSIAP, 2011). These ICT-based agricultural input information tools are presented below.

2.2.7.1. Senekela

Technology used: Mobile phones

Model of business: Subscription based (consumers pay)

Description: "SENEKELA" is an ICT' service provided by Orange Mali to help the Malian farmers to increase their farm productivity and to provide the ingredients, which can assist them to commercialise their production better. The project uses an SMS service for farmers to access market information. It is currently deployed in two regions out of eight. However, the cereals concern is addressed only in the Sikasso region while the shea nut is dealt with in Koulikoro (Palmer, 2015).

Agricultural input information: advice to the farmers – in French and in Bambara – on all their daily questions in the agricultural domain including the planting methods, the seeds, the sowing time, the fertilisers(Orange, 2014).

2.2.7.2. Myagro

Technology used: Mobile phones and a network of associate in the villages who can work with around one thousand farmers.

Model of business: Subscription based (consumers pay)

Description: Myagro is an agricultural VAS that assists smallholder farmers in rural Mali to plan, save for, and purchase inputs to make their farms more profitable. The project is also operating in Senegal. It enables farmers to purchase high-quality agricultural inputs (certified seeds and fertiliser) on layaway through an SMS-based platform and a network of local vendors.

The project is currently concentrating on cereals mainly maize, sorghum and peanut (Myagro, 2016).

Agricultural input information: modern planting techniques; provides technical training for farmers and market access for their goods to enable them to sell extra produce at a higher profit margin.

The project has shown some advancement for farmers as noted here. "*Two years ago, Amadou visited the MyAgro store during the market day where he met with one of our agents and was told how he could substantially increase his productivity. He purchased a seed/fertiliser package from us on layaway and saved up using our mobile-phone savings platform. Later that year MyAgro delivered his package, and he planted half of his family's 2.5-acre field using myAgro planting/fertilising methods. The previous year his fully planted fields yielded only 11 sacks of corn, the year he started with Myagro he increased his yield by 40%*" (Myagro, 2016).

2.3. OBSERVATION OF THE REVIEWED EXPERIENCES

The experiences from developing countries conclude that ICT services have assisted in adopting agricultural input information to farmers. For instance, the Chinese experience was a success in achieving a transformation of the agricultural activities according to Siyao (2012). We can conclude from the Chinese experience that the timeliness, the relevancy and the appropriateness of the information, which are information quality characteristics, were the key factors for the success of the ICT service. It was also found that the use of Personal Digital Assistant (PDA) and computer were the most ICT means used to get agricultural input information.

The question to ask now is that can we implement the Chinese experience in developing countries? In most of developing countries, the ICT Skills and Illiteracy are barriers to the use of PDAs or computers. The cost of such devices is another factor to take into account for farmers. The answer to that question is therefore that the Chinese experience cannot be applied in most of developing countries.

On the other hand, in China, giving the agricultural input information in a printed form is an appropriate manner of presenting the information to the farmers who do not have the ICT Skills. Nevertheless, they have to read it, which is re-challenged by the illiteracy in most developing countries. The fact that farmer organisations help farmers to access and use agricultural input information can be helpful for most of the developing countries. However, it supposes that the farmers have to travel from their farm to get the information. That would be a waste of time for the farmers. Therefore, again, the ICT models from the Chinese experience on agricultural input information cannot be applied to most developing countries.

The main conclusion is that three issues come up: 1) farmers are still facing a lack of agricultural input information; 2) This lack of information is restrained by the low use of ICT on agricultural input information and 3) that low use is due to certain factors. The next section discusses these factors.

2.4. TECHNOLOGY ADOPTION THEORIES/MODELS

This section describes some of the relevant models for ICT on agricultural (input) information adoption. In Information System Research, theories and models have been developed to explain users' use (adoption) of technology. IS research was built upon the use of theories (Lim *et al.*, 2009).

Attempts were made to define a theory. Mittelstraß (2004) argues that generalisation of empirical evidence constitutes a theory. It is an important vessel to document our interpretation of the world. Bacharach (1989) defines theory as a system of statements targeted at describing, explaining, and predicting real-world phenomena. A scientific theory is a system composed of two core constituents: (1) factors and (2) hypotheses (Mueller and Urbach, 2013). Therefore, a tested conceptual framework with constructs and relationship between these constructs constitutes a model.

Doing a literature review from 1998 to 2006, covering 386 research articles, Lim et al. (2009) identified 154 theories in the field of IS research. Among these, there were ten widely used theories. Concerning Information Technology and Individual study, they identified five most used models. The Technology Acceptance Model (TAM) was the most used with 20% of the papers using it; Theory of Reasoned Action (TRA) followed it as the second; Diffusion of Innovation Theory (DOI/IDT) was third and the fourth and fifth widely used were the Theory of Planned Behavior (TPB) and the Social Cognitive Theory (SCT) (Lim *et al.*, 2009).

In the field of agricultural input information and technology adoption research, the DOI has been applied in Benin (Adebedi et al, 2012) to propose a model of ICT' adoption by rice farmers. In Iran, TAM and DOI have been applied to predict the construct that affects ICT' adoption in Iran (Rezaei-Moghaddam & Salehi, 2010). In addition, Zewge and Dittrich (2017) also report the TAM and DOI as the most used theory in developing countries in explanation and prediction studies on agriculture. However, Woosley and Ashia (2011) argue that TAM, DOI and the Unified Theory of Technology Acceptance Model (UTAUT) are the three most technology acceptance models. The TAM, DOI and UTAUT can be categorized as belonging to the stream of thought that is based on the intention of usage as the dependent variable (Woosley and Ashia, 2011). TAM, UTAUT and DOI are presented below.

2.4.1. Technology Acceptance Model (TAM)

TAM adapted from the Theory of Reasoned Action (TRA) is an information system theory that models how users come to accept a technology and how they use that technology. Kondo et al. (2013) argue that amidst the well-developed theories, TAM received extensive empirical documentation on the validations, applications, and replications of its power to forecast the behaviour of adoption.

Perceived Usefulness and Perceived Ease of Use determine an individual's intention to use a system with the intention to use serving as a mediator of actual system use according to the TAM (Surendran, 2012). It includes beliefs about usefulness and ease of use as the primary determinants of ICT adoption in organisations. The two most important individual beliefs of TAM in using information technology is the Perceived usefulness and the Perceived ease of use (Li, 2010). The literature defines Perceived usefulness is defined as the degree to which a person believes that using a particular system would enhance his or her job performance (Li, 2010; Kondo, Ishida and Ghyas, 2013). In addition, perceived ease of use is defined as the degree to which a person believes that using a particular system would be free of effort. The two behavioural beliefs, perceived usefulness and perceived ease of use, then lead to individual behaviour intention and actual behaviour (Figure 2.1). Ventkatesh et al. (2003) argued that perceived usefulness is also seen as being directly impacted by perceived ease of use.

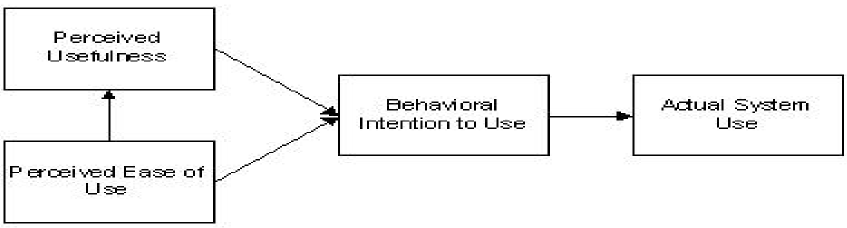


Figure 2.1 Technology Acceptance Model (TAM)

Source: Davis et al. (1998), Venkatesh et al. (2003)

Researchers have also extended the model. For instance, many other factors such as subjective norm perceived behavioural control, and self-efficacy have added to the model

(Hartwick and Barki, 1994; Mathieson et al., 2001; Taylor and Todd, 1995). Other researchers introduce additional belief factors from the diffusion of innovation literature, such as trialability, visibility, or result demonstrability (Agarwal and Prasad, 1997; Karahanna et al., 1999; Plouffe et al., 2001). However, Li (2010) argues that the structure and major presupposition of these theories rest the same as those of the TAM.

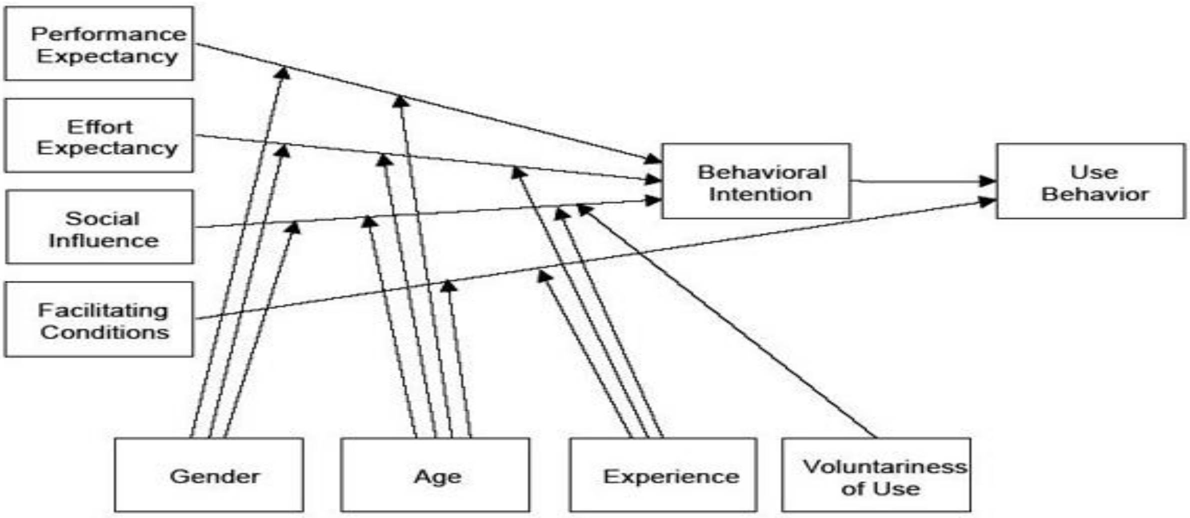
Despite being the widely used theory, shortcomings have been pointed out about TAM. Li (2010) argues though TAM is a useful model, it needs to be expanded to include social and human factors. Among the critics of TAM, Bagozzi (2007) has highlighted perhaps the most shortcomings. The researcher noted that the issues with TAM are not entirely peculiar to it, but in here as well in the TRA and the TPB, which should bring interruption to accepting any proposal suggesting that the TRA and TPB constitute panaceas for the field. In addition, that for purposes of organization, he maintains that the primary shortcomings of TAM (and the TRA and TPB) reside in (1) two critical gaps in the framework, (2) the absence of a sound theory and method for identifying the determinants of PU and PEU, as well as other bases for decision making, (3) the neglect of group, social, and cultural aspects of decision making, (4) the reliance on naïve and over-simplified notions of affect or emotions, and finally (5) the over-dependence on a purely deterministic framework without consideration of self-regulation processes (Bagozzi, 2007).

Moreover, (Li, 2010) argues that many other researchers found no empirical evidence to support the relationship between perceived ease of use and perceived usefulness (Chau and Hu, 2001; Bajaj and Nidumolu, 1998; Hu et al., 1999; Jackson et al., 1997; Subramanian, 1994). The researcher concludes that though TAM is useful, it needs to be expanded to include social and human factors.

2.4.2. Unified Theory of Acceptance and Use of Technology (UTAUT)

Venkatesh et al. (2003) examined eight technology acceptance models. They formulated a model that integrates and unifies the characteristics and elements of these eight models. This proposal is labelled the UTAUT Model. The theories that were incorporated into the UTAUT are the Theory of reasoned action (TRA), Theory of Planned Behaviour (TPB), Technology

Acceptance Model (TAM), Combination of TPB and TAM, Motivational Model, Personal Computer (PC) Utilization, Diffusion of Innovation (DOI), and the Social Cognitive Theory. The UTAUT integrates the common elements of these eight theories (Ventkatesh *et al.*, 2003). The validation of the UTAUT was conducted to conclude a 70% variance in usage intention (Venkatesh et al., 2003). UTAUT suggests that three constructs are the main determinants of intention to use an information technology (Figure 2.2). The three constructs are performance expectancy, effort expectancy, and social influence (Li, 2010). The fourth construct (Facilitating conditions) affects user behaviour. Ventkatesh et al. (2003) define Performance expectancy as the degree to which an individual believes that using the system will help him or her to attain gains in job performance. They argue that Effort expectancy is the level of ease associated with the utilization of the scheme. Social influence is defined as the extent to which an individual perceives that important others believe he or she should use the new system.



Finally, they argue that Facilitating conditions are defined as the degree to which an individual believes that an organisational and technical infrastructure exists to support the use of the system. The theory has been extended to UTAUT 2, which has the construct price as affecting the behavioural intention.

Figure 2.2 Unified Theory of Technology Acceptance Model (UTAUT)

Source: Ventkatesh et al. (2003)

The model and its extensions were criticised. Bagozzi (2007) criticised the model and its subsequent extensions. The researcher argues that UTAUT is a well-meaning and thoughtful presentation, but that it presents a model with 41 independent variables for predicting intentions and at least eight independent variables for predicting behaviour, and that it contributed to the study of technology adoption “reaching a stage of chaos.”

In addition, van Raaij & Schepers (2008) argue that the grouping and labelling of items and constructs are problematic because a variety of different items were combined to reflect a single psychometric construct. For instance, the facilitating conditions construct integrates perceived behavioural control (Ajzen, 1991), facilitating conditions (Thompson, Higgins, & Howell, 1991) and compatibility (Moore & Benbasat, 1991). It thus combines items on the fit between the technology and the individual’s work style, the availability of assistance, and the availability of required resources. It is hard to understand how such a wide variety of items can reflect one single psychometric construct (van Raaij and Schepers, 2008). They further argued that UTAUT’s high R^2 is only achieved when moderating the key relationships with up to four variables (gender, age, experience and voluntariness) to yield coefficients that are more significant.

2.4.3. Diffusion of Innovation Theory (DOI/IDT)

The Diffusion of Innovation (or Innovation Diffusion Theory –IDT-) of Rogers (1983) is one of the theories used in Information System to study the adoption or use of ICT service by users. In such settings, it is used as a technology acceptance model. Many studies (Carter and Belanger, 2004; Atkinson, 2007; Li, 2010; MacVaugh and Schiavone, 2010; Woosley and Ashia, 2011) have emphasised that in the field of information systems, DOI is used as technology acceptance model. Simin & Janković (2014) argue that the theory attempts to predict the behaviour of individuals and social groups in the process of adoption of innovation, considering their characteristics, their social relations, the time factor and the features of the innovation. They further argue that in the study of Innovation, which, individuals, most often use the term diffusion to describe the process of adoption of innovation or replace the old one with the new. Moreover, Kapoor et al. (2013) report that many researchers argue that the classic Diffusion of Innovation based on Rogers (1983) diffusion of Innovation model may be used to assist our understanding of technology adoption. Therefore, the Diffusion of Innovation Theory is used as a Technology acceptance model. The advantage of using the DOI is that it provides the contextual sets that drive the acceptance of the technological innovation (Ituma-aleke and Egwu, 2014) such as the use of ICT on agricultural input information.

Explaining the theory, Rogers (1983) argues that the characteristics which determine the rate of adoption are: Relative Advantage, Compatibility, Complexity, Trialability and Observability (Table 2.1).

Table 2.1. Core Perceived Attributes of Innovation

Attribute	Definition	Application
Relative advantage	The degree to which an innovation is perceived as better than the idea it supersedes	Innovation that appear to be beneficial when compared to others, both previous and current, are more likely to be adopted and used. The perception by the farmer that using ICT on agricultural input information would enhance his/her knowledge (access and use) on agricultural input information.
Compatibility	The degree to which an innovation is perceived as consistent with the existing values, past experiences and needs of potential users.	Adoption and use are more likely when the innovation is consistent with the economic, sociocultural, and philosophical value system of the users and the users' expectations needs.
Complexity /simplicity	The degree to which an innovation is perceived as relatively difficult to understand and use	Innovations that are perceived as more complex are less likely to be adopted and used. ICT on agricultural input information that perceived as simple to use would be more likely used.
Trialability	The degree to which an innovation may be experimented with on a limited basis	ICT on agricultural input information that can be tested before adoption are adopted more rapidly than those that cannot.
Observability	The degree to which the results of an innovation are visible to others	An ICT that realised benefits are visible to potential users through an interaction with a fellow ICT user are more likely to be used

Source : Rogers (1983); Atkinson (2007); author (2016)

The Diffusion of Innovation Theory (DOI) explains how over time ICT (innovation) gains momentum and diffuses. There is a time dimension in the diffusion process. The time involved in diffusion is in the innovativeness of an individual or another unit of adoption (Rogers, 1995). Innovativeness is the degree to which an individual or another unit of adoption is relatively earlier in adopting new ideas than other members of a social system (Rogers, 1983). According to (Rogers, 1983), there are five adopter categories, or classifications of the members of a social system on the basis of their innovativeness:

i. Innovators: They are the first to test an innovation. Very willing to take a risk.
ii. Early adopters: these people represent opinion leaders.
iii. Early majority: This category of adopters are rarely leaders. However, these people do adopt adoption before the average person. That said, they typically need to see evidence that the innovation works before they are willing to use it.
iv. Late majority: these people are sceptical of change. They will only adopt an innovation after the majority has tried it.
v. Laggards: these people are bound by tradition and very conservative (to change by using a new system such as ICT)

The theory has been widely used in adoption/use studies. For instance, Harindranath & Berna (2009) used the Diffusion of Innovation theory to investigate the challenges of ICT adoption by South African SMEs. It was also tested in Benin (Adegbidi et al., 2012), in Iran (Rezaei-Moghaddam and Salehi, 2010) and Saudi Arabia (Al-Ghaith, Sanzogni and Sandhu, 2010).

The DOI has been criticised. For instance (Wainwright and Waring, 2007) argue that the theory put different and vague statements afore that therefore requires an address. However, it can be considered adequate within a research context of use of ICT by small-scale farmers to access and use farm input information for three reasons. Firstly, the development of the DOI began in the agricultural input sector with research on ameliorated hybrid seed technologies (innovation). For that ground, it is a beginning point for studies on the innovative use of ICT on agricultural input information. Secondly, it fits well the identified constructs, i.e. Relative Advantage, Compatibility, Simplicity, Observability and Use of ICT on agricultural input information than any other technology acceptance model, which include UTAUT, TAM, TPB and TRA. Thirdly, it has been applied in the agricultural information services' adoption/use by farmers in developing countries than any other theory/model. Figure 2.3 displays the DOI theory.

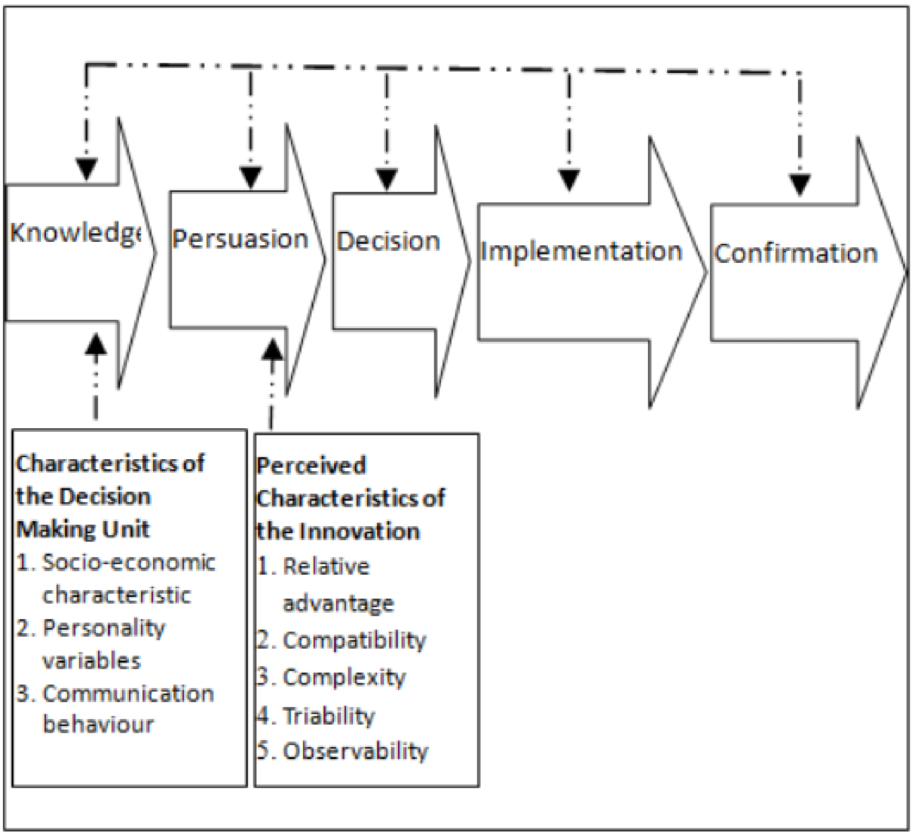


Figure 2.3 Diffusion of Innovation Theory (DOI/IDT)

Source: (Rogers, 1995)

Another critic of the Diffusion of Innovation Theory is from Honor (1998) who argues that the theory does not take into account an individual's resources or social support to adopt the new behaviour (or innovation). In addition, Woosley (2011) also argues that though the DOI has been comprehensively applied and documented, it still presents some deficiencies. To address these issues coming from Honor (1998) and Woosley (2011), we rely on other theories to extract some of the identified constructs such the information quality and the ICT service cost that were not taken into account by the DOI. These theories are discussed below in section 2.4.5.

2.4.4. Summary of the Reviewed IS Technology Acceptance Theories/Models

In conclusion, from the literature on the reviewed theories/models, Carter & Belanger (2004) quoting Tornatzky & Klein (1982) argue that the Relative Advantage, Compatibility, and Complexity are the most relevant constructs to adoption research. Nevertheless, Adegbidi et al. (2012) reported Observability as having a positive effect on use of ICT on agricultural input information. Their findings were similar to another one conducted by Atkinson (2007) on ICTs' adoption. Hence, the construct can be considered in a study on ICT on agricultural input information adoption by small-scale cereal farmers. However, Atkinson (2007) argued that some researchers use the term Simplicity so that the attributes would have the same directionality regarding their relationship with adoption, thus a study on ICT-based agricultural input information should use Simplicity instead of Complexity.

As argued by van Raaij & Schepers (2008), the grouping and labelling of items and constructs in UTAUT are problematic. The relative advantage, compatibility and simplicity are captured respectively in the UTAUT as Performance Expectancy, Facilitating Conditions, and Effort Expectancy. Moreover, Woosley (2011) argued that the Ease of Use variable from TAM and Simplicity from the DOI capture the essence of the construct Effort Expectancy. However, the Social Influence construct can be extracted from the UTAUT.

These three theories stopped at the intention of usage of ICT on agricultural input information. They did not go beyond, for instance, to look at the adoption of agricultural input information. Some other theories/models have been proposed by researchers (Foucault, 1977; Heeks and Alemayehu Molla, 2009) that goes beyond the intention of usage of IT/ICT. Some of these relevant theories/models are reported below.

2.4.5. The DIKDAR Model

The DIKDAR model (Heeks and Alemayehua Molla, 2009) propose an information needs/mapping approach. The approach proposes two variants: linking information to development and intended information requirements analysis. The model is an adaption of the information need/map approach which is sensitive to the specific information needs of individual communities and maps these against ICT4D impacts.

The approach is that lack of access to information exposes individual and communities to vulnerabilities. It is peculiarly suitable for ICT4D given its emphasis on information delivery capabilities. The DIKDAR model specifies that ICT services are the mean for farmers to access and use information. AS shown in figure 2.4, the Decision and Action are behaviours and they are taken only after the exposition of information and knowledge. However, to access information, the user needs information resources and that includes the cost (Heeks and Alemayehu Molla, 2009).

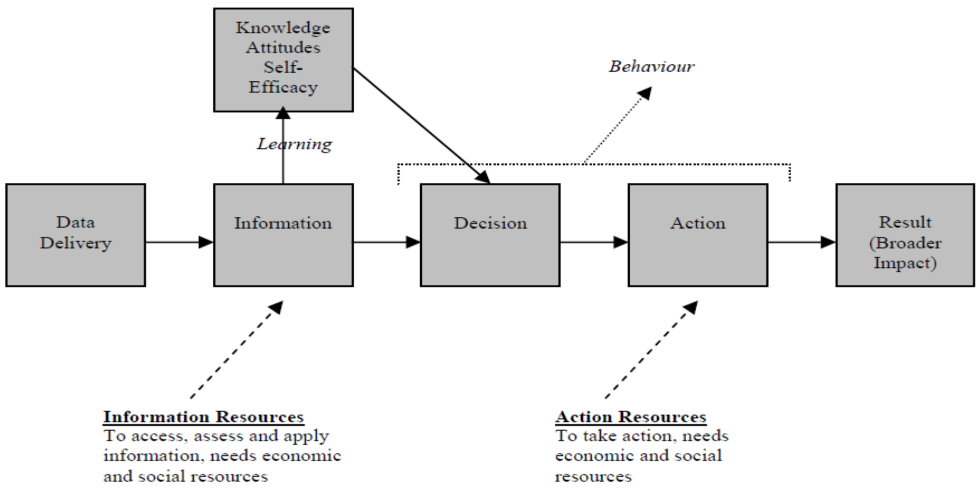


Figure 2.4 DIKDAR Model

Source: Heeks and Alemayehua Molla (2009)

2.4.6. Theory of Knowledge

The information got through an ICT service should lead to more access and use of agricultural inputs. The theory of Knowledge seems to drive towards that. Foucault (1977) draws a close link between knowledge and power. The scholar maintains that human experience is based on communication, with structures arising from the rules of the communication. Further, knowledge gives way to power that generates further knowledge through the process of surveillance and new discourse.

It is assumed that whoever has knowledge or information is empowered and whoever lacks it, is incapacitated. In the case of the current study, the agricultural input information provided by an ICT service to farmers will lead to an increased adoption of agricultural input information, which will be more knowledge on agricultural inputs. The use of Foucault theory is because of the link between knowledge and power. In a study of ICT on agricultural input information' use by small-scale cereal farmers, the power can be labelled as an increased adoption of agricultural input information.

The theory was empirically tested and validated in the same settings. For instance, Kaddu (2011) using the Foucault's theory to study rural women adoption of ICT on agricultural information in Uganda. The scholar found evidence that agricultural information empowers rural women.

In addition, there is a link between ICT Skills, Illiteracy and the information quality. For instance in India, Mittal & Mehar (2012) found that farmers in Bihar and Punjab State, farmers having access to information on farm inputs (seed, best cultivation practices, protection from weather-related damage and handling plant disease) have seen a yield increase of respectively 63.82% and 76.64%. Further, they argue that Bihar has a literacy rate of 21.1% and Punjab a literacy rate of 49.2%. Therefore, the use of ICT on agricultural input information is higher in Punjab where the illiteracy is lower than Bihar where the illiteracy is high. However, Glendenning & Ficarelli (2012) argue that the appropriateness, usability, relevancy of information are mediated by the users (farmers) capacity (literacy and skills). Therefore, ICT Skills and Literacy moderate information quality effect on the Use of ICT on agricultural input information.

2.5. REVIEW OF EMPIRICAL LITERATURE USING THE GROUNDED THEORY

A literature review is an essential feature of any academic project (Webster and Watson, 2002). The literature reveals many ways of conducting a literature review. In the field of Information Systems research, Webster and Watson (2002) proposed a method for doing the literature review. This method has become the standard one in the field. However, Urquhart and Fernández (2013) published a paper in the leading journal of the field (Management Information Systems Quarterly) on using Grounded Theory as a method for rigorously reviewing literature. This new method has become the highly recommended method in the field of Information Systems Research (Müller-Bloch and Kranz, 2015). Hence, this section describes the literature review done following that method of Urquhart and Fernández (2013). The fundamental principle of this method is to use (secondary) data to yield a framework (Müller-Bloch and Kranz, 2015). That fits well for studies that are gathering the empirical factors from ICT on agricultural input information deployed in developing countries

To efficiently perform the systematic literature search, we defined the conditions for inclusion or exclusion of an article in the data set. The main inclusion criteria were that the article should have been published within the last 15 years and related to the context of agricultural input information. Then, the fields of research were identified, and the specifics search terms were defined (Table 2.2).

Table 2.2. Research Source and Terms Definition

Inclusion	
Time	Between 2001–2016
Fields	Information Systems, Computer Science and Agriculture
Appropriate sources	Researchgate.net, google scholar, sciencedirect.com, aisnet.org, Willey, PubMed, webofscience.com
Search terms	ICT; ICT4D; Agriculture; agricultural inputs; developing countries; information; access to information on agricultural inputs; use of information on agricultural inputs; ICT in developing countries; ICT and agriculture; ICT in agriculture; ICT and agricultural input information; ICT and agricultural input information adoption.

The open coding (first stage) of the Grounded Theory (Urquhart and Fernández, 2013) to extract the keys concepts (factors) that were coming out of the dataset. This stage maps the reviewed ICT services with the literature and comes up with the concepts (factors) that are affecting use of ICT by small-scale cereal farmers. Each paper was picked and skimmed and spotlighted any discovery and insights in the article (text) that seemed pertinent to the scope and research questions of the current study. Each word, sentence or paragraph that was spotlighted in every one of the paper represented a pertinent (relevant) selection. We started then to re-read selection after selection. While perusing through them some of the concepts that capture parts of the selection data set and their respective studies were analysed and synthesised. That led us to incorporate each group of selection into a group of concepts and insights. The concepts (factors) that came up are presented in Table 2.2.

After finishing with the open coding, the emerged concepts were grouped into categories according to the defined research objectives. The categories that came out are Farmers' Perception of ICT, Farmers' influence on each other, and Challenges in the use of ICT on agricultural input information. They are referred to in Table 2.2. as Category. These categories were also the research objectives as defined in section 1.4. of this thesis.

The selective coding consisted of identifying the properties of these categories that were identified. In other words, it was to determine the direction of effects of these identified categories according to the literature. The selective coding was also the basis for the generation of the hypotheses and therefore, was aligned to the objective 4 of the research as defined in section 1.4.

Table 2.3 Concept and Category Matrix

Category	Concept	Empirical evidence	Developing country
Farmers' perception of ICT on agricultural input information	**Relative Advantage**	(Carter and Belanger, 2004; Dey, Prendergast and Newman, 2008; Al-Ghaith, Sanzogni and Sandhu, 2010; Pick and Gollakota, 2010; Rezaei-Moghaddam and Salehi, 2010; Adegbidi *et al.*, 2012; Surendran, 2012; Wulystan and Andrew, 2013; Amin and Li, 2014)	Benin, India, Indonesia, Iran, Kenya, Mali, Nigeria, Pakistan, Tanzania, Uganda, Senegal, China, Bangladesh
	Compatibility	(Dey, Prendergast and Newman, 2008; Rezaei-Moghaddam and Salehi, 2010; Adegbidi *et al.*, 2012; Pshenichnaya and Clause, 2013; Palmer, 2015; Sousa, Nicolay and Home, 2016)	Benin, India, Indonesia, Iran, Kenya, Mali, Nigeria, Pakistan, Tanzania, Uganda, Senegal, Bangladesh, Burkina Faso
	Complexity/Simplicity	(Dey, Prendergast and Newman, 2008; Al-Ghaith, Sanzogni and Sandhu, 2010; Rezaei-Moghaddam and Salehi, 2010; Adegbidi *et al.*, 2012; Dandedjrohoun, Diagne and	Benin, India, Indonesia, Iran, Kenya, Mali, Nigeria, Pakistan, Tanzania, Uganda, Senegal, China, Bangladesh

		Biaou, 2012; Amin and Li, 2014; de la Rive Box *et al.*, 2015)	
	Trialability	(Rezaei-Moghaddam and Salehi, 2010)	Iran
Farmers' influence on each other in the use of ICT on agricultural input	**Social Influence**	(Ventkatesh *et al.*, 2003; Kaba, Diallo and Plaisent, 2006; Lwoga, 2010; Pick and Gollakota, 2010; Siraj, 2010; Lwoga, Stilwell and Ngulube, 2011; Palmer, 2011; Wulystan and Andrew, 2013; Aleke, Egwu and N, 2015; GSMA, 2015; Sathye *et al.*, 2015; Sousa, Nicolay and Home, 2016)	Guinea Conakry, Iran, Mali, Tanzania, Uganda, Pakistan, Fiji, Nigeria, India, Burkina Faso
	Observability	(Pick and Gollakota, 2010; Rezaei-Moghaddam and Salehi, 2010; Adegbidi *et al.*, 2012; Palmer, 2015; Sathye *et al.*, 2015; Singh *et al.*, 2016; Sousa, Nicolay and Home, 2016)	Benin, Iran, Mali, Tanzania, Uganda, Fiji, India, Burkina Faso
Challenges faced by farmers in the use of ICT on agricultural input information	**Information Quality**	(Wang and Peng, 2008; Heeks and Alemayehua Molla, 2009; Atajeromavwo *et al.*, 2010; Lwoga, 2010; Hatakka and De, 2011; Lwoga, Stilwell and Ngulube, 2011; Mittal and Mehar, 2012; Williams, 2013; Wulystan and Andrew, 2013; Palmer, 2015,	India, Kenya, Mali, Nigeria, Tanzania, Pakistan, Uganda, China

		2014; Msoffe and Ngulube, 2016; Myagro, 2016; Barakabitze, Fue and Sanga, 2017)	
	Cost	(Sukhpal, 2004; Dey, Prendergast and Newman, 2008; Lwoga, 2010; Siraj, 2010; Kaddu, 2011; Williams, 2013; Wulystan and Andrew, 2013; Mwombe *et al.*, 2014; Palmer, 2014; Chung, 2015; GSMA, 2015; Haug and Tumbo, 2016; Kilima, Sife and Sang, 2016)	Mali, Tanzania, Uganda, Kenya, Pakistan, Jamaica, Bangladesh, India, Trinidad and Tobacco
	ICT Skills	(Kaddu, 2011; Kameswari, Kishore and Gupta, 2011; Williams, 2013; Palmer, 2014; Chung, 2015; Sousa, Nicolay and Home, 2016)	Uganda, Mali, Tanzania, India, Jamaica, Burkina Faso
	Literacy/Illiteracy	(Siraj, 2010; Adegbidi *et al.*, 2012; Glendenning and Ficarelli, 2012; Sanga, Kalungwizi and Msuya, 2013; Williams, 2013; Palmer, 2014; Chung, 2015; Kilima, Sife and Sang, 2016; Sousa, Nicolay and Home, 2016)	Benin, Tanzania, Mali, Pakistan, Burkina Faso

2.5.1. Farmers’ Perception of ICT on agricultural input information and the effects of this perception on the use of these ICTs

The use of ICT depends on the perceptions of their users. It was highlighted by many studies on ICT adoption/use and in different fields such as education (Jorge et al., 2003), health (Atkinson, 2007), e-government (Carter and Belanger, 2004) and others.

In the agricultural sector, researchers have emphasised that the perception is positively related to ICT adoption/use (Siraj, 2010; Kaddu, 2011; Sen and Choudhary, 2011; Bosch et al., 2012; Barakabitze et al., 2015). In addition, studies related to agricultural input report the same relationship between ICT’s use and user’s perception (Kaba, Diallo and Plaisent, 2006; Rezaei-Moghaddam and Salehi, 2010; Adegbidi et al., 2012). Nevertheless, what are these perceptions and to what extent are they influencing use of ICT by small-scale cereal farmers remain two questions that were not answered by these studies?

The perceived attitudes (relative advantage, simplicity, observability, compatibility and trialability) are necessary for the adoption and use of ICT/Innovation (Rogers, 1983; Atkinson, 2007). However, Carter & Belanger (2004) quoting Tornatzky and Klein (1982) emphasised that compatibility, relative advantage and complexity are the most perceived construct in the use of ICT. The open coding also empirically supported relative Advantage, Compatibility and Simplicity. Therefore, they were categorised as farmers’ perception of ICT on agricultural input information.

In terms of effect, the perception was found to be positively affecting use of ICTs on agricultural input information. Atkinson (2007) argues that simplicity is positively related to the use of ICT. Adegbidi et al. (2012) conclude that rice farmers’ perception of ICTs is positively affecting their use of them. Thus, Farmers’ Perception of ICT is positively associated with their use of ICT on agricultural input information. The factors are explained below.

2.5.1.1. Relative Advantage (RA)

Relative advantage (or superiority) is the degree to which an innovation is perceived as being better than the idea it supersedes (Rogers, 2003; Kotler, 1991), and is often expressed in terms of economic profitability and/ or social prestige (Rogers, 2003; Kyewalabye, 2001); in terms of productivity (Sentamu, 2001); in terms of convenience and/ or satisfaction (Kyewalabye, 2001); and so on. Adegbidi et al. (2012) quoting Lunkuse (2004), refer to the relative advantage of innovation as its perceived usefulness, that is "the degree to which the user's subjective probability that using a specific system will enhance his or her productivity". Further, they found an effect of Relative Advantage on rice farmers' use of ICT. This concept has been identified in many developing countries from the conducted literature review (Table 2.3). However, the remaining question is to what extent it is affecting ICT on agricultural input information by cereal farmers.

2.5.1.2. Compatibility

Adegbidi et al. (2012) argue that another important characteristic of an innovation affecting its rate of adoption is its perceived compatibility or acceptability (Kotler, 1991; Rogers, 2003; Sentamu, 2001). Atkinson (2007) reports that Compatibility is the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters. Rogers (2014) concluded that a more compatible idea is less uncertain to the potential adopter and fits more closely with the situation of the individual. Compatibility assists the individual give meaning to the new idea so that it is regarded as more familiar (Bakkabulindi, 2012).

This concept (factor) was highlighted in many studies in developing countries as affecting use of ICT on agricultural input information (Table 2.3). To what extend compatibility is affecting ICT on agricultural input information is a question that needs to be addressed.

2.5.1.3. Complexity/Simplicity

The complexity/simplicity was found to be affecting use of ICT by farmers. For instance, the use of TigoKilimo was perceived as complicated by farmers (Chung, 2015). A similar finding in the use of Senekela in Mali was reported by (GSMA, 2015; Palmer, 2015). In Kenya, Odhiambo (2013) noticed that farmers found the access to production information via mobile phone complicated. Wulystan & Andrew (2013) argue that in their survey, the respondents considered some ICTs simpler than others did. This point implies that the perception simplicity has became reality.

Some researchers prefer to use Simplicity instead of Complexity. For instance, Atkinson (2007) uses simplicity instead of complexity. Hence, Simplicity is recommended in studies on farmers use of ICT on agricultural input information. This concept has been identified in many developing countries from the literature review (Table 2.3).

2.5.1.4. Trialability

Trialability is the degree to which an innovation may be experimented with on a limited basis (Rogers, 1983). Trialability of innovation is important in minimising risk, uncertainty and adverse consequences of innovation (Rezaei-Moghaddam and Salehi, 2010). It was found to affect innovation' use (ICT) in Iran. However, the undertaken systematic literature review did not come across any other study supporting the finding of Rezaei-Moghaddam and Salehi (2010) in the field of agricultural input information. Moreover, Tornatzky and Klein (1982) found that Trialability was not affecting Use. Likewise, Carter and Belanger (2004) also agreed with them. Similarly, this researcher agrees with them in not taking Trialability as a factor in this case.

2.5.2. Farmers' influence on each other in the use of ICT on agricultural input information and the effects of this influence on the use of these ICTs

Farmers share information among themselves. Each community is comprised of people who regularly act around a respective set of issues, profits or needs (Benard, 2013). That was also emphasised by the findings of Lwoga et al. (2011) which demonstrated that the primary sources of information for farmers were predominantly local (neighbours, friends and family). In addition, they further concluded that 67% of farmers found families, friends and neighbours' information very efficiently. That hence means that sharing information about a new technology or new idea on agricultural input information accessed through an ICT service is a major key to the success of an innovation especially ICT.

Palmer (2015) conducting a study on ICT on agricultural input information services in Mali observed that almost all users interviewed in the field said that other farmers come to them every month for farming advice. This finding means that the information seekers were satisfied with the information given to them by their fellow farmers who were using Senekela. Satisfaction of farmers affects information usage because farmers who are satisfied with the information are likely to adopt it (Msoffe and Ngulube, 2016) or keep using it. Therefore, the non-ICT users would try to get the information directly from the source, which is use of ICT.

Moreover, due to the satisfied information that they receive, farmers also received advice to use ICT. That was highlighted by Palmer (2015) whose findings concluded that most repeat users recommend the service and share the information they receive with other farmers. 74% of repeat users in the phone survey said they had recommended the ICT service Senekela to farmers outside of their household, and 63% reported sharing the advice they received with other farmers –both are good indicators of satisfaction with the service (Palmer, 2015). In addition, the customers who used agronomic advice from the service and have seen an increase in yield, share the information they receive with other farmers (ibid.). Further, the same study reports that these farmers recommended to others (non-users) to use the service. Therefore, farmers peer' influence affects use ICT for increased adoption of agricultural input information.

This influence is among the community. Repeat users are influential in their communities, providing advice to other farmers (Palmer, 2015). That can be interpreted as the way the influential ICT users can describe (Observability) their achieved results to other farmers. Thereby, the non-users get knowledge of the ICT and its benefit (Observability). It can also be interpreted as the community pressure (Social Influence) on non-users to use ICT. That is emphasised by Pick and Gollakota (2010), who argue that if people in a person's social or reference groups who use the technology report satisfaction and advocate its use to non-users, they motivate non-users to try the system. In conclusion, there is a relation between observability, social influence and the use of ICT on agricultural input information. Hence, the study categorises Observability and Social Influence as Farmers' influence on each other with respect to use of ICT on agricultural input information.

Farmers influence on each other has a positive effect on their use of ICT on agricultural input information. For instance, observability was positively related to the use of ICT by rice producer in Benin (Adegbidi *et al.*, 2012). Rezaei-Moghaddam & Salehi (2010) argue that the observability affects the intention to the adoption of ICT on precision farming in Iran positively. Precision agriculture is an understandable approach to the management of the farm. That includes farm input management and therefore farm input information (Grisso et al., 2002). These two studies in Benin by Adegbidi et al. (2012) and in Iran by Moghaddam & Salehi (2010) were similar to the current study. Thus this study concludes that the Observability has a positive effect on the use of ICT on agricultural input information (Table 2.3). The social influence was also found to be positively affecting farmers' adoption of ICT in Guinea (Kaba, Diallo and Plaisent, 2006). The two concepts are more explained below.

2.5.2.1. Observability

Observability has been involved in many studies related to developing countries. It is the degree to which the results of an innovation are visible to others (Rogers, 1983). Observability was used to measure people's knowledge of e-service and its gains in Saudi Arabia (Al-Ghaith, Sanzogni and Sandhu, 2010). The study found a significant relationship between Observability and Adoption of the e-service. Is Observability significantly affecting ICT on agricultural input information used by cereal farmers in Mali?

In the field of agricultural input information, Adegbidi et al. (2012) argue that Observability, also known as communicability, demonstrability or describability, is the degree to which results of an innovation are visible to others. Some studies have used Observability as a perception. For instance, Al-Ghaith et al. (2010) used the Observability as a perception factor. However, Moore and Benbasat (1991) found that Observability was not simple (Rezaei-Moghaddam and Salehi, 2010). They consequently divided the construct into two separate constructs that they called visibility and result in demonstrability. Result demonstrability points to “the tangibility of the results of using an innovation”. Visibility points to “the extent to which potential adopters see the innovation as being visible in the adoption context.” Applying this to a context such as use of ICT on agricultural input information, the “tangibility of the results of using an innovation” would be “tangibility of the increased knowledge gained by using ICT on agricultural input information”. The “extent to which potential adopters see the innovation as being visible in the adoption context” would be “the increased knowledge of a fellow farmer using ICT on agricultural input information visible to other farmers due to an interaction between them”. Also, Pick and Gollakota (2010) used Observability and Subjective Norm to measure the Social Influence in their study. Moreover, Rogers (2003) identified the dimension of Observability to the society using it. In conclusion, it is a perception but gotten after an interaction with others. Table 2.3 gives more details of the studies that found an effect of Observability on use of ICT.

2.5.2.2. Social Influence

Rogers (1995) defines pressure or social norms as the values or behaviours, which are the most, accepted by the members of society. Social pressure refers to an individual’s belief that he should adhere to the same practices agreed to by the people enjoying a high social status in an environment. Ventkatesh et al. (2003) argued that Social influence is defined as the degree to which an individual perceives that important others believe he or she should use a new system.

The social influence has been found in related studies to affect the use of ICT. For instance in Guinea, Kaba et al. (2006) found that Social Influence was a key determinant in the use of ICT (cellular phone). Social Influence as defined by (Ventkatesh *et al.*, 2003) should be utilized in the context of cereal production by small-scale farmers. The remaining question that should be addressed is to what extent is it affecting the use of ICT on agricultural input information for an increased adoption of agricultural input information. Table 2.3 summarises studies that linked Social Influence to use of ICT in developing countries.

2.5.3. Other Challenges faced by cereal farmers in the use of ICT on agricultural input information and the effects of these challenges on the use of these ICTs

The concepts ICT' services Cost is a challenge for farmers in their use of ICT on agricultural input information. That was reported by the literature in many developing countries (Table 2.3). The provided Information Quality was also a challenge as shown in Table 2.3. The ICT Skills and Literacy were also challenging farmers in their use of ICT on agricultural input information. Hence, these concepts are grouped to form the category other challenges in accordance with the research objective 3.

The high' cost is a barrier to the use of ICT on agricultural input information in developing countries. For instance, in Tanzania, the cost was an obstacle to the uptake of ICT on agricultural input (information) by farmers (Barakabitze *et al.*, 2015). Therefore, this study identifies the high cost as a barrier to the use ICT in the context of agricultural input information. In contrast to that high cost, lower ICT services cost has a positive effect on the use of ICT on agricultural input information.

On the other hand, the delivered information quality was found to positively affect farmers' use of ICT on agricultural input information. For instance, since farmers are likely to use information that has immediate gains, the information usage' effect may result in foster utilisation (of ICT on agricultural input information) because of the realised benefits (Msoffe and Ngulube, 2016).

2.5.3.1. Cost

The high cost of ICT services constitutes a factor to its use on agricultural input information. For instance in Bangladesh, the high cost was one of the factors that can dilute the advantages of accessing information through mobile phone (Dey, Prendergast and Newman, 2008). This finding was confirmed by many other studies (Wulystan and Andrew, 2013; Haug and Tumbo, 2016; Kilima, Sife and Sang, 2016) in Tanzania. In Mali, 95% of SENEKELA users find that the cost is prohibitive (Palmer, 2014). In India, a case study on e-choupal by Sukhpal (2004) argues that low cost leads to use of ICT by farmers. In Bangladesh, Dey, Prendergast and Newman

(2008) noted that high costs are one of the factors that can dilute the advantages of having access to information through ICT.

This study referred to cost as the search and use of information on agricultural inputs through ICT. Table 2.3 provides empirical evidence in developing countries.

2.5.3.2. Information Quality

Farmers question the effectiveness of the provided information for use. For instance, in India, studying the ICT in Agriculture development Meera et al. (2004) argue that information on agricultural inputs (availability and prices) was sensed as inappropriate by farmers. This finding was similar to another study on an agricultural value-added service (VAS) conducted in Mali by Palmer (2014) who found that the information provided was incomplete. Also, Wang and Peng (2008) report that the information content (quality) was a problem in China. Moreover, Lwoga (2010) reports that relevant and local content were barriers to the use of telecentres in Tanzania by farmers. Therefore, the provided information quality constitutes a challenge for farmers in their use of ICT on agricultural input information.

There are some characteristics related to the agricultural input information quality affecting its use. For instance, in Uganda, Kaddu (2011) argues that the value of information depends upon many factors including accessibility, relevance, accuracy and currency. In addition, in a study on ICT services for development in developing countries, Beardon (2005) argues that the participants said that for information to be useful or valuable, it should be well-timed and comprehensible.

Agricultural input information completeness means that all the data necessary to meet the current need for farm input information was provided by the ICT services (Siyao, 2012). The accuracy means that the information on agricultural inputs was correct for the farmers' need for information on agricultural inputs. Siyao (2012) argues that accuracy implies that information is free from bias. Timeliness means that the farmers are able to get the agricultural inputs' information when they need it (ibid.). Relevance means that the information is suitable for the current information need of farm inputs. Appropriateness means that the information is appropriate for the present need of agricultural input information (ibid.).

Heeks & Alemayehu Molla (2009) argue that the lack of access to complete, accurate, reliable, timely and appropriate information endanger individuals and communities. Accuracy, precision, timeliness, relevance and format were again highlighted by Ndiege et al. (2012) as Information Quality in a case study in Kenya on IS in SMEs. The same observation was made by Mittal & Mehar (2012). Therefore, the quality of the information contributes to the frequent use of ICT services in the agricultural inputs sector, which leads to an increased adoption of agricultural input information.

However, what are these characteristics of the information quality and to what extent do they influence small-scale cereal farmers to use of ICT remains questions that need to be addressed. This concept has been identified in many developing countries from the undertaken literature review (Table 2.3).

2.5.3.3. Literacy and ICT Skills

It is important to know how to access and to have the skills to use ICT to adopt information. Dutta et al. (2004) argue that an educated and ICT aware population is the condition for any community to participate in the networked world fully. In addition, Sanga, Kalungwizi and Msuya (2013) reported that illiteracy remains a challenge for farmers in their use of ICT on agricultural information. The same observation was made by (Kaddu, 2011). Therefore, Illiteracy is a major concern (a challenge for farmers in their use of ICT on agricultural input information.

The low ICT Skills also constitutes a challenge to the use of ICT on agricultural input information. For instance, the GSMA (2015) reports that illiteracy and low technical skills are a major barrier to uptake. In addition, the USSD channel of TigoKilimo[5] in Tanzania necessitates farmers to navigate through a comprehended interface menu text-based information. Msoffe & Ngulube (2016) also argue that low levels of literacy were a barrier to

[5]TigoKilimo is an ICT service that disseminate agricultural (input) information in Tanzania.

access to information. Another study in India on the use of ICT services in agriculture conducted by Meera et al. (2004) reported that frequent use of the internet services was positively associated with education. In Serbia, Simin & Janković (2014) argued that the level of education has a positive effect on Innovations' adoption in agriculture. Finally, in Saudi Arabia, Al-Ghaith et al. (2010) also argued that the adopter of new technology has the appropriate level of education.

Several metrics can be used to measure the educational achievements. These are Illiteracy and the percentage of the population that has a second-degree education (Garcia-Murillo, 2003). Singh et al. (2016) emphasise that the use of ICT such as mobile phone requires basic literacy. Therefore, this study used the Literacy as the metric to measure the educational achievements instead of education Level. This concept has been identified in many developing countries from the literature review (Table 2.3). The category ICT Skills and Literacy were found to be moderating the effects of some of the identified construct. It is detailed in Table 2.4.

Table 2.4 ICT Skills and Literacy Properties

Concept	Moderating	Empirical Support
ICT Skills	Simplicity/Complexity	(Kaddu, 2011; Kameswari, Kishore and Gupta, 2011; Palmer, 2014; Chung, 2015)
	Information Quality	(Atajeromavwo *et al.*, 2010; Kaddu, 2011; Palmer, 2014; Chung, 2015)
Literacy	Simplicity/ Complexity	(Siraj, 2010; Palmer, 2014; Chung, 2015)
	Observability	(Adegbidi *et al.*, 2012)
	Information Quality	(Glendenning and Ficarelli, 2012; Chung, 2015)

2.6. THE IDENTIFIED GAPS

An indispensable feature of an academic project is the literature review (Müller-Bloch and Kranz, 2015). This researcher follows the guidelines of (Webster and Watson, 2002; Wolfswinkel, Furtmueller and Wilderom, 2011) to do the literature review systematically. This method is highly recommended in the field of Information Systems according to Müller-Bloch and Kranz (2015).

Furthermore, Müller-Bloch and Kranz (2015) proposed a framework on how to identify research gaps in IS research. This framework is built on the existing guidelines (Webster and Watson, 2002; Wolfswinkel, Furtmueller and Wilderom, 2011) that were followed. Nevertheless, this researcher agrees with Müller-Bloch and Kranz (2015) that it is important to identify research gaps rigorously and to characterise them. These research gaps should be based on the systematic literature review. That systematic review has provided the factors and their properties (effects) on the use of ICT on agricultural input information in developing countries.

After systematically identifying the factors affecting use of ICT on agricultural input information, there is a need to look for research gaps in this literature. A set of information gap deriving from a literature synthesis and requiring further inquiry to be solved constitutes a research gap (Müller-Bloch and Kranz, 2015). This section discusses the research gaps following the framework of Müller-Bloch and Kranz (2015). It starts with a characterisation of the investigation gaps followed by the related ICT model to address the adoption of ICT services in the field of agricultural input information. It lastly goes on and presents these research gaps.

2.6.1. Research Empirical Gaps

Jacobs (2011) identifies six categories of gaps that are the interesting exception, contradictory evidence, knowledge void, action knowledge conflict, methodological conflict and theoretical conflict. Müller-Bloch and Kranz (2015) refined these gaps and came up in their framework with the following type of research gaps: methodological conflict, contradictory evidence, knowledge void, action-knowledge-void, evaluation void and theory application void.

A dataset of 24 empirical studies related to adoption/use of ICT on agricultural input information in developing countries were analysed using the framework for rigorously identifying the research gaps (Müller-Bloch and Kranz, 2015) related to ICT on agricultural input information use. Table 2.5 presents the categories of the identified research gaps and their definition, as well as the frequency with which they occur.

Table 2.5 Research Gaps per Categories and References

Research Gap Category	Definition	Gaps	References
Contradictory evidence	Results from studies allow for conclusions in their right but are contradictory when examined from a more abstract point of view. Another way to look at that issue is that the study's (or some) findings have not been confirmed by any other study.	2	(Amin and Li, 2014; Cox and Sseguya, 2016; Kilima, Sife and Sang, 2016)
Knowledge void	Desired research findings do not exist. (the study finds something else instead of what it was looking for)	5	(Dey, Prendergast and Newman, 2008; Lwoga, 2010; Pick and Gollakota, 2010; Aleke, Egwu and N, 2015)
Action-knowledge Conflict	Professional behaviour or practices deviate from research findings or are not covered by the research.	4	(Dangi and Singh, 2010; Rezaei-Moghaddam and Salehi, 2010; Lwoga, Stilwell and Ngulube, 2011; Adegbidi

			et al., 2012; Sanga, Kalungwizi and Msuya, 2013)
Methodological conflict	A variation of research methods is necessary to generate new insights or to avoid distorted findings.	10	(Dangi and Singh, 2010; Siraj, 2010; Adegbidi *et al.*, 2012; Sanga, Kalungwizi and Msuya, 2013; Williams, 2013; Amin and Li, 2014; Njelekela and Sanga, 2015; Singh *et al.*, 2016)
Evaluation void	Research findings or propositions need to be evaluated or empirically verified.	25	(Dey, Prendergast and Newman, 2008; Wang and Peng, 2008; Dangi and Singh, 2010; Lwoga, 2010; Pick and Gollakota, 2010; Rezaei-Moghaddam and Salehi, 2010; Siraj, 2010; Lwoga, Stilwell and Ngulube, 2011; Williams, 2013; Wulystan and Andrew, 2013; Ituma-aleke and Egwu, 2014; Haug and Tumbo, 2016)
Theory application void	Theory should be applied to certain research issues to generate new insights.	8	(Dey, Prendergast and Newman, 2008; Rezaei-Moghaddam and Salehi, 2010; Adegbidi *et al.*, 2012; Sanga, Kalungwizi and Msuya, 2013; Amin and Li, 2014; Ituma-aleke and Egwu, 2014; Aleke, Egwu and N, 2015)

The research gap that occurs almost in all the reviewed studies was the Evaluation void. It occurs 25 times. For instance, Pick and Gollakota (2010) have proposed an ICT adoption model by farmers. They came up with some factors such as Perceived outcomes. This perceived outcome need to be empirically tested and defined regarding meaning. Another example of evaluation void is the finding of Wang and Peng (2008) who came up with the information content as a factor in the use (adoption) of ICT services in China by farmers. Nevertheless, they did not explain the extent to which this content affects ICT adoption. Therefore, this finding also needs to be confirmed. It is also necessary to define "information content". This goes almost for all of the factors that came up in Table 2.3. To what extent these factors are affecting use of ICT by (small-scale cereal) farmers is a gap that needs to be filled by this study.

The second research gap that occurs mostly after the evaluation void was the methodological conflict (10 times). For instance, Amin and Li (2014) proposed a model for ICT adoption by farmers in a comparative case study between Bangladesh and China. However, they use PLS-SEM to analyse a sample size of 80 respondents. That was below the recommended sample size for any study using Structural Equation Modelling, which is 200 as suggested by (Kline, 2013). Even if they were applying the rule of ten by Hair, Ringle and Sarstedt (2011), their sample size would have been 90 instead of 80 (nine latent variables * 10 = 90). In addition, it was recommended not to use that rule of ten (Oodhue *et al.*, 2012). This is a methodological conflict gap that needs to be filled by this study.

Another significant research gap coming up was the theory application void. This gap occurred eight times in the reviewed studies. Such a major gap is for instance in the paper of Dey, Prendergast and Newman (2008), which draws a conceptual framework using the Technology Acceptance Model (TAM), the Theory of Reasoned Action (TRA) and the Theory of Planned Behaviour (TPB) and yet the results are presented using the Social Structural Theory. Another example of that theory application void is from Adegbidi *et al.* (2012), who use the Diffusion of Innovation Theory to investigate ICT adoption by rice farmers. Nevertheless, the findings are not consistent with the DOI that was used. These gaps need to be filled.

The research gap knowledge void occurred five times during this process. An example of that gap is that of Amin and Li (2014), where the desired research hypothesis (Relative advantage positively affecting ICT adoption) was not supported by the study's results in Bangladesh. In addition, the same survey did support its desired hypothesis (Ease of use has a positive effect on intention to use) in China. These findings also lead us to contradictory evidence. Indeed, there is broad agreement among IS researchers that Relative advantage, Compatibility and Simplicity are the most perception factors that affect ICT adoption (Carter and Belanger, 2004;

Weigel *et al.*, 2014). Another example of that gap is the study of Rezaei-Moghaddam and Salehi (2010) in Iran. They found a relationship between Observability and Ease of Use, Observability and Perceived Usefulness. No other study, to this researcher knowledge, has confirmed these findings yet. Moreover, the systematic literature review (Table 2.3) reveals also that many studies have found these factors to affect use of ICT by farmers in developing countries.

Lastly, the action-knowledge conflict appeared four times in the reviewed papers. For instance, the model by Amin and Li (2014) did not take into account the factors information quality or cost, which were identified in the systematic literature review. This is a gap that needs to be filled.

2.6.2. Gaps from Theoretical Literature on ICT adoption models on agricultural input information

Researchers have developed models to address use of ICT by farmers in developing countries. This researcher identifies four models that were related to the current study's context. These models are discussed in this subsection.

2.6.2.1. Farmer Technology Acceptance Model (FTAM) in Bangladesh and China

Amin and Li (2014) designed a conceptual framework based on the Technology Acceptance Model (TAM) of Davis (1989). The study concentres on the development and adoption process of ICT enabled products and services by low-income group (farmer) fostering the rural development of developing country like Bangladesh, and China based on the Technology Acceptance Model. The hypotheses testing and results are shown in Figure 2.5.

Hypothesized path	Standard Deviation (STDEV		T Statistics (|O/STERR|)		Total effect		Result of hypotheses	
	BD*	CN**	BD	CN	BD	CN	Bangladesh	China
Innovativeness -> Relative advantage	0.3197	0.1579	0.8367	2.5326	0.2675	0.7787	Not Supported	Supported
Intention to use -> Actual use	0.0337	0.0451	28.5011	18.3421	0.9601	0.8275	Supported	Supported
Occupation Relevance -> Perceived Usefulness	0.2441	0.0575	2.7217	13.5506	0.6642	0.7787	Supported	Supported
Perceived Ease of Use -> Intention to use	0. 3374	0.2819	2.5017	0.0913	0.8442	0.0258	Supported	Not Supported
Perceived Usefulness -> Intention to use	0.2900	0.3046	1.6610	1.6643	0.3267	0.2944	Supported	Supported
Relative advantage -> Intention to use	0.3203	0.1740	0.3445	2.6388	0.1104	0.4591	Not Supported	Supported
Self-efficacy -> Perceived Ease of Use	0.2179	0.1673	2.2900	1.4676	0.7050	0.7357	Supported	Not Supported
Social Influence -> Perceived Ease of Use	0.2308	0.1734	1.2433	3.4761	0.2869	0.6026	Not Supported	Supported

*BD: Bangladesh **CN: China

Figure 2.5 Bootstrapping results from Amin and Li (2014)

There is knowledge void gap in this study of Amin and Li (2014). That is that the desired research hypothesis (Relative advantage having a positive effect on intention to use ICT) was not supported by the study's results in Bangladesh. Also, the same study did support its desired hypothesis (Ease of use has a positive effect on intention to use) in China.

In addition to the knowledge gap, a contradictory evidence also occurred about that study. Indeed, there is broad agreement among IS researchers that Relative advantage, Compatibility and Simplicity are the most perception factors that affect ICT adoption (Carter and Belanger, 2004; Weigel *et al.*, 2014). Moreover, the undertaken systematic literature review (Table 2.3) reveals also that many studies have found these factors to affect use of ICT by farmers in developing countries.

The action-knowledge conflict appeared in this study when it fails to identify some factors such as Cost or Information Quality. These factors were identified by the systematic literature review (Table 2.3). Furthermore, this study was not done in the context of cereal production that is the principal interest of the current study

2.6.2.2. The model by Rezaei-Moghaddam & Salehi (2010) in Iran

Predicting the determinant of intention to adopt precision agriculture technologies among agricultural specialists was the purpose of the study (Rezaei-Moghaddam and Salehi, 2010). The study uses the Diffusion of Innovation Theory, Theory of Planned Behaviour and Technology Acceptance Model to propose a theoretical framework (Figure 2.6).

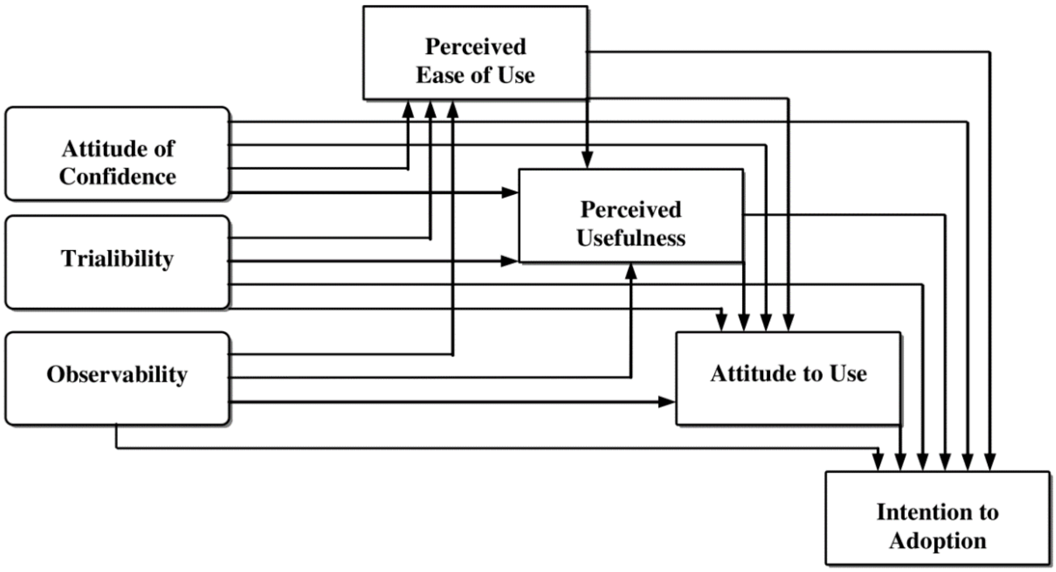


Figure 2.6 Theoretical Framework of Rezaei-Moghaddam & Salehi (2010)

This model has three research gaps that have been identified. There was a knowledge void when the study did not confirm some hypotheses. For instance, as shown in Figure 2.6., the desired research hypothesis H7 was not supported. That can be that Perceived ease of use is not a determinant for agricultural extension officers’ intention to adopt ICT on agricultural input information. Nevertheless, the study did not indicate Perceived Ease of Use nor as a driver or a barrier. In addition, farmers’ utilization and usage of ICT factors differ from extension officers.

The second gap that was found in the study is an evaluation void. The factors Observability, Perceived Ease of Use (Simplicity), Perceived usefulness (Relative Advantage) should be further investigated to see if they are drivers or barriers for use of ICT by farmers.

The third and last gap is the contradictory evidence. The relationship between Observability and the factors Perceived Ease of Use and Perceived Usefulness, seems contradictory. We did not come across any study that has confirmed them. The hypotheses validation of the model are displayed in figure 2.7

Hypotheses	Path	Coefficient	p-value
H1	AOC → PEOU	0.31	0.01
H2	AOC → ATU	0.16	0.01
H3	AOC → PU	0.04	ns
H4	AOC → INA	0.08	ns
H5	PEOU → ATU	0.16	0.01
H6	PEOU → PU	0.23	0.01
H7	PEOU → INA	0.06	ns
H8	PU → ATU	0.18	0.01
H9	PU → INA	0.08	ns
H10	ATU → INA	0.52	0.01
H11	OBS → PEOU	0.16	0.01
H12	OBS → PU	0.25	0.01
H13	OBS → ATU	0.38	0.01
H14	OBS → INA	0.14	0.05
H15	TRI → PEOU	0.32	0.01
H16	TRI → PU	0.11	ns
H17	TRI → ATU	0.13	0.05
H18	TRI → INA	0.16	0.01

Figure 2.7 Path Coefficients and p-values of Hypotheses of Rezaei-Moghaddam & Salehi (2010)

2.6.2.3. The model of Miraj (2010) in Pakistan

In Pakistan, Miraj (2010) designed an ICT service for agriculture extension. The service provides to agricultural (input) information to farmers. This model was not a conceptual model. However, it was informed by four factors: farmers' lack of adaptable information (relevancy), economics barriers (ICT services cost), social and motivational issues and farmers' perception. The information needs identified by the model were on farm inputs. This model did not take into account all the characteristics of the information quality. That action-knowledge conflict gap needs to be filled. The experiences from Mali, Kenya and Tanzania showed that the information characteristics such as completeness, timeliness and accuracy are major concerns for farmers in their use of ICT on agricultural input information. Moreover, the model did not take into account the influence of farmers on each other in the use of ICT to disseminate agricultural input information. Palmer (2015) reports that farmers do share agricultural input information.

2.6.2.4. The model of Adegbidi et al. (2012) in Benin

In Benin, the model by Adegbidi et al. (2012) identified User friendliness (simplicity), Observability, Relative Advantage, Compatibility as drivers in the use of ICT by rice farmers. There is an evaluation gap on the drivers that were identified. Also, the model did not address the Information Quality and the Cost that is an action -knowledge conflict gap to address. The literature review showed that Information Quality and Cost are important in the use of ICT on agricultural input information. Moreover, the targeted cereal crop was only rice while it was argued that the most cereal crops were maize, sorghum and millet in Africa (Wood and Cowie, 2001).

The study has an Evaluation void gap. It identified from the literature these factors but fail to hypothesise them. In addition to that gap, there is a methodological conflict deficit. The study indeed did not provide any statistical significance for the identified factors (relative advantage, compatibility, simplicity, observability, and use of ICT). This study needs to fill these gaps.

Another gap in this study is an action-knowledge gap. The study did not cover some factors that were identified in the systematic literature review. These factors were Information quality and Social Influence. This shortcoming also needs to be filled.

2.7. CONCEPTUAL FRAMEWORK

Vaughan (2008) defines a conceptual framework as a written or visual presentation that: a) explains either graphically, or in narrative form, the main things to be studied –the keys factors, concepts or variables-, b) and the presumed relationship among them.

The Diffusion of Innovation theory was the main theory of this study as it fits well the identified empirical constructs and has been applied in similar context. To the DOI, we have added some constructs from other theories/models supported by empirical evidence in the agricultural input information. The DOI extensions are not included in this study. According to DOI, the rate of diffusion is affected by an innovation's relative advantage, complexity, compatibility, trialability and observability. All the factors are included in this study except the trialability. In a study on ICT adoption among rice producers in Benin, Adegbidi et al. (2012) did not find any evidence supporting that the construct trialability affects the use of ICT. That is comparable to another study by Carter & Belanger (2004) who argued that it was dubious that perceived trialability would display adequate variance to offer explanatory power. The literature review did not show any empirical evidence of any relationship between trialability and use of ICT on agricultural input information. Therefore, the construct trialability was not included in this study.

As the DOI did not have all the empirical constructs, this study borrows three new theoretical constructs from other theories/models. Table 2.6 gives the theoretical constructs distribution by theory/model and the name to be used in this study. In addition, Table 2.4 also provides empirical evidence as discussed in the literature of the moderating variables. The conceptual framework is displayed in figure 2.8.

Table 2.6 Constructs Extracted from Theories

Theory	Construct extracted	Name to be used
Diffusion of Innovation Theory (DOI)	Relative Advantage	Relative advantage
	Compatibility	Compatibility
	Complexity/Simplicity	Simplicity
	Observability	Observability
DIKDAR MODEL	Information Quality	Information Quality
	Information resources (economic)	Cost
Unified Theory of Acceptance and Use of Technology	Social Influence	Social influence
Theory of Knowledge	Power	Increased adoption agricultural input information

The conceptual framework is composed of nine theoretical constructs (Table 2.6) that were obtained from empirical constructs (Table 2.3). In addition, we have five moderating variables that were also empirically supported (Table 2.4).

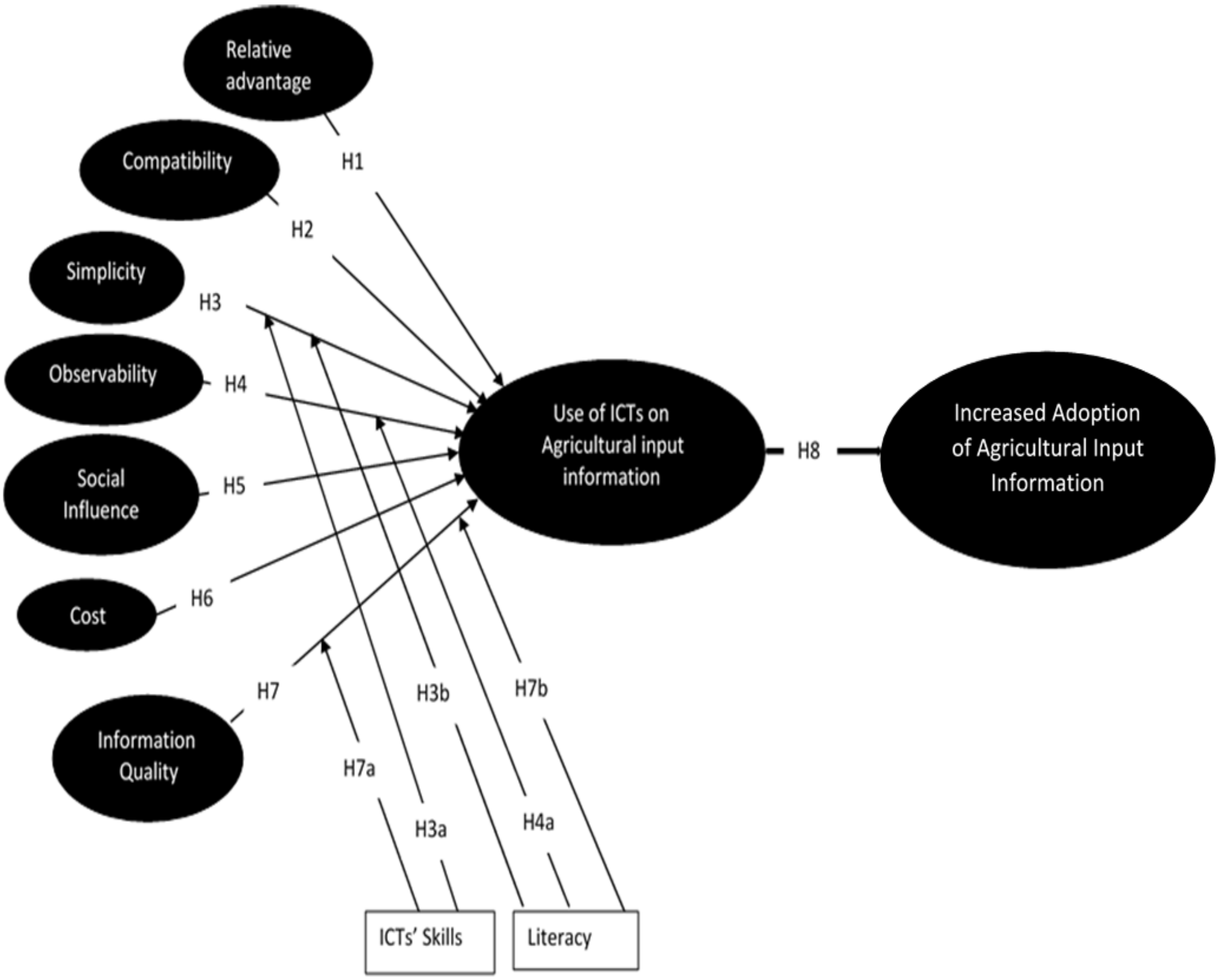


Figure 2.8 Conceptual Framework

A hypothesis is a testable proposition about the relationship between two or more concepts or variables. Based on the conceptual framework above and the theoretical and empirical argument, hypotheses were formulated.

Objective 1. To establish farmers' perception of ICT on agricultural input information and to identify the effects of that perception on the use of ICT on agricultural input information.

H1: Relative Advantage has a positive effect on the use of ICT on agricultural input information.

H2: Compatibility has a positive effect on the use of ICT on agricultural input information.

H3: Simplicity has a positive effect on the use of ICT on agricultural input information.

H3a: ICT Skills moderates the positive effect of simplicity on the use of ICT on agricultural input information.

H3b: Literacy moderates the positive effect of Simplicity on the use of ICT on agricultural input information.

Objective 2. To establish farmers' influence on each other in the use of ICT on agricultural input information and to identify the effects of this influence on the use of ICT on agricultural input information.

H4: Observability has a positive effect on the use of ICT on agricultural input information.
H4a: Literacy moderates the positive effect of Observability on the use of ICT on agricultural input information.
H5: Social influence has a positive effect on the use of ICT on agricultural input information.

Objective 3. To establish the challenges faced by farmers in the use of ICT on agricultural input information and to identify the effects of these challenges in the use of ICT on agricultural input information.
H6: Cost has a positive effect on the use of ICT on agricultural input information.
H7: Information quality has a positive effect on the use of ICT on agricultural input information.
H7a: ICT Skills moderates the positive effect of Information Quality on the use of ICT on agricultural input information.
H7b: Literacy moderates the positive effect of Information Quality on the use of ICT on agricultural input information.

Objective 4. To propose an ICT model for increased adoption of agricultural input information in developing countries using the case of Sikasso, Mali.
H8: Use of ICT on agricultural input information has a positive effect on an increased adoption of agricultural input information.

CHAPTER THREE

METHODOLOGY

3.1. INTRODUCTION

Research methodology is divided broadly in two: quantitative and qualitative. The Oxford University Press (2008) reports traditional scientific methods that yield numerical data and look for establishing the qualitative relationship among variables using statistical tools to validate this relationship is the quantitative research. On the other hand, Michael D Myers and David Avison (2002) report that qualitative research is interested in the conduct of interviews, collect of documents and observation data to explain a social phenomenon. This study was conducted through quantitative methods. The first section describes the research philosophy while the second one discusses the research design. The next section gives an overview of the overall approach of this study. In section four, the steps taken to analyse the data are described. Section five follows that and present the technique that was used for data analysis namely the Partial Least Square Structural Equation Modelling (PLS-SEM). Finally, the last section describes the data management.

3.2. RESEARCH PARADIGM

Myers (2015) argues that all research is supported by some assumptions that define what constitutes 'valid' research and which research methods are suitable. A paradigm is a way of examining social phenomena from which particular understandings of these phenomena can be gained, and explanations attempted (Saunders et al., 2009).

Four research philosophies can be applied in information management research (Positivism, realism, interpretivism and pragmatism). Nevertheless, Michael D Myers & David Avison (2002) quoting Orlikowski and Baroudi (1991) classified IS research as positivism if there was evidence of formal propositions, quantifiable measures of variables, hypothesis testing, and the drawing of inferences about a phenomenon from the sample to a stated population. Thus, this study adopted a positivist paradigm.

3.3. RESEARCH DESIGN:

The research design is the overall plan for connecting the conceptual research problems to the pertinent (and achievable) empirical research (Wyk, 2012). In this study, the steps that were to arrive at the study's conclusions are presented below in Figure 3.1.

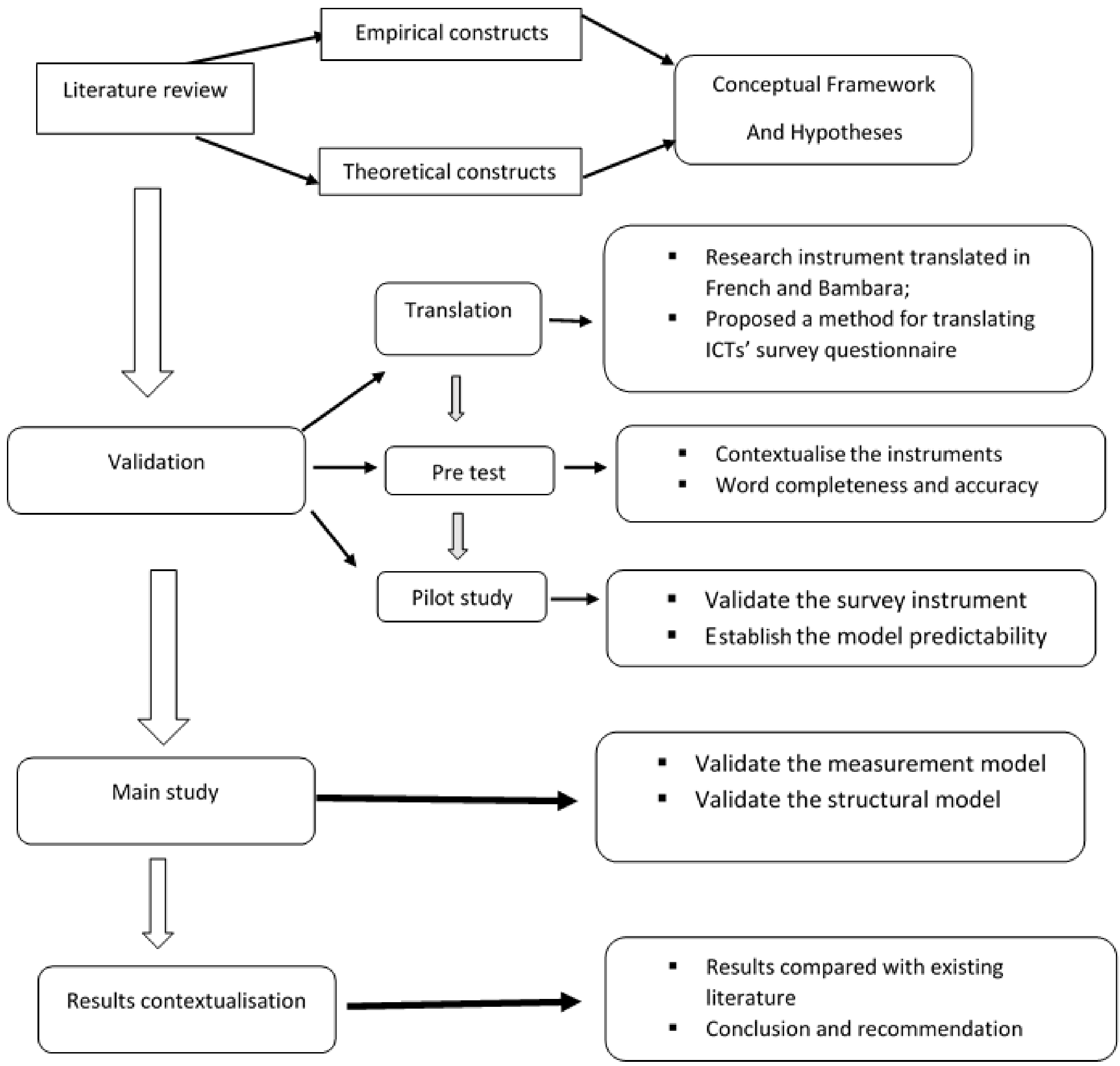


Figure 3.1 Research Design Summary

3.3.1. Research Approach

The extent to which the researcher is evident about the theory at the beginning of his/her research raises an important question concerning the design of his/her research project (Saunders, Lewis and Thornhill, 2009). That is whether the research should use the deductive approach, in which one can develop a theory and hypothesis (or hypotheses) and design a research strategy to test the hypothesis, or the inductive approach, in which you would collect data and develop a theory as a result of your data analysis (ibid.). This research developed hypotheses based on a conceptual framework that was based on some theories/models. It needed to test these hypotheses, which therefore was a deductive approach. It is the dominant research approach in the natural sciences, where laws present the basis of explanation, allow the anticipation of phenomena, predict their occurrence and therefore permit them to be controlled (Collis and Hussey 2003).

3.3.3. Research Strategy

Saunders et al. (2009) argued that survey is a popular and shared strategy in business and management research and is most frequently used to answer who, what, where, how much and how many questions. It, therefore, tends to be used for exploratory and descriptive research. Surveys are popular as they allow the collection of a large amount of data from a sizeable population in a highly economical way. They further argued that the survey strategy permit the collection of quantitative data that can be analysed using statistical tools. In addition, the data collected using a survey strategy can be used to suggest possible reasons for particular relationships between variables and to produce models of these relationships. Using a survey strategy should give the researcher more control over the research process and, when sampling is used, it is possible to generate findings that are representative of the whole population at a lower cost than collecting the data for the entire population. In this study, the survey strategy was used to gather data. The survey strategy is usually associated with the deductive approach (Saunders, Lewis and Thornhill, 2009).

3.3.4. Time Horizon

Saunders et al. (2009) argue that Cross-sectional studies often employ the survey strategy. The survey strategy with cross-sectional was used for the current study.

3.3.5. Description of Study Area

This study was done in the region of Sikasso, the third administrative region of Mali. It has a surface area of 71,790 km^2 and a population of 2,643,179 and 406,774 households in 2009 (RGPH, 2013). The region had seven districts that are Sikasso, Bougouni, Kadiolo, Kolondieba, Koutiala, Yanfolila and Yorosso. Sikasso is the most populated region of Mali with 18.3% of the country's population.

Each district had some communes, which was constituted of villages. The region had three urban communes (Sikasso, Bougouni, and Koutiala) and 144 rural communes. It counted 1831 villages. The agricultural production falls under three products: cotton, cereals and horticulture (Csa, 2007). The literacy rate of the household head of the region is about 39.7% (INSTAT, 2014).

Data was specifically collected from the district of Bougouni. The district of Bougouni has a population of 458, 546 and a surface area of 20 028 km^2 (RGPH, 2013). Cereal, dominated by small-scale farmers constitutes the main agricultural production of Bougouni (Promisam, 2007). The district is the most exposed district in the region of Sikasso to ICT on agricultural input information (KANTE and Myagro, 2016).

3.4. OVERALL APPROACH

The research approach is a plan and procedure that first involves making broad assumptions and then moves to a detailed method of data collection, analysis and interpretation (Saunders, Lewis and Thornhill, 2009). The steps that were followed to arrive at the conclusion of this study are presented below.

3.4.1. Research Instrument Translation and Pre-test of the Translated Instrument

Information and Communication Technologies (ICT) has seen an exponential development in the dissemination of information, especially in agriculture. Researchers have used many tools to gather data on the subject. These tools are based on some theories. The most technology acceptance models are Technology Acceptance Model (TAM), Diffusion of Innovation Theory (DOI) and the Unified Theory of Acceptance and Use of Technology (UTAUT) (Woosley and Ashia, 2011). The data collection instrument (questionnaire) of these models are in English. For other speaking languages especially French and Bambara[6], these instruments need to be translated. There is an increasing demand for non-English language tools to collect data (Pan and de la Puente, 2005). Information on ICT survey translation methods or procedures is limited to the translation process from English to French and Bambara. For instance, developing a guideline for translation from English to Spanish, a study arguing that there is limited information on the translation procedure (Pan & de la Puente, 2005). Therefore, there is need to provide a method to translate ICT survey instrument into French and Bambara.

Factors that are affecting use of ICT on agricultural input information in developing countries was provided by researchers (Kante, Oboko and Chepken, 2016). The Diffusion of Innovation Theory was the basis of the proposed model. This researcher needed to collect data in Sikasso, Mali using the data collection instrument adapted from researchers (Ventkatesh *et al.*, 2003; Atkinson, 2007). Nevertheless, there were two remaining questions: a) Can we propose a method for translating this questionnaire into French and Bambara? b) What lessons have we learned?

The literature (Pan and de la Puente, 2005; Forsyth *et al.*, 2006a) describes two approaches, which is adoption and adaptation to translate a survey questionnaire. The adoption method is where the instrument to collect data is directly translated from the original language to the targeted one regardless to the linguistic-cultural nuances, which can impact the intended meaning of the question (Carrasco, 2003). In contrast to the adoption, the adaptation takes into account the cultural differences to make the translated instrument suitable and

[6] Bambara is a language spoken in Mali.

appropriate (Hoffmeyer-Zlotnik and Harkness, 2006). Adaptation admits and answers for any differences that exist crosswise languages.

We used the Census Bureau Guidelines (Pan and de la Puente, 2005) and the model ASQ (Ask the Same Question) (Zavala-Rojas, 2014) to translate the DOI's instrument adapted from (Ventkatesh *et al.*, 2003; Atkinson, 2007) into French and Bambara. We modified the guidelines to integrate some translating rules from TRAPD (Translation, Review, Adjudication, Pre-testing and Documentation) and the model Ask the Same Question (Harkness, 2000; Presser *et al.*, 2004). The translation process is described in details in appendix 5. The results were published in a conference (Kante, Chepken and Oboko, 2017).

The cognitive interview technique was used to pre-test the survey instrument for biases. We purposively selected six respondents (6) who were grounded in the field of ICT4D so that we can have their insight into the choice of words and phrase. These respondents were chosen on the basis that they were familiar with the field in Mali. They were asked to delineate the way they understood the specific question and determine whether they had difficulty in understanding. The pre-test was done after the translation process and was part of the method that we proposed for translating into French and Bambara. It helped us to contextualise the instrument. The cognitive interview and the review suggest the target languages French and Bambara translations effectively represent the source questionnaire. As argued by Hoffmeyer-Zlotnik and Harkness (2006), the review and cognitive interview permit to effectively translate a survey questionnaire from one language to another. In addition, we replaced the phrase 'ICT on Agricultural Input Information' by 'Ngasene/Senekela' because Ngasene/Senekela provides ICT-based agricultural input information in Sikasso. More details of this process are available in appendix 3.

3.4.2. Validation of the Research Instrument and Conceptual Framework

As mentioned above, a pilot study was conducted in the village of Lobougoula, which was in the study area of Sikasso. It was done from 12 May 2016 to 12 June 2016 in the village of Lobougoula, commune of Lobougoula and district of Sikasso. Forty (40) respondents were interviewed at this stage. Each indicator (item) was written in English, French and Bambara. Some of the constructs had more than four items. That was voluntarily done so that we could later choose the most appropriate indicators. This approach also confirmed to the PLS-SEM design. In IS research, Ringle, Sarstedt and Straub, (2012) reported a median of 3.5 indicators for a construct of a reflective model. The objectives of the pilot study were to validate the survey instrument and to establish model predictability.

3.4.2.1. Research Survey Instrument Validation

The instrument is validated when the measurement model is established. PLS-SEM algorithm was run, and the results such as convergent validity and discriminant validity were reported.

The type of reliability coefficient that the literature most often write up is the Cronbach's alpha (Kline, 2013). It is a statistic that measures the internal consistency reliability, which is the degree to which responses are consistent across the items within a construct. It varies between 0.4 to 0.7 for exploratory study (Urbach and Ahlemann, 2010). The extent to which a given construct is different from other constructs also known as discriminant validity in PLS-SEM was measured. Each construct AVE (Average Variance construct) should be larger than its correlation with other constructs, and each item should load more highly on its assigned construct than on the other constructs (Gefen, Straub and Boudreau, 2000).

The discriminant validity measures the extent to which constructs differ from each other. Many methods have been used to assess the discriminant validity. In PLS-SEM, methods such as AVE of Fornell-Larcker, Cross-loading, Heterotrait-Monotrait Ratio (HTMT) are used to evaluate the discriminant validity (Garson, 2016). Nevertheless, it is not recommended to use the cross-loadings and the Fornell-Larcker criterion for assessing discriminant validity in studies that use PLS-SEM (Garson, 2016). Simulation studies demonstrated that the heterotrait-monotrait (HTMT) detect better the lack of discriminant validity than those criteria

(Henseler, Ringle and Sarstedt, 2014). Moreover, in Information System research, it was argued that Discriminant validity should be assessed by the Heterotrait-Monotrait Ratio (HTMT) (Henseler, Hubona and Ash, 2016). The recommended threshold for a well-fitted model is an HTMT ratio below 1.0 (Garson, 2016), below 0.90 or 0.80 (Henseler, Ringle and Sarstedt, 2014).

3.4.2.2. Structural Model

Many steps should be taken to assess the structural model after the assessment and validation of the measurement model. The model's quality evaluation is based on its ability to anticipate the endogenous constructs. The evaluation of the structural model taken through some criteria such as Coefficient of Determination (R^2) (Urbach and Ahlemann, 2010), Predictive Relevance (Q^2) (Evermann and Tate, 2014), and Path Coefficients (Garson, 2016).

As stated, this is an exploratory study. PLS path modelling can be used both for explanatory and predictive research. Depending on the analyst's aim – either explanation or prediction – the model assessment will be different. If the analyst seeks to predict, the assessment should focus on blindfolding and the model's performance about holding out samples (Evermann and Tate, 2014).

It was argued that while in traditional regression models the R^2 proportion of explained variance is an indicator of the predictive strength of the model, researchers have recently advocated the use of blindfolding for assessing the predictive strength of structural equation models (Evermann and Tate, 2014). The Blindfolding reports four statistics for the model predictive reliability that is the construct cross-validated redundancy, the construct cross-validated communality, the indicator cross-validated redundancy and the indicator cross-validated communality. However, in IS research, it is recommended to use redundancy-based blindfolding to assert the model's theoretical/structural predictability (p. 680) and suggests a threshold of value above 0.5 (Evermann and Tate, 2012). Hence, this pilot study assessed the structural model validity by the predictive relevance.

3.4.2.3. Results and Discussion

The survey instrument was validated. However, nine items were dropped due to lack of reliability and predictability and due to the cognitive pre-test results (more details on appendix 3). In addition, the name of some the constructs was changed. The construct ICT Contribution the access and use of agricultural input information was changed to Increased Adoption of agricultural input information. In addition, the study area was re-specified to only one district instead of three. The ICT-based agricultural input information on cereals was used only in two out of the seven districts of Sikasso region. These districts were Bougouni and Koutiala. We gathered this information after interacting with the team of Myagro and Senekela. Therefore, the study area was refined after the pilot study.

On the structural model, the results showed that the constructs Relative Advantage, Compatibility, Observability, Simplicity, Cost, Information Quality were highly predictive of the endogenous latent variable Use of ICT on agricultural input information (0.715) and the Use was highly predicting the Contribution of ICT to the access and use of agricultural input information (0.594) in the outer and inner model through Q^2. It is detailed in appendix 3.

In addition, the assessment of R^2 suggested the same highly prediction of these two endogenous latent variables 95.8% and 70.9%. However, the tiny sample of this pilot-study phase could be biased. Nonetheless, it helped us to refine the research instrument for the phase of this research, which is to gather data from 300 households in the Sikasso region, Mali. This sample should enable us to test moderating effects such as Literacy and ICT Skills.

3.4.3. Main Study

This section presents the Sampling method, data collection tools, field approach and the Ethical considerations of the main study.

3.4.3.1. Sampling

The region of Sikasso was purposively selected because it was the main coarse grain (millet, sorghum, maize and fonio) production area in Mali (DRPSIAP, 2011). For the selection of the district, this study adopted a purposive sampling. The choice of the district was based on: a) ICT services in the area and b) cereal production (maize, millet, sorghum, fonio and rice). Two ICT services were operating on agricultural input information in Mali especially in Sikasso as discussed above in the literature review. Bougouni was the Sikasso district with the largest number of farmers using the ICT service Myagro (KANTE and Myagro, 2016). For Senekela, Koutiala was the zone where the service has the greater number of farmers, but these farmers were mainly trial users. Therefore, Bougouni was chosen. The district has a cereal production of 105,805.07 tonnes and a population of 69,750 households (DRPSIAP, 2011; RGPH, 2013).

Bougouni has nine communes where cereals are produced (DRPSIAP, 2011) and the ICT service on agricultural input information cover four (4) of these 9. Therefore, the strata were these four communes (KANTE and Myagro, 2016). Among these four municipalities, only Zantiebougou's farmers produce all the cereals (DRPSIAP, 2011; PROMISAM, 2012) and also the commune has the largest number of farmers using Myagro (KANTE and Myagro, 2016). Thus, this study chose that municipality (Table 3.1).

Table 3.1. Samples (communes) from District

District	Number of communes	Commune Chosen	Number of villages	Sample
Bougouni	4	1 (Zantiebougou)	16	4

We adopted a stratified purposive sampling for the selection of the villages from the selected commune. In the municipality of Zantiebougou, the village of Sirakoro, Zantiebougou, Monzondougou Koloni and Oure had the largest number of farmers using ICT on agricultural input information. They respectively had 152, 473, 194 and 139 households (RGPH, 2013). A random sampling was adopted for the selection of the respondents.

The sampling frame was a list of households who were cereal farmers. Kline (2013) argues that about a good sample size for SEM's studies should be around 200 cases. In addition, Garson (2016) agrees to that 200 cases for PLS-SEM. Data were collected from 300 respondents, which was at least 50% above the required number of 200. This was also conform to the sample size by Hair et al. (2006) that is between 30 and 500. This figure was spread out to the selected sites proportionally (Table 3.2).

Table 3.2 Samples Distribution

District	Commune	Village	Households	Sample
Bougouni	Zantiebougou	Zantiebougou	473	473*300/958 = 148.12 ≈ 148
		Monzondougou koloni	194	194*300/958 = 60.75 ≈ 61
		Sirakoro	152	152*300/958 = 47.59 ≈ 48
		Oure	139	139*300/958 = 43.52 ≈ 43
1 district	1 commune	4 villages	958	300

3.4.3.2. Data Collection Tools and Methods

This study used and adapted the survey instrument from Atkinson (2007) and Ventkatesh et al. (2003) to refer to ICT on agricultural input information. These instruments are provided in Table 3.3.

Literature revealed essentially two methods of data collecting in a survey a self-administered questionnaire and face-to-face interview. Bowling (2005) concluded that the legitimacy of a study is difficult to establish with some methods than others (more details in appendix 7). With a low rate of Literacy that did not allow the farmers to fill out the form, enumerators were formed on how to record an agreement/disagreement scale answer from a respondent. This was based on the framework of Villar (2009).

However, some of the respondents were able to fill out the form. The questionnaire was given to respondents to fill and return them to enumerators as appropriate. If they could not fill, statements were read out to them, and they were asked to indicate their level of agreement or disagreement on a 5-point Likert scale from strongly agree to disagree strongly. Table 3.3 provides an overview of the indicators.

Table 3.3. Constructs and Indicators

Section A. Moderators

Literacy	
1.	I can read and understand alphabets letters
2.	I can read to learn and apply my understanding
3.	I can write the alphabet letters and numbers
4.	I can write a personal letter, a brief description of an event or image
5.	I can fill out a simple form
ICT Skills (for all the respondents)	
6.	I can turn on a computer
7.	I can name parts of a computer and connect devices to a computer
8.	I can create, modify and delete a folder on a computer
9.	I can use Word processing
10.	I have an email address
11.	I can read and write an email
12.	I can use a browser and find online the information I am looking for

13.	I can write an SMS on a mobile phone
14.	I can a follow up procedure given by a customer care on a mobile phone
15.	I can take pictures with my mobile phone or download a video on my phone

Section B: Determinants (for ICT users)

Cost
16. The transaction cost such as airtime, bundles for N'gasene/Senekela is not expensive
17. I use N'gasene/Senekela because they are cheaper
18. Getting agricultural input information through other means such as radio, TV, community meetings, newspaper is expensive than using N'gasene/Senekela
Relative Advantage (RA)
19. N'gasene/Senekela is better than using books or newspaper to get AII
20. N'gasene/Senekela is more interesting than another source of information that I have used to get AII
21. Using N'gasene/Senekela contributed to the access and use of AII than it would not be possible without them for me
Compatibility
22. N'gasene/Senekela is suitable to the way that I like to get information on agricultural inputs
23. I think other farmers should use N'gasene/Senekela to access/use AII
24. Using N'gasene/Senekela made what I was doing about AII seem more relevant
Simplicity (Simp)
25. When using N'gasene/Senekela, I had no difficulty finding the information that I wanted

26. I had no difficulty understanding how to get around in N'gasene/Senekela
27. When using N'gasene/Senekela, I had no difficulty implementing the information that I got
Observability
28. Other farmers were/seemed interested in N'gasene/Senekela when they saw me using it (them) (because I discuss with them sometimes)
29. People can tell that I know more about access and use of agricultural input information since I have started using N'gasene/Senekela (because I discuss with them sometimes on these ICTs)
30. Other farmers using N'gasene/Senekela liked using them, i.e. they found them (it) satisfactory (because I discuss with them sometimes on these ICTs)
Social influence (for all the respondents)
31. My neighbours (village mates, friends) think I should start using/keep using N'gasene/Senekela
32. My friends and parents use N'gasene/Senekela
33. I feel that using N'gasene/Senekela gives me a particular status than those who do not
Information Quality
34. The information I got from N'gasene/Senekela was complete, i.e. all the data necessary to meet my current need for farm input information was provided
35. The information I got from N'gasene/Senekela was relevant, i.e. the information is suitable for the current need
36. The information I got from N'gasene/Senekela was appropriate, i.e. in the suitable format and quantity

Section C: Endogenous variables

Use of N'gasene/Senekela (All the respondents)
37. I use/plan to use N'gasene/Senekela regularly when preparing to plant my crops
38. I intend to use/continue to use N'gasene/Senekela

39.	I recommend farmers to use N'gasene/Senekela
Increased adoption of agricultural input information (For those using ICT)	
40.	Before I started using N'gasene/Senekela, I found it difficult to access agricultural input information
41.	Before I started using N'gasene/Senekela, I found it difficult to use agricultural input information
42.	After I started using N'gasene/Senekela, I found it easier to access agricultural input information, and I have more access to agricultural input information
43.	After I started using N'gasene/Senekela, I found it easier to use agricultural input information, and I have improved the use of agricultural input information

3.4.3.3. Field Approach

The field approach describes the way data collection was achieved in the field. The procedure is explained below:

- Once in the village, we identified the community leader(s) who was then visited (including local agriculture officer).
- We then explained to him/her (them) the aim of the study.
- We scheduled with him/her (them) the best time to conduct the study in the village.
- The best time to conduct the interview or drop the questionnaire to be filled was in the evening. It was the rainy season, and farmers were in the field during the day.

3.4.3.4. Ethical Considerations

During the survey and before the interviews, this researcher informed the respondents of the aims of the research. It was stated that the interviews were not part of a supervision process. The letter provided by the University of Nairobi (see appendix 6) was enough to collect data using a survey questionnaire. The letter was translated into French and presented to the local executives in the study area.

3.5. DATA ANALYSIS

SPSS V20 was used for descriptive statistics, and SMARTPLS 3.2.6 was used to assess the model. SEM model contains two models that are also related to each other: the measurement model and the structural model.

3.5.1. Outer Model Fit Evaluation

Internal Consistency Reliability, Indicator Reliability, Convergent Validity, and Discriminant Validity were tested to establish the Constructs’ validity of the measurement (outer model) validity by using the guidelines from the IS research literature.

Urbach & Ahlemann (2010) argue that the traditional criterion for assessing internal consistency reliability is Cronbach’s alpha (CA), whereas a high alpha value assumes that the scores of all items with one construct have the same range and meaning (Cronbach 1951). However, Garson (2016) reports that in the reflective model, Composite Reliability is a favoured criterion in assessing the convergent validity than Cronbach's alpha. Values above .700 are desirable for exploratory research either using Cronbach’s Alpha or Composite Reliability (Urbach and Ahlemann, 2010).

Convergent Validity represents the extent to which individual items reflecting a construct converge in comparison to items measuring different constructs. Urbach & Ahlemann (2010) argued that an average variance extracted (AVE) proposed by Fornell and Larcker (1981) is a commonly applied technique for assessing the convergent validity. It measures the percent of variance captured by a construct by showing the ratio of the sum of the variance captured by the construct and measurement variance (Gefen, Straub and Boudreau, 2000). A value above 0.5 of this measure indicates that an LV is on average able to explain more than half of the variance of its indicators and, thus, indicating a sufficient convergent validity (Urbach and Ahlemann, 2010; Garson, 2016).

The discriminant Validity represents the extent to which the measures of different constructs differ from each other. Whereas convergent validity tests whether a particular item measures the construct it is supposed to measure, discriminant validity tests whether the items do not unintentionally measure something else (Urbach and Ahlemann, 2010). In SEM using PLS, two measures of discriminant validity are commonly used: Cross loading criterion and Fornell–Larcker (Urbach and Ahlemann, 2010). However, simulation studies demonstrated that the discriminant validity could be well assessed by the heterotrait-monotrait (HTMT) than the other techniques (Henseler, Ringle and Sarstedt, 2014). Moreover, in Information System research, it was argued that Discriminant validity should be assessed by the Heterotrait-Monotrait Ratio (HTMT) (Henseler, Hubona and Ash, 2016). Table 3.4 summarises the measurement model assessment.

Table 3.4 Measurement Model Assessment

Validness	Measure	Characterisation
Indicator reliability	Indicator loading > .600	Loadings represent the absolute effect of the indicator to the definition of its latent variable (Urbach and Ahlemann, 2010).
Internal consistency reliability	Cronbach's α > 0.6	Measures the degree to which the MVs load simultaneously when the LV increases (Urbach and Ahlemann, 2010; Garson, 2016).
Internal consistency reliability	Composite reliability > 0.6	Attempts to measure the sum of an LV's factor loadings relative to the sum of the factor loadings plus error variance. Leads to values between 0 (completely unreliable) and 1 (perfectly reliable).
Convergent validity	Average Variance Extracted (AVE) > 0.5	the degree to which individual items reflecting a construct converge in comparison to items measuring different constructs (Urbach and Ahlemann, 2010; Garson, 2016; Henseler, Hubona and Ash, 2016).
Discriminant validity	Cross-loadings	requires that the loadings of each indicator on its construct are higher than the cross-loadings on other constructs (Gefen, Straub and Boudreau, 2000; Urbach and Ahlemann, 2010).
Discriminant validity	Fornell-Larcker	Requires an LV to share more variance with its assigned indicators than with any other LV. Accordingly, the AVE of each LV should be greater than the LV's highest squared correlation with any other LV (Urbach and Ahlemann, 2010).
Discriminant validity	Heterotrait-Monotrait Ratio (HTMT) less than 1	In Information System research, it was argued that Discriminant validity should be assessed by the Heterotrait-Monotrait Ratio (HTMT) (Henseler, Hubona and Ash, 2016). Its ratio is the geometric mean of the heterotrait-hetero-method correlations (i.e., the correlations of indicators across constructs measuring different phenomena) divided by the average of the monotrait-hetero-method correlations (i.e., the correlations of indicators within the same construct) (Garson, 2016).

3.5.2. Structural Model Evaluation

The assessment of the structural model is based on the model capacity to anticipate the endogenous constructs. Some criteria are assessed to establish the model predictability and interpretability: Coefficient of Determination (R^2) (Urbach and Ahlemann, 2010), Predictive Relevance (Q^2) (Evermann and Tate, 2014), and Path Coefficients (Garson, 2016).

As stated, this is an exploratory study. PLS path modelling can be used both for explanatory and predictive research. Depending on the analyst's aim – either explanation or prediction – the model assessment will be different. If the analyst seeks to predict, the assessment should focus on blindfolding (Tenenhaus et al., 2005) and the model's performance about holding out samples (Evermann and Tate, 2014).

While in traditional regression models the R^2 proportion of explained variance is an indicator of the predictive strength of the model, researchers have recently advocated the use of blindfolding for assessing the predictive strength of structural equation models (Chin, 2010; Ringle et al., 2012). Garson (2016) reported that Blindfolding utilises a cross-validation strategy and reports cross-validated communality and cross-validated redundancy for constructs as well as indicators.

In IS research, Evermann & Tate (2012) quoting Chin (2010) recommends using redundancy-based blindfolding to evaluate the structural model predictive relevance with a value of $Q^2 > 0.5$.

R^2 is the measure of the proportion of the variance of the dependent variable about its mean that is explained by the independent variable(s) (Gefen, Straub and Boudreau, 2000). Urbach & Ahlemann (2010) report that path coefficients exceeding .100 can be considered as having an impact on the model. The paths coefficient significance test and p-value were done through the bootstrapping technique.

Finally, we assessed the model fitness. Henseler et al. (2016) argued that currently, the only approximate model fit criterion implemented for PLS path modelling is the standardised root mean square residual (SRMR). They further claimed that as can be derived from its name, the SRMR is the square root of the sum of the squared differences between the model-implied and the empirical correlation matrix, i.e. the Euclidean distance between the two matrices. Scholars also recommend the cut-off of less than .1 (Garson, 2016). Table 3.5. summarises the structural model assessment.

Table 3.5 Structural Model Assessment

Validness	Measure	Characterisation
Model Predictability	Predictive relevance $Q^2 > 0.05$	By systematically assuming that a certain number of cases are missing from the sample, the model parameters are estimated and used to predict the omitted values. Q^2 measures the extent to which this prediction is successful (Urbach and Ahlemann, 2010; Garson, 2016; Henseler, Hubona and Ash, 2016).
Model validity	Model fit SRMR < 0.08	SRMR is a measure of close fit of the researcher's model (Garson, 2016; Henseler, Hubona and Ash, 2016).
Model validity	$R^2 > 0.100$	Coefficient of determination (Urbach and Ahlemann, 2010)
Model validity	Path coefficients Critical t-values for a two-tailed test are 1.65 (significance level = 10 per cent), 1.96 (significance level = 5 per cent), and 2.58 (significance level = 1 per cent).	Structural path coefficients are the path weights connecting the factors to each other (Garson, 2016).

Table 3.6 summarises an operationalisation of the research hypotheses. For each one of the hypothesis, six hundred (600) responses are expected as the hypothesis is constituted of a dependent and independent variable.

Table 3.6: Hypotheses Measurement

Hypotheses	Variables		Measurements of Scale	Expected Responses	Data Analysis technique	Hypotheses Support
H1	Dependent	Use of ICT on agricultural input information	Ordinal	600	Bootstrap technique	Paths coefficients significant (t-statistics; β) (Urbach and Ahlemann, 2010; Garson, 2016)
	Independent	Relative advantage	Ordinal			
H2	Dependent	Use of ICT on agricultural input information	Ordinal	600	Bootstrap technique	Paths coefficients significant (t-statistics; β) (Urbach and Ahlemann, 2010; Garson, 2016)
	Independent	Compatibility	Ordinal			
H3	Dependent	Use of ICT on agricultural input information	Ordinal	600	Bootstrap technique	Paths coefficients significant (t-statistics; β) (Urbach and Ahlemann, 2010; Garson, 2016)
	Independent	Simplicity	Ordinal			
H4	Dependent	Use of ICT on agricultural input information	Ordinal	600	Bootstrap technique	Paths coefficients significant (t-statistics; β) (Urbach and Ahlemann, 2010; Garson, 2016)
	Independent	Observability	Ordinal			

H5	Dependent	Use of ICT on agricultural input information	Ordinal	600	Bootstrap technique	Paths coefficients significant (t-statistics; β) (Urbach and Ahlemann, 2010; Garson, 2016)
	Independent	Social influence	Ordinal			
H6	Dependent	Use of ICT on agricultural input information	Ordinal	600	Bootstrap technique	Paths coefficients significant (t-statistics; β) (Urbach and Ahlemann, 2010; Garson, 2016)
	Independent	Cost	Ordinal			
H7	Dependent	Use of ICT on agricultural input information	Ordinal	600	Bootstrap technique	Paths coefficients significant (t- statistics; β) (Urbach and Ahlemann, 2010; Garson, 2016)
	Independent	Information quality	Ordinal			
H8	Dependent	Increased adoption of agricultural input information	Ordinal	600	Bootstrap technique	Paths coefficients significant (t-statistics; β) ; $Q^2 > 0.05$ (Urbach and Ahlemann, 2010; Garson, 2016)
	Independent	Use of ICT on agricultural input information	Ordinal			

3.6. STRUCTURAL EQUATION MODELLING

March & Smith (1995) argue that a model is a set of propositions or statements expressing relationships among constructs. After proposing a model, it is necessary to evaluate the model. Evaluation requires the development of metrics and the measurements of artefacts according to those metrics. The many types of research aim to analyse causal relationship among variables. Several techniques allow researchers to evaluate their models such as regression and structural equation modelling (SEM).

SEM is highly recommended and applied in the field of IS Research. For instance,
Gefen et al. (2000) argue that SEM techniques are second-generation data analyses techniques that can be used to test the extent to which IS research meets recognised standards for high-quality analysis. In addition, Evermann & Tate (2014) argue that quantitative research in Information System (IS) frequently uses structural equation modelling, allowing researchers to represent latent constructs, observations and their relationship in a single statistical model. Moreover, in contrast to the first generation of statistical tools such as regression, SEM allows researchers to respond to a set of the interrelated research question in a single, systematic, and comprehensive analysis by modelling the relationship between multiple independent and dependent constructs simultaneously. This capability for simultaneous analysis differs greatly from most first generation regression models such as linear regression, LOGIT, ANOVA, and MANOVA, which can analyse only one layer of linkages between independent and dependent variables at a time (Gefen, Straub and Boudreau, 2000).

There are two models in a Structural Equation Model. The model that represents the hypotheses, i.e. linking the latent variables is called the structural or inner model. The second model is known as the measurement model (or outer model). This model deal with how do you measure your latent variables.

Two types of indicators measure the Latent Variables (LV) in the outer models. The outer model can be composed of Reflective or Formative LV. Each one of these LVs is explained below in Figure 3.2. This study used the reflective model.

Criteria	Formative Model	Reflective Model
1. Direction of causality from construct to measure implied by the conceptual definition	*Direction of causality is from items to construct.*	*Direction of causality is from construct to items.*
Are the indicators (items) (a) defining characteristics or (b) manifestations of the construct?	Indicators are defining characteristics of the construct.	Indicators are manifestations of the construct.
Would changes in the indicators/items cause changes in the construct or not?	Changes in the indicators should cause changes in the construct.	Changes in the indicator should not cause changes in the construct.
Would changes in the construct cause changes in the indicators?	Changes in the construct do not cause changes in the indicators.	Changes in the construct do cause changes in the indicators.
2. Interchangeability of the indicators/items	*Indicators need not be interchangeable.*	*Indicators should be interchangeable.*
Should the indicators have the same or similar content? Do the indicators share a common theme?	Indicators need not have the same or similar content/indicators need not share a common theme.	Indicators should have the same or similar content/indicators should share a common theme.
Would dropping one of the indicators alter the conceptual domain of the construct?	Dropping an indicator may alter the conceptual domain of the construct.	Dropping an indicator should not alter the conceptual domain of the construct.
3. Covariation among the indicators	*Not necessary for indicators to covary with each other*	*Indicators are expected to covary with each other.*
Should a change in one of the indicators be associated with changes in the other indicators?	Not necessarily	Yes
4. Nomological net of the construct indicators	*Nomological net of the indicators may differ.*	*Nomological net of the indicators should not differ.*
Are the indicators/items expected to have the same antecedents and consequences?	Indicators are not required to have the same antecedents and consequences.	Indicators are required to have the same antecedents and consequences.

Figure 3.2 Overview of Reflective/Formative Models

Source: adapted from Urbach & Ahlemann (2010)

The inner model (structural model) also had two types of variables: Exogenous and Endogenous. A latent variable is qualified exogenous when there is no other latent variable affecting it in the model. It is qualified as endogenous if there is another (others) latent variable affecting it (it has at least one arrow that comes from another LV) (Garson, 2016). In the case of this study, the model had only two endogenous latent variables (Use of ICT on agricultural input information and increased adoption of agricultural input information). As no other variables predict the other latent variables, they are exogenous latent variables.

3.6.1. Philosophical Foundation of SEM

Many philosophical positions characterise Information System Research. Saunders et al. (2009) draw a comparison of the four research philosophies, which can be applied in information management research (Positivism, realism, interpretivism and pragmatism). As argued in the paradigm section, this research was a positivist one.

In Information System research, Urbach & Ahlemann (2010) claim that a positivist epistemological belief is the commonly used philosophical point of view adopted by studies using SEM. Furthermore, they claimed that the positivist researcher plays a passive, neutral role and does not intervene in the phenomenon of interest. Epistemologically, the positivist perspective is concerned with the empirical testability of theories. In other words, these theories are either confirmed or rejected. The paradigm is, therefore consistent with the philosophical foundations of SEM.

3.6.2. PLS vs CB

There are two major techniques in SEM. The Partial Least Squares (PLS) and the Covariance Based (CB). These techniques are different in their analyses' objectives, their underlying statistical assumptions, and the nature of the fit statistics they produce (Gefen, Straub and Boudreau, 2000). The two techniques are compared in Figure 3.3. This figure applies to information system research.

Criteria	PLS	CBSEM
Objective	Prediction-oriented	Parameter-oriented
Approach	Variance-based	Covariance-based
Assumption	Predictor specification (nonparametric)	Typically multivariate normal distribution and independent observations (parametric)
Parameter estimates	Consistent as indicators and sample size increase (i.e., consistency at large)	Consistent
Latent variable scores	Explicitly estimated	Indeterminate
Epistemic relationship between an LV and its measures	Can be modeled in either formative or reflective mode	Typically only with reflective indicators. However, the formative mode is also supported.
Implications	Optimal for prediction accuracy	Optimal for parameter accuracy
Model complexity	Large complexity (e.g., 100 constructs and 1,000 indicators)	Small to moderate complexity (e.g., less than 100 indicators)
Sample size	Power analysis based on the portion of the model with the largest number of predictors. Minimal recommendations range from 30 to 100 cases.	Ideally based on power analysis of specific model—minimal recommendations range from 200 to 800.
Type of optimization	Locally iterative	Globally iterative
Significance tests	Only by means of simulations; restricted validity	Available
Availability of global Goodness of Fit (GoF) metrics	Are currently being developed and discussed	Established GoF metrics available

Figure 3.3 Comparison of PLS and CB

Source: Urbach & Ahlemann (2010)

PLS can be an adequate alternative to CBSEM if the problem has the following characteristics:

- The phenomenon to be investigated is relatively new, and measurement models need to be newly developed (Urbach & Ahlemann, 2010). That is relevant to this study. A model for cereal farmers in developing countries is a new model that has to be developed.
- The structural equation model is complex with a large number of LVs and indicator variables. This argument is also suitable for the proposed model, which has twelve latent variables with forty-two items.
- Relationships between the indicators and LVs have to be modelled in different modes (i.e., formative and reflective measurement models). The proposed model has only

reflective variables. However, Hair et al. (2011) argued that reflective models should use PLS instead of CB-SEM.

- The conditions relating to sample size, independence, or normal distribution are not met, and. CB requires a large sample size while PLS does not require large sample size. If the sample size is small, PLS is recommended in Information System research (Evermann and Tate, 2014), in Marketing research (Hair, Ringle and Sarstedt, 2011).

Moreover, PLS is well developed and used in IS research than CB. Evermann & Tate (2010) identify IS as the primary user of PLS. In a survey of four IS journals (Management Information System Quarterly, Information System research, Journal of management of Information System and Journal of the Association for information system) from 2004 through 2008, they identified 76 studies using PLS, 54 studies using CB-SEM and six studies using both PLS and CB-SEM. That was similar to another study conducted by Henseler et al. (2016). PLS is widely used in information systems research (Marcoulides and Saunders, 2006), strategic management (Hair et al., 2012a), marketing (Hair et al., 2012b), and beyond. Therefore, this study used PLS.

3.6.3. Critic of the use of PLS in Information System

There are some critics against PLS and its use in the IS research field. Rönkkö et al. (2012) argued that the use of partial least squares path modelling as a tool for theory testing has been increasing in the late 90's and PLS is one of the most common quantitative data analysis methods in the top IS journals. However, they argued that reliance on PLS method has possibly resulted in producing and publishing a large number of studies, whose results are invalid. In a paper entitled 'Comments on Ronkko and Evermann in (2013), J. Henseler et al. (2014) concluded that PLS should continue to be used as a valuable statistical tool for management and organisational research, as well as other social science disciplines.

Specifics critics have been identified, and the literature has addressed them in IS research. Rönkkö et al. (2012) argue that PLS is not truly an SEM method because it produces inconsistent and biased estimates and lacks an overidentification test. To this critic, J. Henseler et al. (2014) argued that hence, bias cannot be a reason for PLS not to be seen as an SEM method. Moreover, while the lack of an overidentification test in PLS has repeatedly been criticised (e.g., Gefen et al., 2011; Hair et al., 2011), there is in fact no reason that prevents the testing of the discrepancy between the observed covariance matrix and PLS's model-implied covariance matrix (and, indeed, we do this later when addressing Critique 3). They concluded, therefore, that PLS is an SEM method. Moreover, it is designed to estimate composite factor models.

Another critic from Rönkkö et al. (2012) is that PLS reduces the effect of measurement error. In addition, they argued that 'the idea that PLS results can be used to validate a measurement model is a myth. Their critics were pointed out on composite reliability, AVE, and the Fornell–Larcker criterion. However, it was concluded that PLS reduces measurement error but does not eliminate it (Henseler et al., 2014). Moreover, Researchers can rely on PLS-based assessment criteria such as the test of exact fit (i.e., statistical inference on the discrepancy between the empirical covariance matrix and the covariance matrix implied by the composite factor model) or the SRMR to determine to what extent the composite factor model fits the data (Henseler et al., 2014). In addressing these critics and comments on them, this research used in addition to the composite reliability, AVE, Fornell-lacker criterion, and Cronbach's alpha, the SRMR.

PLS should not be used for null hypothesis testing or path coefficient (Rönkkö, Parkkila and Ylitalo, 2012). J. Henseler et al. (2014) concluded that PLS is suitable for null hypotheses significance test, even if the interrelated constructs are not embedded in a wider nomological net, if the sample size is relatively low, and if expected effects are small. They further argue that there is a need for researchers to take care only that they use normal, percentile, or BCa bootstrapping, but not basic bootstrapping. Given that the dominant PLS software implementations of SmartPLS (Ringle, Wende, & Will, 2005) and PLS-Graph (Chin & Frye, 2003) already use normal bootstrapping (Temme, Kreis, & Hildebrandt, 2010), it is unlikely that researchers using this software have faced or will face problems with Null Hypothesis Significance Test. Therefore, this research chose to use SMARTPLS for analysis.

Using PLS as an exploratory or early-stage theory testing tool does not feature strongly in the early PLS articles (Rönkkö, Parkkila and Ylitalo, 2012). However, the inventor of the PLS, Herman Wold argued that PLS is primarily intended for research contexts that are simultaneously data-rich and theory- skeletal. In addition, PLS can be a valuable tool for exploratory research because it estimates a less restricted model (the composite factor model), because it reliably provides estimates even in situations in which other methods fail, and because as a limited-information approach it is less prone to consequences of misspecification in subparts of the model (Henseler et al., 2014).

3.6.4. Causal and Predictive Models

PLS has been applied mainly in Information System, Management and Marketing. Rouse & Corbitt (2008) report the IS discipline as the main user of PLS, Management as the second user and marketing as third one. In a review in the IS research discipline, Ringle et al. (2012) reported 65 studies in the top journal of IS over the period 2001 to 2011. They further argue that this was more than three times the combined number of PLS research in the top three marketing journals (JMR, JM, JAMS) in the same period.

The literature provides three purposes of any research: exploratory, descriptive or explanatory (confirmatory). An exploratory study is a valuable means of finding out what is happening; to seek new insights; to ask questions and to assess phenomena in a new light (Saunders, Lewis, & Thornhill, 2009). Exploratory research goes with a predictive model (Evermann & Tate, 2014). The object of descriptive research is to portray an accurate profile of persons, events or situations (Saunders et al., 2009). Studies that establish causal relationships between variables may be termed explanatory research (Saunders et al., 2009). Explanatory research goes with the causal model (confirmatory) model (Kante, Oboko, & Chepken, 2017).

However, Evermann & Tate (2014) argued that the causal and predictive modelling does not form a dichotomy but that there is a middle-ground between the two extreme positions. A predictive model may be easier to accept by decision makers and other stakeholders when it can be plausibly interpreted. Further, it may be simpler to determine the prediction boundaries, i.e. determine under what situations the model will hold and under what situations the model will break when a plausible substantive interpretation is available. Users of predictive models have more trust in its results, especially for unexpected or counterintuitive predictions, when there is a plausible interpretation possible. In contrast to explanatory modelling, the plausible interpretations in this context do not entail a rigorous formal statistical testing of all posited relationships and model constraints as in causal-explanatory modelling (Evermann and Tate, 2014).

PLS path modelling was developed to occupy this middle ground and to straddle the traditional divide between causal-explanatory and predictive modelling at the extremes. It aims to maintain interpretability while engaging in predictive modelling (Evermann and Tate, 2014). This technique is characterised as a technique most appropriate where the research purpose is a prediction or an exploratory modelling (Garson, 2016). This study is exploratory; therefore, it is predictive rather than explanatory or confirmatory. However, as argued above, it maintained the interpretability.

3.6.5. Design

Kline (2013) suggests a flowchart of basic steps of SEM that has six steps: model specification; identification; measure selection and data collection; estimation; re-specification and reporting the results. Urbach & Ahlemann (2010) proposed a guideline of six steps too when using PLS-SEM in IS research as the case of this study (Figure 3.4). In addition, Henseler et al. (2016) proposed a revised guidelines for IS research. This research, therefore, combined these guidelines.

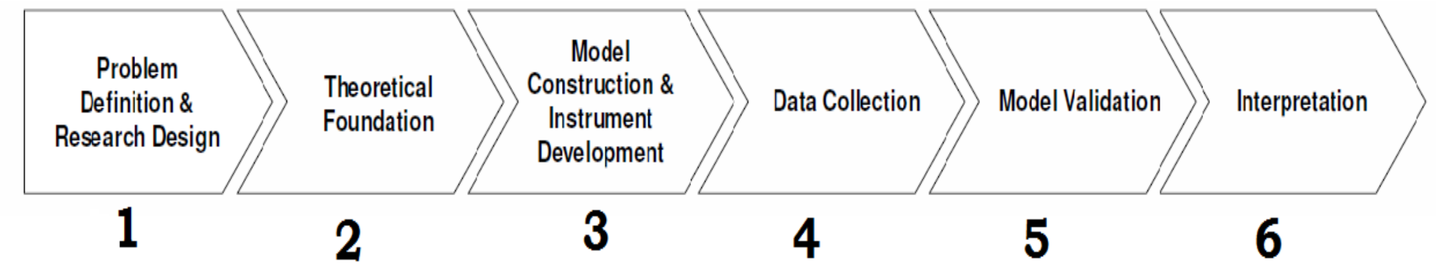


Figure 3.4 Steps of PLS-SEM Source: Urbach & Ahlemann (2010)

The activities that were done following the design of PLS-SEM are reported in Table 3.7.

Table 3.7. PLS-SEM Design Activities

Problem definition and research design	Research Objectives ▪ To establish farmers' perception of ICT on agricultural input information and to identify the effect of that perception on the use of these ICTs. ▪ To establish farmers' influence on each other in the use of ICT on agricultural input information and to identify the effect of that influence on the use of these ICTs. ▪ To establish the challenges faced by farmers in the use of ICT on agricultural input information and to identify the effects of these challenges in the use of these ICTs. ▪ To propose an ICT model for increased adoption of agricultural input information in developing countries using the case of Sikasso in Mali. Research design ▪ **A review of some relevant theories/model set the basis for ICT-based agricultural input information used by cereal farmers** ▪ A literature review was conducted in more than 15 developing countries over 2001 to 2016 to extract Empirical constructs ▪ The empirical constructs were transformed into theoretical constructs by meaning and definition ▪ The constructs were transformed into a structural equation model
Theoretical foundation	**Literature review** ▪ Diffusion of innovation theory (DOI/IDT) ▪ Unified Theory of Acceptance and Use of Technology (UTAUT) and its extensions ▪ TAM and its extensions ▪ DIKDAR model ▪ Theory of Knowledge ▪ Conceptual Framework and Hypotheses
Model construction and instrument development	**Structural Model** ▪ Extraction from the theories of factors affecting use of ICT ▪ Eight direct Hypotheses and five moderating effects were developed **Measurement model** ▪ Adaptation of 36 items ▪ Operationalisation of the variables in reflective models **Instrument: Questionnaire** ▪ Instrument translation into French and Nko (Bambara) ▪ Pre-/pilot test: The instrument was validated through a pretest, and a pilot study and nine items were dropped ▪
Data collection	**Target** ▪ 300 (200 required) cereal farmers in Sikasso

	Mode of administration ▪ Self-administered/interview face to face **Collected** ▪ 222 **Quality assessment** ▪ screening, missing values, outliers, Multivariate Normality and Multicollinearity
Model validation	**Measurement model (outer model)** ▪ Indicator reliability ▪ Convergent validity ▪ Discriminant validity **Structural model (inner model)** ▪ Q^2 ▪ R^2 ▪ Paths coefficients ▪ SRMR
Interpretation	**Results and Discussion** ▪ **Measurement model fit** Convergence Convergent validity Discriminant validity ▪ **Structural Model fit (inner model)** The Standardized Root Mean Square Residual (SRMR) The coefficient of determination (R^2) The path coefficient Predictive relevance (Q^2) Hypothesis validation Moderating variables validation ▪ Results **Discussion**

Source: adapted from Urbach & Ahlemann (2010)

3.7. DATA MANAGEMENT

The dataset was entered into SPSS v 20 for Screening, Missing Values, Outliers, Multivariate Normality and Multicollinearity. The findings and adjustments are presented in this section.

3.7.1. Data screening

The goal of the screening was to establish the accuracy of the data. The data screening showed that 40 questionnaires were partially filled disqualifying them for analyses. In addition, 38 responses had a low rate of responses. Thus, we had 222 valid responses.

For the 222 valid responses, we compared the data to the original questionnaires to check that items had been entered correctly. There were no incorrect data but missing values.

3.7.2. Missing values

Missing data analysis was carried out using SPSS. The topic how to analyse dataset with missing observations is complicated. Kline (2013) argued that prevention is the recommended approach. For example, items that are clear and unambiguous may prevent missing answers (Kline, 2013). The translation of the current survey instrument from English to French and Bambara helped us in this view.

There are many techniques to deal with missing values. PLS-SEM offers three-technique to deal with missing values (Kline, 2013; Garson, 2016). These are Imputation, Casewise Deletion and Pairwise deletion. The method of imputation involves placing estimated scores into the data set in the location of the missing data (Carter, 2006). A variation is a group-mean substitution, in which a missing score in a particular group is replaced by the group mean (Kline, 2013). In PLS-SEM, the group-mean technique is known as Mean Replacement whereby all missing data points are replaced with the average value of all remaining data points per column (i.e. indicator or variable). In Casewise Deletion or Listwise Deletion, cases with missing scores on any variable are excluded from all analyses (Carter, 2006; Kline, 2013). Based on the sample size and number of variables this can result in a considerable reduction in the sample size available for data analysis (Carter, 2006). An advantage of listwise deletion is that all analyses are conducted with the same number of cases. That is not so with Pairwise Deletion, in which cases are excluded if they have missing data on variables involved in a particular analysis (Kline, 2013). Accordingly, pairwise deletion is not recommended for use in SEM unless the number of missing observations is small (Carter, 2006; Kline, 2013).

Bovaird et al. (2007) argued that Listwise Deletion, Pairwise Deletion and Single Imputation are not recommended in PLS-SEM. They recommend the Multiple Imputation. As a rule of thumb, they further suggested that imputation of a variable is often called for when more than 5% of its values are missing. However, the variable should simply be dropped from the analysis if there too missing values (Bovaird et al., 2007). In contrast, other researchers suggested that “too numerous” is greater than 15%, but researchers vary on the appropriate cut off (Hair *et al.*, 2014).

For the 222 records, there were eight missing values throughout three variables. We applied the Mean Replacement (group imputation) technique.

3.7.3. Outlier Analysis

An outlying observation, or outlier, is one that appears to deviate markedly from other members of the sample in which it occurs (Hodge and Austin, 2004). Outliers are scores that are different from the rest (Kline, 2013). The objective of this analysis was to detect these outliers.

For the outliers’ detection, the software used SmartPLS 3.2.6 was used rather than SPSS. We designed the study according to PLS-SEM, and we think that a PLS-SEM tool such because SMARTPLS is more suitable for detecting outliers in this case. Garson (2016) argued that as with other procedures, PLS results might be distorted due to the presence of outliers.

Using SMARTPLS, the function Residuals was analysed to identify outliers in the data. Since residuals reflect the difference between observed and expected values, there is good model fit when residuals are low, and also since data are standardised and assuming a normal distribution of scores, residuals greater than absolute 1.96 may be considered outliers at the .05 level (Garson, 2016). In the case of this study, as no value was higher than 1.96 at the level of 0.05, this researcher concluded that there were no outliers. These results are reported in appendix 5. In addition, the coefficients in the Table 3.8 showed that there were not outliers as the values were not greater than 1.96.

Table 3.8. Latent Variable Correlation

	SI	Increased adoption	cost	cp	iq	ob	ra	simp	u_i_aif
SI	1.000								
Increased adoption	0.059	1.000							
cost	0.032	0.576	1.000						
cp	0.037	0.808	0.756	1.000					
iq	0.040	0.799	0.741	0.819	1.000				
ob	-0.032	0.809	0.767	0.867	0.825	1.000			
ra	0.035	0.752	0.729	0.827	0.811	0.803	1.000		
simp	0.088	0.410	0.447	0.429	0.406	0.404	0.487	1.000	
u_i_aif	0.087	0.827	0.768	0.836	0.818	0.841	0.805	0.501	1.000

3.7.4. Data Coding

Data were coded as follows:

- The village was coded as 1, 2 and 3
- The gender was coded as 1 for male and 2 for female
- The head of household was coded as 1 for yes or 2 for no
- The cereal farmers as 1 for yes or 2 for no
- Each cereal was coded as 1 for producing and 2 for not producing that one,
- The use of ICT was coded as 1 for yes and 2 for no,
- The use of Ngasene was coded as 1, Senekela as 2 and 3 as telecentre
- Time of use was coded as 1 for less than a year, 2 for one year and 3 for more than a year
- For each of the constructs, a number between 1 and 5 was used for each of the Likert scale choice (from strongly agree to disagree strongly).

There were missing data that was coded as 0. This was the data part of the design, and they were to be ignored according to Schafer (1997). The missing value that was not part of the design was left empty so that they could be detected and treated.

3.7.5. Multivariate Normality

Multivariate normality assumes that the joint effect of two variables is usually distributed (Gupta, 2014). Many instances of multivariate nonnormality are detectable through inspection of univariate distributions (Kline, 2013). We determined the Skew and kurtosis of the data.

There are two ways that a distribution can be non-normal, and they can occur either separately or together in a single variable (Kline, 2013). Skew implies that the shape of a unimodal distribution is asymmetrical about its mean. Positive skew indicates that most of the scores are below the average, and negative skew indicates just the opposite. The Kurtosis measures the relative peak of the average in distribution. For a unimodal, symmetrical distribution, positive kurtosis indicates heavier tails and a higher peak and negative kurtosis indicates just the opposite, both relative to a normal distribution with the same variance (Kline, 2013) (Table 3.9).

Table 3.9 Statistical Analysis of the Variables

	Mean	Std.	Skewness	Kurtosis	Construct

		Deviation	Statistic	Std. Error	Statistic	Std. Error	
cost_15	3.13	2.022	-.392	.163	-1.455	.325	Cost
cost_16	3.42	2.056	-.715	.163	-1.208	.325	
cost_17	3.45	2.057	-.747	.163	-1.171	.325	
ra_18	1.41	.912	.094	.163	.506	.325	Relative Advantage
ra_19	1.48	.906	-.172	.163	.367	.325	
ra_20	1.38	.908	.129	.163	.221	.325	
cp_21	1.42	.840	-.596	.163	-.825	.325	Compatibility
cp_22	1.45	.949	.176	.163	.639	.325	
cp_23	1.59	1.063	.138	.163	-.164	.325	
sp_24	.84	.888	.408	.163	-1.418	.325	Simplicity
sp_25	.93	1.004	.553	.163	-.953	.325	
sp_26	.91	1.028	.705	.163	-.813	.325	
ob_27	1.48	.890	-.468	.163	-.775	.325	Observability
ob_28	1.51	.895	-.473	.163	-.366	.325	
ob_29	1.53	.959	-.264	.163	-.776	.325	
si_30	1.14	.973	.212	.163	-.891	.325	Social Influence
si_31	1.23	1.037	.131	.163	-1.078	.325	
si_32	1.37	1.276	.506	.163	-.845	.325	
iq_33	1.28	.838	.030	.163	-.246	.325	Information Quality
iq_34	1.50	.992	.055	.163	-.453	.325	
iq_35	1.35	.842	-.327	.163	-.665	.325	
u_i_o_aif_36	1.13	.774	.486	.163	.716	.325	Use of ICT
u_i_o_aif_37	1.16	.789	.327	.163	.037	.325	
u_i_o_aif_38	1.48	.870	-.595	.163	-.726	.325	
ctr_39	1.09	.728	.209	.163	-.287	.325	Increased adoption
ctr_40	1.11	.725	.041	.163	-.609	.325	
ctr_41	1.01	.652	.189	.163	-.019	.325	
ctr_42	1.00	.645	.204	.163	.071	.325	

It was argued that the values of skewness and kurtosis lie between +/-1 (Joanes and Gill, 1998). As shown in Table 3.9, the data distribution was not within the acceptable values, indicating a non-normal distribution.

However, Garson (2016) argues that it is possible to use PLS path modelling using data that are highly skewed. The researcher further reports, "All of the SEM techniques are quite robust against the skewness scenario". These techniques justified the use of PLS-SEM by this researcher again.

3.7.6. Multicollinearity

Multicollinearity is not a problem in PLS (Garson, 2016). However, Gustafsson & Johnson (2004) noted that this does not mean that multicollinearity just "goes away." The factor indicators multicollinearity in the outer model remains a problem for high correlations between indicators for one factor and indicators for another. PLS might miss a simple factor structure, and the factor cross-loadings will mean PLS factors will be difficult to label, interpret, and distinguish to the degree this type of multicollinearity exists (Garson, 2016).

We run a bivariate correlation between the variables of the study. The results showed that there was no Multicollinearity between the variables (Appendix 5).

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1. INTRODUCTION

This chapter presents the results SMARTPLS 3.2.6 (Ringle, C. M., Wende, S., and Becker, 2015) and discusses them. The first section (4.2.) describes the descriptive statistics of the respondent. The section 4.3. discusses the outer model assessment (measurement model), and the section 4.4. addresses the inner model (structural model). The section 4.5. addresses the study's objectives by hypotheses. It also compares the findings with the current literature.

4.2. DESCRIPTIVE STATISTICS AND DISCUSSION

The descriptive statistics are reported and discussed in this section.

4.2.1. USE OF ICT

Table 4.1 summarises the ICT services' distribution among the respondents. Over 80% of the respondents were using ICT on agricultural input information.

Table 4.1 use of ICT services distribution

	Frequency	Percentage
Farmers using ICT services	178	80.18%
Farmers not using ICT services	44	19.82%
Total	222	100%

4.2.2. Gender and Age

The results of Table 4.2 showed that 75.23% of the respondents were female. In addition, there were more female farmers using ICT on agricultural input information: 74.72% female ICT users against 25.28% male. Although the man was the head of the household in most cases, the woman was chosen by the household head to address the questionnaire if she wanted to.

Large payment of seeds and fertilisers as expected by farmers in most cases is almost an unattainable task for them. The Layaway plan of the mobile phone (myagro) helps small-scale farmers to pay for agricultural inputs (fertilisers, seeds, and training packages) on a layaway basis, using their cell phone (de la Rive Box *et al.*, 2015). This phenomenon is like the way people buy talk-time for telephone conversations. Users (registered farmers) can save easily when continuously topping up their Myagro (the most used ICT' service in the area) accounts via the purchase of additional cards. The Mobile Layaway plan makes saving for these larger purchases as easy as buying a bar of soap or cup of oil. This method of payment (small amount) attract women than men. It explains the high number of Women using the service to adopt agricultural input information for the household.

A study entitled "Information technologies as a tool for agricultural extension and farmer-to-farmer exchange: Mobile-phone video use in Mali and Burkina Faso' by Sousa et al. (2016) argue that older male farmers have privileged access to agricultural information (including agricultural input information). Our findings on the gender and use of ICT on agricultural input information are in contrast with that finding of Sousa et al. (2016). However, they supported the conclusion of a study (Njelekela and Sanga, 2015) in Tanzania whose results revealed that females tend to be more adopting ICT on agricultural services compared to male.

Regarding age distribution, over 51% of the respondents were between 30 to 45 years old. A high rate 66.09% of these respondents were using ICT services was observed among women between 30 to 45 years (see Table 4.2).

Table 4.2. Gender Distribution by Age and use of ICT service

Age	Use of ICT				Total	
	Yes		No			
	Female	Male	Female	Male	Frequency	Percentage
< 30	27	5	5	0	37	16.67%
30-45	76	17	18	4	115	51.80%
> 45	30	23	11	6	70	31.53%
Total	133	45	34	10	222	100%

4.2.3. Family size and Use of ICT

Table 4.3 showed that majority of ICT services users was the family where the family size is between four and eight. The second are families where the size is more than eight members. It was also noticed that the families where the members are below four were very few to use ICT on agricultural input information. Perhaps, there is a need to conduct further inquiry to see if the factor family size has any moderating effect on use of ICT.

Table 4.3. Use of ICT Services Distribution by Family Size

Family size bracket	USE OF ICT		Frequency	Percentage
	yes	no		
< 4	30	1	31	13.96%
4 - 8	81	27	108	48.65%
>8	67	16	83	37.39%
Total	178	44	222	100%

4.2.4. Duration

Use of ICT (adoption) duration is provided in Table 4.4

Table 4.4. Usage Duration of ICT and Adopters' Categories

Duration	Category	Frequency	Percentage
Less than a year	Late majority adopters	57	32.02%
A year	Early majority adopters	77	43.26%
More than a year	Early adopters	44	24.72%
Total		178	100%

People in a social system do not adopt an innovation at the same time. Rather, they adopt in a time sequence, and they may be classified into adopter categories by when they first begin using a new idea (Rogers, 1983). The results revealed three categories of adopters (users): early adopters, early majority adopters and late majority adopters. The early adopter is considered by many as "the individual to check with" before using a new idea or ICT on agricultural input information. The early majority may deliberate for some time before completely adopting a new idea. Their innovation-decision period is relatively longer than that of the innovator and the early adopter. This time in the case of this study was likely one year.

In this study, the late majority adopt ICT services when more than 67% used ICT services on agricultural input information.

These results are shown in Table 4.4. confirmed this time dimension of the Diffusion of Innovation Theory (DOI/IDT). Moreover, the time dimension was highlighted to be the missing link in many theories of technology adoption such as TAM (and its extensions) and UTAUT (and its extensions). For instance, Kiwanuka (2015) reports that UTAUT fails to measure traits of individuals like innovativeness. That justifies the use of Diffusion of Innovation Theory again as the basis for this study.

4.2.5. Literacy and ICT Skills

Table 4.5 summarises the Literacy and ICT (mobile phone) Skills among the respondents. High level of Skills in both Literacy and Mobile phone are observed in the ICT's user category. Only 3.15% reported that they could turn on a computer.

Table 4.5 Skills Distribution

Skills			Yes		No	Total
			ICT services' user	**ICT services' non-user**		
Literacy	Basic	Able to read and write alphabet letters and numbers	67.56%	13.51%	18.93%	100%
	Mean	Able to write a personal letter or a brief description of an event	10.36%	4.50%	85.14%	100%
	Advanced	Fill out a form	7.65%	4.05%	88.30%	100%
Mobile phone skill	Write an SMS		29.28%	16.22%	54.5%	100%
	Call and follow up instruction given by a customer care centre		72.52%	16.22%	8.26%	100%
	Take a picture or download a video		51.80%	15.77%	67.57%	32.43%

The basic literacy rate was higher among ICT services' users than among non-users. The same observation was made about the mobile phone skills. However, 54.5% and 67.57% of the respondents respectively could not write an SMS, take a picture, or download a video.

Nevertheless, farmers have access to someone in the household who has the required skills if he/she is not the one using an ICT service. With the advent of smartphones, it has become possible for the illiterate farmers to use mobile phones with ease (Singh *et al.*, 2016). The touchscreen technology and the audio-visual feedback of smartphones can enable illiterate people to deal with digital information. Aker (2011) argues that the use of ICT services in rural extension may prove to be even more relevant in a context of widespread illiteracy, or even inexistent, access to extension services in much of rural Africa. Our results on Literacy gives evidence of that argument of Aker (2011).

4.3. MEASUREMENT MODEL EVALUATION AND DISCUSSION

PLS-SEM assessment typically follows a two-step that involves separate evaluations of the measurement models (outer) and the structural model (inner). This section discusses the outer model assessment. The outer model answers the question of how well did you measure the constructs.

4.3.1. Convergence

PLS-SEM does not have any problem with convergence according to Garson (2016). Nevertheless, Henseler (2010) argues that PLS does not always converge. Therefore, we checked the convergence of data set.

The solution converges when the number of iterations is below 300 (Garson, 2016). Convergence was reached in seven (7) iterations as illustrated in Figure 4.1 below.

Matrix	cost_15	cost_16	cost_17	cp_21	cp_22	cp_23	ctr_39	ctr_40
Iteration 0	0.910	0.910	-0.910	0.772	0.772	-0.772	0.518	0.518
Iteration 1	0.308	0.393	0.397	0.385	0.368	0.375	0.315	0.288
Iteration 2	0.337	0.378	0.385	0.389	0.366	0.372	0.284	0.284
Iteration 3	0.337	0.378	0.385	0.389	0.366	0.372	0.284	0.284
Iteration 4	0.337	0.378	0.385	0.389	0.366	0.372	0.284	0.284
Iteration 5	0.337	0.378	0.385	0.389	0.366	0.372	0.284	0.284
Iteration 6	0.337	0.378	0.385	0.389	0.366	0.372	0.284	0.284
Iteration 7	0.337	0.378	0.385	0.389	0.366	0.372	0.284	0.284

Figure 4.1 Data Convergence in SMARTPLS 3.2.6

4.3.2. Convergent Validity

A group of variables presumed to measure the same construct shows convergent validity if their inter-correlations are at least moderate in magnitude (Kline, 2013). In PLS-SEM, some actions are used to assess the convergent validity.

- Composite reliability

  The reliability is defined as the truthiness to which a question extends in its claim to measure what it intended to measure. Construct reliability assessment routinely focuses on composite reliability as an estimate of a construct's internal consistency (Hair, Ringle and Sarstedt, 2011). Unlike Cronbach's alpha, composite reliability does not assume that all indicators are equally reliable, making it more suitable for PLS-SEM, which prioritises indicators according to their reliability during model estimation (Hair *et al.*, 2014). The Composite reliability should be equal or greater than.6 for exploratory research (Hair, Ringle and Sarstedt, 2011; Kline, 2013; Garson, 2016). Table 4.6 shows that the Composite Reliability of each one of the constructs under study was greater than 0.8.

- Cronbach's Alpha

  It also assesses the question of reliability of the indicators for latent variables. Table 4.6 shows that the Cronbach's alpha of each one of the construct was greater than 0.8 that was right scale according to scholars (Hair, Ringle and Sarstedt, 2011; Kline, 2013; Garson, 2016).

- Average Variance Extracted (AVE)

  The AVE measures the percent of variance captured by a construct by showing the ratio of the sum of the variance captured by the construct and measurement variance (Gefen, Straub and Boudreau, 2000). For a model to be qualified as adequate, the value this measure (AVE) should be above .5 (Urbach and Ahlemann, 2010; Garson, 2016). Table 4.6 shows that the AVE of each one of the construct was greater than 0.6.

- Indicator reliability

  The loadings squared represent the indicator reliability value. They represent the path weights linking up factors and indicator variables. Table 4.6 shows that the indicator reliability of each one of the items was greater than 0.7 except three items: si_30 (0.353), si_32 (0.661) and u_i_o_aif_36 (0.696). Nevertheless, low cutoffs such as 0.4 can be accepted in exploratory setting (Urbach and Ahlemann, 2010).

Table 4.6 Convergent Validity

Construct	Items	Loadings	Indicator reliability	Cronbach's alpha	Composite reliability	AVE
Cost	cost_15	0.837	0.701	0.891	0.933	0.823
	cost_16	0.938	0.880			
	cost_17	0.943	0.889			
Compatibility	cp_21	0.89	0.792	0.864	0.917	0.785
	cp_22	0.887	0.787			
	cp_23	0.882	0.778			
Increased adoption	ctr_39	0.884	0.781	0.908	0.935	0.784
	ctr_40	0.858	0.736			
	ctr_41	0.894	0.799			
	ctr_42	0.904	0.817			
Information Quality	iq_33	0.882	0.778	0.869	0.919	0.792
	iq_34	0.891	0.794			
	iq_35	0.897	0.805			
Observability	ob_27	0.916	0.839	0.913	0.945	0.852
	ob_28	0.929	0.863			
	ob_29	0.924	0.854			
Relative Advantage	ra_18	0.932	0.869	0.922	0.950	0.864
	ra_19	0.936	0.876			
	ra_20	0.921	0.848			
Social Influence	si_30	-0.594	0.353	0.909	0.827	0.621
	si_31	-0.922	0.850			
	si_32	-0.813	0.661			
Simplicity	sp_24	0.945	0.893	0.928	0.954	0.874
	sp_25	0.933	0.870			
	sp_26	0.927	0.859			
Use of ICT on AII	u_i_o_aif_36	0.834	0.696	0.820	0.893	0.735
	u_i_o_aif_37	0.843	0.711			
	u_i_o_aif_38	0.894	0.799			

Based on the Indicator Reliability, Cronbach's Alpha, Composite Reliability and Average Variance Extracted, the study concluded that the convergent validity of each one of the constructs under study was established.

4.3.3. Discriminant Validity

Discriminant validity and Convergent validity are measures of Construct validity. Hair et al. (2014) argued that Discriminant validity corresponds to the extent to which the construct measures what it is intended to measure compared to other constructs in the model. The results of this assessment are reported below.

- The Fornell–Larcker criterion

This method is successful in achieving discriminant validity only if the construct shares more variance with its indicators than with any other construct (Hair *et al.*, 2014; Garson, 2016). To test this requirement, the AVE of each construct should be higher than the highest squared correlation with any other construct (Gefen, Straub and Boudreau, 2000; Hair *et al.*, 2014). As shown in Table 4.7, the discriminant validity of each one of the construct under study was established according to this criterion.

Table 4.7. Fornell–Larcker Discriminant Validity criterion

	SI	Increased adoption	cost	cp	iq	ob	ra	simp	u_i_aif
SI	**0.788**								
Increased adoption	0.059	**0.885**							
cost	0.032	0.576	**0.907**						
cp	0.037	0.808	0.756	**0.886**					
iq	0.040	0.799	0.741	0.819	**0.890**				
ob	-0.032	0.809	0.767	0.867	0.825	**0.923**			
ra	0.035	0.752	0.729	0.827	0.811	0.803	**0.930**		
simp	0.088	0.410	0.447	0.429	0.406	0.404	0.487	**0.935**	
u_i_aif	0.087	0.827	0.768	0.836	0.818	0.841	0.805	0.501	**0.858**

- Heterotrait-Monotrait Ratio (HTMT)

In PLS-SEM, methods such as AVE of Fornell-Larcker, Cross-loading, Heterotrait-Monotrait Ratio (HTMT) are used to assess the discriminant validity (Hair, Ringle and Sarstedt, 2011; Hair *et al.*, 2014; Garson, 2016). However, the use of the heterotrait-monotrait (HTMT) is recommended in assessing discriminant validity (Henseler, Ringle and Sarstedt, 2014).

In Covariance Based Structural Equation Modelling (CB-SEM), Henseler et al., (2014) argue that the HTMT should be lower than 0.85 or at least 0.90. The values could be used in PLS-SEM in confirmatory settings. However, Garson (2016) argues that the HTMT ratio should be below 1.0. The constructs of this study passed the heterotrait-monotrait ratio test (Table 4.8).

Table 4.8 HTMT Criterion

	SI	**INCREASED ADOPTION**	**COST**	**CP**	**IQ**	**OB**	**RA**	**SIMP**	**U_I_AIF**
Social Influence	0.000								
Increased adoption	0.038	0.000							
Cost	0.048	0.641	0.000						
Compatibility	0.053	0.911	0.860	0.000					
Information Quality	0.052	0.898	0.841	0.942	0.000				
Observability	0.114	0.887	0.849	0.974	0.924	0.000			
Relative Advantage	0.052	0.822	0.803	0.926	0.906	0.874	0.000		
Simplicity	0.131	0.447	0.491	0.479	0.452	0.437	0.525	0.000	
Use of ICT on AII	0.053	0.958	0.896	0.991	0.968	0.969	0.925	0.575	0.000

It was concluded that the discriminant validity of the construct of this study was established. After establishing the Convergent and Discriminant validity, this researcher argued that the Construct Validity was established for each one of the latent variables.

4.4. STRUCTURAL MODEL EVALUATION (INNER MODEL) AND DISCUSSION

Structural model or Inner model is assessed if the measurement model or outer model assessment was acceptable. The outer model defines the meaning of the constructs in the structural model/inner model (Garson, 2016). The structural model or inner model represents the causal model. The primary criterion for the evaluation of the causal model is the coefficient of determination (R^2). The second criterion is the path coefficient (β), and the third is the effect size. The fourth criterion is the Predictive relevance (Q^2). The last criterion is to test the moderating variables if there is any. The results of these assessments are described in this section.

4.4.1. The Coefficient of Determination (R^2)

It measures the proportion of the variance of the dependent variable about its mean that is explained by the independent variable(s) (Gefen, Straub and Boudreau, 2000). As shown in Figure 4.3, the variance for the first endogenous variable (Use of ICT on agricultural input information –u_i_aif) was 0.807. That means that the Relative Advantage, Compatibility, Simplicity, Cost, Information Quality, Observability and Social Influence explained 80.7% of the variance in Use of ICT on agricultural input information. This R^2 value of Use of ICT on agricultural input information was higher than previous studies in this context and beyond. For instance, R^2 values of 0.437 by Ajjan & Hartshorne (2008), 0.35 by Lin (2008), 0.14 by Gumussoy & Calisir (2009), 0.269 by Hartshorne & Ajjan (2009), 0.69 by Moghaddam & Salehi (2010) and 0.584 by Kapoor et al. (2013) were less than that of this study, which is 0.807. This value shows that the R^2 value of this study is good and that the validated model (variables) of this study explains more clearly the adoption or use of ICT services than these previous studies in the agricultural input information field and beyond. Urbach and Ahlemann (2010) quoting chin (1998b) argue that values of approximately .670 are substantial, values approximately .333 are average, and values of .190 and lower are weak. As the model's R^2 was greater than 0.670, it was again substantial in explaining use of ICT by small-scale cereal farmers. The latent variable Use of ICT on agricultural input information explained 68.4% the variance of Increased Adoption of agricultural input information.

4.4.2. The Path Coefficient

Weights closest to absolute 1 reflect the strongest paths while weights closest to 0 reflect the weakest paths (Garson, 2016).

On the first endogenous variable, it was found that Observability has the strongest effect on Use of ICT on agricultural input information (0.286), followed by Compatibility (0.191). The Information Quality and Cost come as the third and fourth latent variable having the strongest effect on Use of ICT on agricultural input information (0.190) and (0.132).
On the last endogenous variable, the Use of ICT on agricultural input information has a strong effect (0.827) on an increased adoption of agricultural input information. The path coefficient β of the entire model's construct was greater than 0.1 except for the Social Influence (0.064).

Using SMARTPLS 3.2.6, we run the bootstrapping function as suggested by Garson (2016) (Figure 4.2). In Figure 4.2., the recommended values for running the bootstrapping technique can be seen as suggested by (Garson, 2016). In addition to the path coefficient β, we reported the path coefficient value significance (t statistics) in Table 4.9.

Table 4.9 Path Coefficients

	β	T Statistics	P Values
SI -> U_I_AIF	0.064	1.089	0.277
COST -> U_I_AIF	0.132	2.299**	0.022
CP -> U_I_AIF	0.191	2.806***	0.005
IQ -> U_I_AIF	0.190	3.068***	0.002
OB -> U_I_AIF	0.286	3.726***	0.000
RA -> U_I_AIF	0.114	1.667*	0.096
SIMP -> U_I_AIF	0.107	2.736***	0.006
U_I_AIF -> INCREASED ADOPTION	0.827	33.590***	0.000

Critical t-values for a two-tailed test are 1.65* (significance level = 10 per cent), 1.96** (significance level = 5 per cent), and 2.58*** (significance level = 1 per cent).

4.4.3. Effect Size (f^2)

The effect size measures if an independent LV has a substantial impact on a dependent LV. It is calculated as the increase in R^2 of the LV to which the path is connected, relative to the LV's proportion of unexplained variance (Chin 1998). Values for f between .020 and .150, between

.150 and .350, and exceeding .350 indicate that an exogenous LV has a small, medium, or large effect on an endogenous LV (Urbach and Ahlemann, 2010; Garson, 2016). The effect size is part of the hypotheses validation and is therefore reported in Table 4.15.

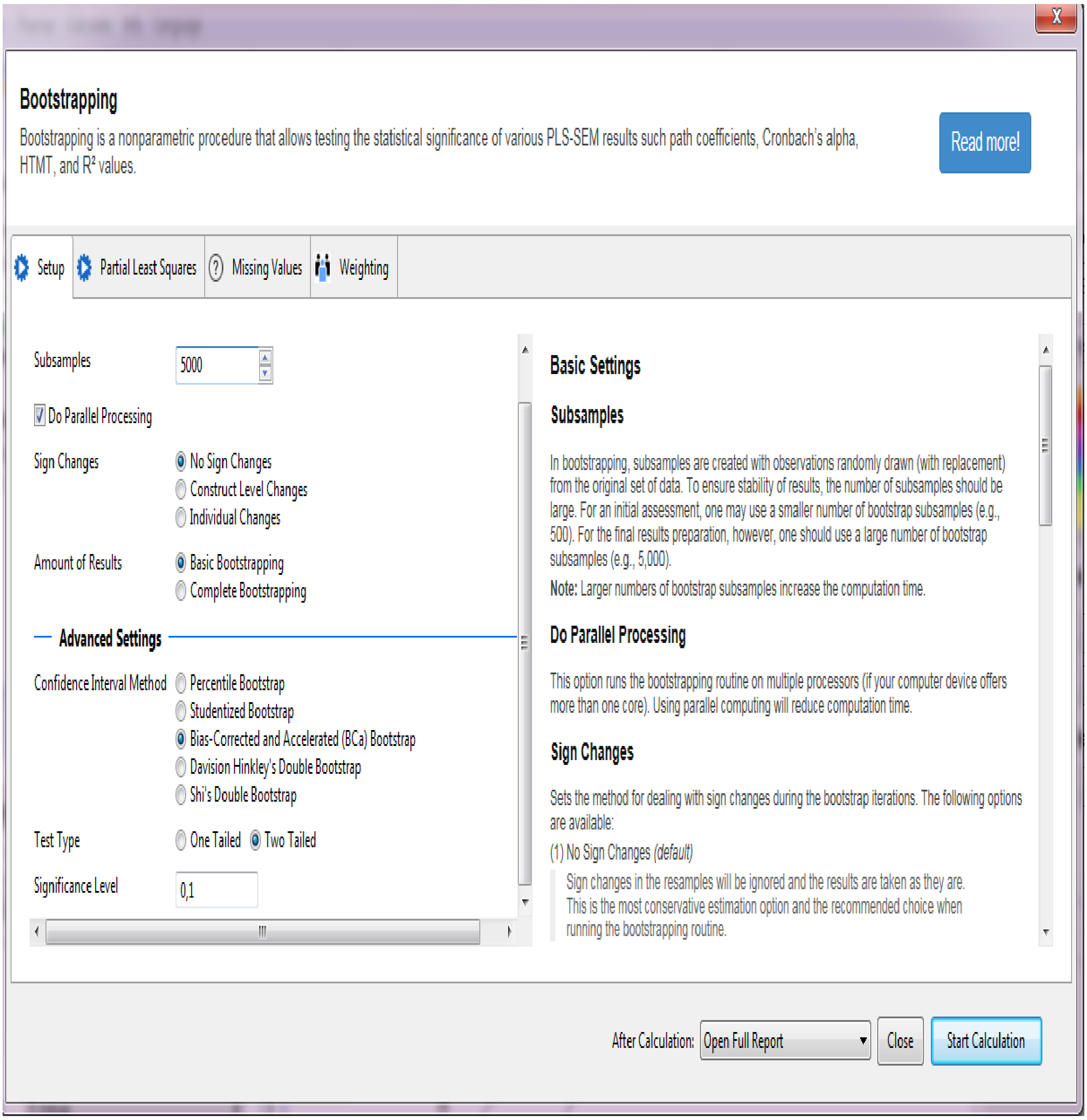


Figure 4.2 Bootstrapping function in SMARTPLS 3.2.6

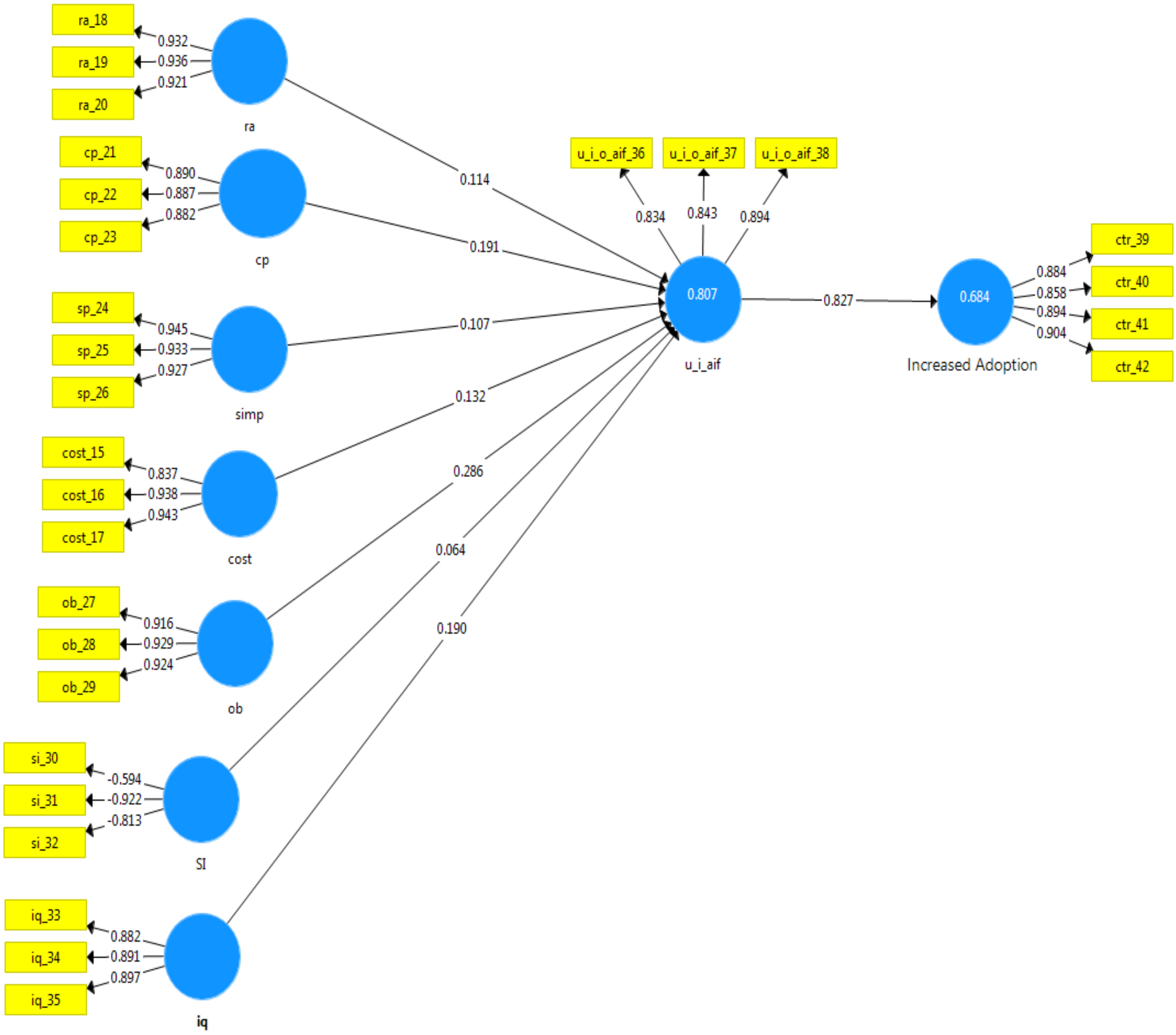


Figure 4.3 Model Results

4.4.4. Predictive Relevance (Q^2)

Another assessment of the structural model involves the model's capability to predict. Table 4.10 displays the results of the predictive relevance done using the Blindfolding function of SmartPLS 3.2.6 following Garson (2016).

The Cost, Compatibility (cp), Information Quality (IQ), Observability (ob), Relative Advantage (ra), Social Influence (si) and Simplicity (simp) are highly predictive of the use of ICT on agricultural input information with a high Q^2 (0.555). The Use of AII (u_i_aif) is also highly predictive of its endogenous latent variable Increased Adoption with a strong Q^2 (0.504).

Table 4.10 Predictive Relevance

	SSO	SSE	Q^2 (=1-SSE/SSO)
SI	666.000	666.000	0.000
INCREASED ADOPTION	888.000	440.514	**0.504**
COST	666.000	666.000	0.000
CP	666.000	666.000	0.000
IQ	666.000	666.000	0.000
OB	666.000	666.000	0.000
RA	666.000	666.000	0.000
SIMP	666.000	666.000	0.000
U_I_AIF	666.000	292.945	**0.555**

4.4.5. Standardised Root Mean Square Residual (SRMR) Approximate Fit

It measures the approximate fit of the model under study. Using SMARTPLS, the function Model fit provided us with the SRMR value, **0.055.** The understudy model passed this test. An SRMR value less than 0.08 is adequate for PLS (Garson, 2016; Henseler, Hubona and Ash, 2016).

4.5. HYPOTHESIS VALIDATION AND DISCUSSION

This section reports the results of the hypotheses assessment. This section begins with the moderating variables and then continues by reporting the evaluation of the direct hypotheses.

4.5.1. Moderating Variables Validation

The moderating variables were tested using the Multi-Group Analysis function. The significance of a moderating variable is established if the p-value is less than .05 or greater than .95 (Garson, 2016). It is the most commonly used in assessing moderating effect using PLS-SEM (Garson, 2016).

Using SMARTPLS 3.2.6, we created two data groups Literacy (Literacy and Illiteracy) and ICT Skills (Skilled and Unskilled) as suggested by Garson (2016). The function MGA was used to analyse the two groups for each variable. The results are reported in this section.
The multi-group analysis in SmartPLS 3.2.6 reports three techniques in this analysis (Asyraf Afthanorhan, Nazim and Ahmad, 2014).

- The parametric approach, which assumes that the data are normally distributed (Asyraf Afthanorhan et al., 2014). The data were not satisfying this condition; thus, it was excluded.
- Equal Variance, which often assumes the analyses are usually distributed (Asyraf Afthanorhan et al., 2014). This approach also was rejected because our data distribution was not normal.
- Unequal variance known as the **Satterthwaite test** is appropriate to try once to apply multi-group analysis (modelling the moderating effect). This approach is perceived more relevant compared with the equal variance because this test does not assume that all the data are usually distributed (Asyraf Afthanorhan et al., 2014). Therefore, this researcher chose to rely on the Satterthwaite test.

4.5.1.1. Literacy

As shown in Table 4.11 below, there is a difference in the paths between the two groups (Literacy and Illiteracy). However, these differences cannot be the source of any statistical significance.

Table 4.11 Paths coefficient for Literacy and Illiteracy

	Path Coefficients Original (Illiteracy)	Path Coefficients Original (Literacy)	t-Values (Illiteracy)	t-Values (Literacy)	p-Values (Illiteracy)	p-Values (Literacy)
SI -> u_i_aif	0.024	-0.022	0.204	0.399	0.838	0.690
cost -> u_i_aif	0.238	0.220	0.858	2.998	0.391	0.003
cp -> u_i_aif	-0.074	0.172	0.123	2.157	0.902	0.031
iq -> u_i_aif	0.554	0.132	0.825	1.867	0.410	0.063
ob -> u_i_aif	0.401	0.255	0.689	3.462	0.491	0.001
ra -> u_i_aif	-0.235	0.142	0.368	1.709	0.713	0.088
simp -> u_i_aif	0.108	0.115	0.554	2.790	0.580	0.005
u_i_aif -> Increased adoption	0.900	0.814	25.102	26.489	0.000	0.000

The Welch-Satterthwaite Test was run and the results are reported in Table 4.12.

Table 4.12. Welch-Satterthwaite Test

	Path Coefficients-diff (Literacy - Illiteracy)	**p-Value (Literacy vs Illiteracy)**	**Hypothesis**
SI -> u_i_aif	0.046	0.722	
cost -> u_i_aif	0.018	**0.949**	
cp -> u_i_aif	0.245	0.684	
iq -> u_i_aif	0.422	0.530	H7b
ob -> u_i_aif	0.146	0.802	H4a
ra -> u_i_aif	0.377	0.556	
simp -> u_i_aif	0.007	0.970	H3b

The Welch-Satterthwaite supported the hypothesis H3b. Thus, the conclusion was that hypothesis H3b is supported. However, H4a and H7b were not supported as their respective p-value showed in Table 4.12 was neither below 0.05 nor above 0.950 as recommended

(Garson, 2016). In addition, the p-value (0.949) of Literacy on the positive effect of Lower Cost on Use of ICT on agricultural input information is close enough to the recommended value of 0.950.

H3b. Literacy moderates the positive effect of Simplicity on Use of ICT on agricultural input information (supported).

H4a. Literacy moderates the positive effect of Observability on Use of ICT on agricultural input information (rejected)

H7b. Literacy moderates the positive effect of Information Quality on Use of ICT on agricultural input information (rejected).

The Welch-Satterthwaite Test reveals a new moderating effect.

H6b. Literacy moderates the positive effect of Lower Cost on Use of ICT on agricultural input information.

The transaction cost (such as airtime or communication time) is less for a literate farmer than for an illiterate one.

4.5.1.2. ICT Skills

Table 4.13 shows that there is a difference between the paths of these two groups.

Table 4.13. Paths Coefficient for ICT Skills

	Path Coefficients (SKILLED)	**Path Coefficients** (UNSKILLED)	**t-Values** (SKILLED)	**t-Values** (UNSKILLED)	**p-Values** (SKILLED)	**p-Values** (UNSKILLED)
SI -> u_i_aif	0.002	0.053	0.031	1.035	0.976	0.301
cost -> u_i_aif	0.190	0.195	2.685	2.820	0.007	0.005
cp -> u_i_aif	0.149	0.163	1.834	2.195	0.067	0.028
iq -> u_i_aif	0.188	0.168	2.775	2.483	0.006	0.013
ob -> u_i_aif	0.275	0.269	3.715	3.662	0.000	0.000
ra -> u_i_aif	0.109	0.115	1.390	1.500	0.165	0.134
simp -> u_i_aif	0.121	0.114	3.173	3.040	0.002	0.002
u_i_aif -> Increased adoption	0.826	0.827	29.596	31.173	0.000	0.000

However, the aforementioned should be tested using Welch-Satterthwaite to see which factor is significantly moderating the effects. The results of that test is reported in Table 4.14

Table 4.14. Welch-Satterthwaite Test

	Path Coefficients-diff (UNSKILLED - SKILLED)	**p-Value (UNSKILLED vs SKILLED**)	**Hypothesis**
SI -> u_i_aif	0.052	0.477	
cost -> u_i_aif	0.006	**0.954**	
cp -> u_i_aif	0.014	0.899	
iq -> u_i_aif	0.020	0.832	H7a
ob -> u_i_aif	0.006	**0.957**	
ra -> u_i_aif	0.006	**0.959**	
simp -> u_i_aif	0.007	0.893	H3a

As shown in Table 4.14, the Welch-Satterthwaite failed to support the hypotheses H7a and H3a. Thus, this study rejected these hypotheses. However, the Welch-Satterthwaite showed in Table 4.14 that the p-values of the Cost, Observability and Relative Advantage are greater than 0.95. In other words, the ICT SKILLS moderated the effect of these constructs on the use of ICT.

H3a: ICT Skills moderates the positive effect of simplicity on use of ICT on agricultural input information (rejected).

H7a: ICT Skills moderates the positive effect of information quality on use of ICT on agricultural input information (rejected).

The new findings are as follows:

H6a: ICT Skills moderates the positive effect of Cost on the Use of ICT on agricultural input information. The transaction cost (such as airtime, communication time) is less for a farmer who has more ICT skills than that who is lacking ICT Skills.

H4a: ICT Skill moderates the positive effect of Observability on the Use of ICT on agricultural input information.

The results of the use of ICT on agricultural input information are more visible, that is, can be more easily described by/to a farmer with more ICT Skills by/to one with fewer ICT Skills.

H1a: ICT Skills moderates the positive effect of Relative Advantage on the Use of ICT on agricultural input information.

A farmer with more ICT Skills believes more strongly that using ICT on agricultural input information would improve his agricultural input information adoption compared with one with fewer ICT Skills.

4.5.2. Direct Hypotheses Validation

After validating the outer and inner model, the hypotheses were assessed considering the paths coefficients significance, the direction, the effect size and the predictive relevance. This study had 13 hypotheses. Among these 13, there were five moderators (Table 4.15).

Table 4.15. Hypotheses Testing

Objective	Hypothesis	β	T Statistics	Q^2	Effect size (f^2)	Model
To establish farmers' perception of ICT on agricultural input information and to identify the effect of that perception on the use of these ICTs.	H1: Relative advantage has a positive effect on the use of ICT on agricultural input information	0.114	1.6675*	000	0.013	supported
	H2: Compatibility has a positive effect on the use of ICT on agricultural input information	0.191	2.8067***	000	0.020	supported
	H3: Simplicity has a positive effect on the use of ICT on agricultural input information	0.107	2.736***	000	0.051	supported
To establish farmers' influence on each other in the use of ICT on agricultural input information and to identify the effect of	H4: Observability has a positive effect on the use of ICT on agricultural input information	0.286	3.726***	0.000	0.073	supported
	H5: Social influence has a positive effect on the use of ICT on agricultural input information	0.064	1.089	000	0.012	Rejected

that influence on the use of these ICTs						
To establish the challenges faced by farmers in the use of ICT on agricultural input information and to identify the effects of these challenges in the use of ICT on agricultural input information	H6: Cost has a positive effect on the use of ICT on agricultural input information.	0.132	2.299**	000	0.058	supported
	H7: Information Quality has a positive effect on the use of ICT on agricultural input information	0.190	3.068***	000	0.036	supported
To propose an ICT model for increased adoption of agricultural input information in developing countries using the case of Sikasso in Mali.	H8: Use of ICT on agricultural input information has a positive effect on an Increased Adoption of agricultural input information.	0.827	33.590***	0.504	2.322	supported

Note: The Critical T-values are 1.65 for a significance level of 10% (*); 1.96 for a significance level of 5% (**); and 2.58 for a significance level of 1% (***) in a two-tailed test.

4.5.2.1. Discussion on the Specific Objective 1

To establish farmers' perception of ICT on agricultural input information and to identify the effect of that perception on the use of these ICTs.

Relative Advantage

The point that H1 (RA has a positive effect on Use of ICT on agricultural input information) was supported was consistent with the literature review. The Diffusion of Innovation Theory (DOI/IDT) confirmed that there was a relationship between Relative advantage and Use of innovation (ICT) (Rogers, 1995).

RA was found to be a driver in the use of eHealth innovation (Atkinson, 2007) and many other domains such as agriculture, education and e-government (Carter and Belanger, 2004) in developing countries. Moreover, Kapoor et al. (2013) argue that studies on mobile internet and mobile banking services have reported a positive effect of relative advantage on behavioural intention. The relative advantage is associated with or labelled as Performance Expectancy in UTAUT (Ventkatesh *et al.*, 2003) and Perceived Usefulness in TAM and varieties (Surendran, 2012) and was found to have a positive effect on Behavioural Intention (BI) to use. The Diffusion of Innovation Theory labels BI as Use.

The relationship is significant in the agricultural input information domain. The construct is a driver in the use of ICT on agricultural input information. Most of the respondents of this study expected an increase of their knowledge on access to information on inputs and the use of that information. That key was one that helped them to start using ICT on agricultural input information.

Compatibility

H2 (CA has a positive effect on Use of ICT on agricultural input information) was supported. There is considerable empirical evidence to support this finding. The construct was studied and confirmed as Facilitating conditions by Ventkatesh et al. (2003) and by Rogers (1995) for affecting use or adoption.

Kapoor et al. (2013) argue that studies on a mobile network (Hsu et al., 2007), mobile internet (Shin, 2010) and mobile ticketing services (Mallat et al., 2008) have shown that compatibility has a strong positive influence on consumer's use intentions. Furthermore, their study confirmed that positive effect of Compatibility on Intention to Use the mobile phone in India, a developing country like Mali.

The construct is a driver in the use of ICT on agricultural input information. Some beliefs played an important role in their choice to use ICT:

- These ICT services fit how they like to obtain information on agricultural inputs,
- ICT services made what they were doing to appear more relevant
- In addition, these ICT services help them to adopt (access and use) agricultural input information.

Simplicity

H3 stated that SIMP has a positive effect on Use of ICT on agricultural input information. This hypothesis was supported. There is substantial empirical evidence to support this finding. The construct was studied and confirmed as Effort Expectancy by Ventkatesh et al. (2003); Perceived Ease of Use by Davis (1989); and as Simplicity for affecting use or adoption by Rogers (1995). Moreover, Kapoor et al. (2013) quoting Lu et al. (2008) studied determinants of mobile data services in China, find that the reduced complexity associated with the use of these services positively influenced use intentions. Reduced complexity is labelled in this study as simplicity.

The construct is a driver in the agricultural input information domain. Some perceived beliefs were playing an important role in the choice of the respondents to use ICT on agricultural input information:

- Easy to access and find the information that they were seeking;
- Easy to understand that information;
- Implementing that information was easier.

4.5.2.2. Discussions on the Specific Objective 2

To establish farmers' influence on each other in the use of ICT on agricultural input information and to identify the effect of that influence on the use of these ICTs.

Observability

H4 stated that Observability has a positive effect on Use of ICT on agricultural input information. This hypothesis was also supported. There is substantial empirical evidence to support the finding of this study. The construct was examined and confirmed by Rogers (1995) as Observability for affecting use or adoption.

Vishwanath and Goldhaber (2003) in their study on technology products found that this attribute had a significant effect on adoption intention. Arts et al. (2011) also confirmed a similar behaviour for this attribute. Moreover, Kapoor et al. (2013) argue that Observability is posited to influence the behavioural intentions of potential users significantly.

The construct is a driver in the agricultural input information domain. This construct has the strongest effect on use of ICT by the respondents. The fact that the visible results achieved by a fellow farmer using the ICT, drove them in the utilisation of this ICT. In addition, this confirms that the interaction between the early adopters and other has the strongest effect on farmers' use of ICT on agricultural input information. Moreover, this result confirms the finding of Msoffe & Ngulube (2016) which concluded that most of the poultry farmers preferred interpersonal and informal sources of information. They further argued that family, friends, neighbours represents 67.7% of the most preferred source of information for farmers. This finding was confirmed by Zewge and Dittrich (2017), who report that peer influence is more significant than any other influence among farmers in developing countries.

Social Influence

H5 stated that SI has a positive effect on Use of ICT on agricultural input information. This hypothesis was not supported. The path coefficient (0.064) was not greater than the recommended one 0.1. In addition, the path coefficient significance failed to reach the recommended value of 1.65. Therefore, this construct was removed from the model. There is substantial empirical evidence to support this finding.

Doing a literature review on technology acceptance models entitled A critical examination of technology acceptance literature, Li (2010) reports that only 25% of the reviewed studies found that Social Influence predicts the Use of ICT on agricultural input information (adoption). In the agricultural input information field, we did not encounter any study supporting this hypothesis. There was an effect of the construct (Social Influence) on use of ICT on agricultural input information, but the effect was not statistically significant.

4.5.2.3. Discussions on the Specific Objective 3

To establish the challenges faced by farmers in the use of ICT on agricultural input information and to identify the effects of these challenges in the use of ICT on agricultural input information

Cost

H6 stated that Lower Cost has a positive effect on the Use of ICT on agricultural input information. This hypothesis was supported. There is substantial empirical evidence to support this finding.

Lower costs are often viewed as having a positive association with the adoption of an Innovation (Tornatzky and Klein, 1982). Thus, lower costs linked with using technology will favour easy use (adoption). A study by Shin (2010) on a mobile virtual network found the cost to be negatively influencing consumers' use behaviour. In contrast, Lower Cost would be positively affecting CTs' use. Furthermore, Kapoor et al. (2013) argue that Reduced costs are posited to influence behavioural intentions of potential users.

In the field of ICT tools on agricultural input information used by farmers, high cost was found to be a barrier to the use of these ICTs. For instance, in Tanzania, a case study on agricultural information dissemination in rural areas of developing countries found that only 9.1% of the respondents used the mobile phone as an agricultural information source, whereas 95.5%

used Posters. The affordability of the source was the cause of that use for 68.2% of the respondents and (in addition) Skill using the source (Msoffe and Ngulube, 2016). This point implies that lower or reduced cost (affordability) would have been a driver in the use of such ICTs.

Information Quality

H7 reported that IQ has a positive effect on Use of ICT on agricultural input information. This hypothesis was supported. There is substantial empirical evidence to support this finding. IQ was found to be a driver in the use of ICT by a study reviewing the factors affecting the use of ICT on agricultural input information by farmers in developing countries (Kante, Oboko and Chepken, 2016).

Information Quality (IQ) was found to be a major factor in the use of ICTs services (Briceño-Garmendia and Estache, 2004) in developing countries. In addition, studying Information system success in Malaysia, Hussein et al. (2007) argued that the Information Quality is one of the IS dimensions of success. Moreover, using the DOI to establish the factors affecting the adoption and usage of online services, Al-Ghaith et al. (2010) labelled Information Quality e-service quality and found a positive effect of it on use of the service use. Therefore, the construct plays a determinant role in the use of ICT on agricultural input information by cereal farmers.

4.5.2.3. Discussions on the Specific Objective 4

To propose an ICT model for increased adoption of agricultural input information in developing countries using the case of Sikasso in Mali.

Use of ICT on agricultural input information

H8 reported that Use of ICT on agricultural input information has a positive effect on increased adoption of agricultural inputs information. There is evidence in the literature to support that.

The construct Power was extracted from the Theory of Knowledge and labelled as Increased adoption in the context of this study. The most recent and outstanding paper that this researcher can link to an Increased Adoption is hope from Heeks & Krishna (2016). They argued that Hope might be an outcome of human behaviour. Applied to the case of this study, increased adoption is the result of Use of ICT on agricultural input information. That point was stated by Williams (2013), who argued that more use of ICT enhance the delivery of the content (information) to farmers. This study confirmed that argument. The cereal farmers said that use of ICT on agricultural input information has enhanced their adoption of Agricultural input information.

4.5.3. Conclusion on the Hypotheses

The study's results showed that 24.72% of the respondents (ICT services' users) were early adopters. These early adopters expected and experienced an increase of their knowledge (information) on agricultural inputs and therefore an increased adoption of agricultural input information. These ICT services met their expectations (Relative Advantage). This adopter category is posited with the greatest degree of opinion leadership in most social systems (Rogers, 1983). The categorisation of technology (ICT) adopters was unique to the Diffusion of Innovation Theory. This study has tested and proved this category of the theory is valid for the adoption of innovations.

The early adopters (users) of ICT on agricultural input information were the community elders (chief of the villages and their committee). Other farmers (potential adopters) look to them (early adopters) for advice and information about the ICT services. The early adopter is considered by many as "the individual to check with" before using a new idea (Rogers, 1983). The interaction of these early adopters and other farmers was the most significant factor driving the other farmers in the use of ICT on agricultural input information. The results achieved by the early ICT services on agricultural input information users and the fact that these were visible to other farmers through an interaction was significant for non-ICT services' users to start using it. That was the **Observability** as measured in this study. As members of the community interact, they build relationships that enable them to learn from each other (Benard, 2013). This finding and explanation were confirmed by the development of Myagro (Ngasene) in Sikasso. Before launching its services and recruiting clients in any village, Myagro deploys its agricultural technicians to explain the village cultural committee - gathered around the village chief - and the farmers' representative about its service packages and the advantages of working with Myagro. Once the head of the village and its committee approve the Myagro concepts, any person from that village may become a Myagro client (de la Rive Box *et al.*, 2015). **ICT skilled** farmers had more Observability than the unskilled one. The early adopter is respected by his or her peers and is the embodiment of the successful use of new ideas (Rogers, 1983). Observability was the strongest driver in the use of ICT on agricultural input information.

Another factor driving farmers in the use of ICT on agricultural input information was the way they perceived the quality of the information delivery. Most of them argued that ICT on agricultural input information were conform to their social context (culture, beliefs). This factor (**Compatibility**) was the second most significant driver in the model. The third most effective driver of ICT services' use by small-scale cereal farmers is the **Information Quality**. Since farmers use information that has immediate benefits on their knowledge of agricultural inputs, the consequence of information utilisation results in further seeking and usage because of the realised profits. That is 'keep using ICT on agricultural input information or start using them' as employed in the research instrument for this study.

In addition, farmers found it easier to access the information that they were seeking. They even argued that they understood and implement that information easily. That point means the ICT was easier to use for them (Simplicity). This was mostly the case with literate users than with illiterate users.

The Cost of using ICT on agricultural input was found to have reduced. This applied to the majority of the farmers. Nevertheless, this researcher encounter some farmers who were not using ICT on agricultural input information because of the cost that they could not afford. The positive relationship between the Cost of ICT services and use of ICT on agricultural input information was found to be stronger among farmers who are **ICT Skilled,** as they would spend less time searching for information than those who are ICT unskilled.

CHAPTER FIVE

ACHIEVEMENTS, CONCLUSION AND RECOMMENDATIONS

5.1. INTRODUCTION

This chapter concludes the study. The first section (5.2) presents a summary of the research with a focus on the findings and linking the objectives with these findings. The chapter continuous by introducing the contribution and implications (section 5.3) of these findings, limitations (section 5.4) of the results of the study, conclusion (section 5.5) and recommendations (section 5.6) of this research.

5.2. ACHIEVEMENTS

This study had identified four objectives. The broad objective was to propose an ICT for increased adoption of agricultural input information. It was divided into four specific objectives, and these were broken down into eight direct hypotheses and five moderating variables. The achievements on each one of these objectives are presented below.

Objective one. To establish the farmers' perception of ICT on agricultural input information and to identify the effects of this perception on the use of these ICTs.
The constructs Compatibility, Relative Advantage and Simplicity were established as the perceived factors of farmers on ICT on agricultural input information. Their construct validity was established validating, therefore, this study's claims (Table 4.6, 4.7 and 4.9). On their effects, H1 (Relative Advantage has a positive effect on Use of ICT on agricultural input information), H2 (Compatibility has a positive effect on Use of ICT on agricultural input information) and H3 (Simplicity has a positive effect on Use of ICT on agricultural input information) were supported (Table 4.15).

Objective two. To establish farmers' influence on each other in the use of ICT on agricultural input information and to identify the effects of this influence on the use of these ICTs.

The constructs Observability and Social influence were established as the factors that constitute the farmers influence on each other (peer influence) in the use of ICT on agricultural input information. Their validity was also established (Table 4.6, 4.7 and 4.9). In identifying their effects on the use of ICT on agricultural input information, H4 (Observability has a positive effect on Use of ICT on agricultural input information) was supported, and H5 (Social Influence has a positive effect on Use of ICT on agricultural input information) was rejected (Table 4.15).

Objective three. To establish the challenges faced by farmers in the use of ICT on agricultural inputs information and to identify the effects of these challenges in the use of these ICTs. The constructs Information Quality and Cost were established as other factors challenging the use of ICT on agricultural input information (Table 4.6, 4.7 and 4.9). In addition, the Literacy and the ICT Skills were found to be also challenging as moderators. In identifying their effects, H3b, H6 (Cost has a positive effect on Use of ICT on agricultural input information) and H7 (Information Quality has a positive effect on Use of ICT on agricultural input information) were supported (Table 4.15). However, H3a (ICT Skills moderates the positive effect of Observability on Use of ICT on agricultural input information), H4a (Literacy moderates the positive effect of Observability on Use of ICT on agricultural input information), H7b (Literacy moderates the positive effect of Information Quality on Use of ICT on agricultural input information) and H7a (ICT Skills moderates the positive effect of Observability on Use of ICT on agricultural input information) were rejected as moderators. The data of this study revealed unexpected hypotheses in this objective. They were discussed in section 4.5.1. of moderating variables validation. These new hypotheses were:

H1a. ICT Skills moderates the positive effect of Relative Advantage on Use of ICT on agricultural input information.

H4a. ICT Skills moderates the positive effect of Observability on Use of ICT on agricultural input information.

H6a. ICT Skills moderates the positive effect of Cost on Use of ICT on agricultural input information.

H6b. Literacy moderates the positive effect of Cost on Use of ICT on agricultural input information.

Objective four. To propose an ICT model for increased adoption of agricultural input information in developing countries using the case of Sikasso in Mali. The development of the study's model was achieved through the establishment of the measurement model. We established that Relative Advantage, Compatibility, Simplicity, Observability, Information Quality and Cost explained 80.7% of the variance in Use of ICT on agricultural input information. In addition, the latent variable Use of ICT on agricultural input information explained 68.4% the variance of Increased Adoption of information on agricultural input information.

Regarding prediction, the latent variables were predictive of the first endogenous variable Use of ICT on agricultural input information 55.5%, and the Use of ICT on agricultural input information was predictive of the Increased Adoption 50.4%.

5.3. CONTRIBUTION AND IMPLICATIONS

This research made it clear that use of ICT on agricultural input information by small-scale cereal farmers in Mali and developing countries are subject to a particular model that was not provided by the technology acceptance models. The study has made Theoretical, Methodological and Practical and Managerial Contribution.

5.3.1. Theoretical Contribution

The technology acceptance models provided a basis for understanding relationships between constructs and use of technology. The UTAUT, TAM and DOI that are the three most used and applied technology acceptance models provided some constructs to understand the use of technology by the farmers in the agricultural context. These models have been implemented in a different context but barely in the agricultural input information context. In addition, they have rarely been applied to small-scale cereal producers that dominate the agricultural activities in developing countries. It identified in the literature review eight theory application void gaps. This undertaken study has addressed these deficiencies in the cereal production context. For instance, Adegbidi *et al.* (2012) did not present their study's result according to their framework (Diffusion of Innovation Theory). This researcher has been successful in addressing the gap in the context of use of ICT on agricultural input information by presenting the results of this undertaken study according to the Diffusion of Innovation Theory. Moreover, it has met all the requirements of the diffusion of innovation theory and went beyond by linking technology' use and increased adoption. Another theoretical gap that was successfully addressed in the current context is the knowledge void research gap. An example of that gap is that from the paper of Amin and Li (2014), where the desired research hypothesis (Relative advantage has a positive effect on intention to use ICT) was not supported by the study's results in Bangladesh. In the case of this research, the Relative advantage has a positive effect on the use of ICT. A contradictory evidence (Müller-Bloch and Kranz, 2015) research gap emerged from the study of Rezaei-Moghaddam and Salehi (2010) in Iran. They found a relationship between Observability and Ease of Use, Observability and Perceived Usefulness. Up to date, no other study has confirmed these findings to the knowledge of this researcher. This undertaken study did not find any evidence supporting these findings in Iran. Thus, this study was successful in addressing that gap in the context of use of ICT on agricultural input information.

A literature conducted over the last fifteen years showed that the DOI was the most technology acceptance models that could be applied in the agricultural input information context. However, the DOI had to be contextualised and extended to some construct that was lacking. To the knowledge of this researcher, it is the first time that the DOI is applied in the agricultural input information sector and extended. Hence, the results and conclusions from this study should succeed in providing the researchers with the first insights into the behaviour of Rogers' innovation attributes, cost and information quality on the use of ICT on agricultural input information. This study was successful in addressing the theory application void gap in the context of use of ICT on agricultural input information.

The final revised model indicates that the technology acceptance models, which are developed and tested in developed countries, cannot be applied in developing countries without contextualisation. Though all the constructs of the original DOI were included in the final revised model except trialability, it was apparent that the strength of contribution of these factors was contrary to what was found in the original DOI when the model was tested in different contexts. Particularly, the most predictive factor for use of ICT on agricultural input information was found to be the Observability. This was another theoretical contribution of this study.

The relationship between use of ICT and contribution of ICT through an increased adoption of the content (agricultural input information) was not stated in the DOI. This study went beyond the traditional technology acceptance models to extract the construct Increased Adoption from the theory of Knowledge from Foucault (1977). A Conceptual framework was proposed and validated. To the researcher's knowledge, this is the first time that a relationship has been established between use of ICT (Behavioral Intention) and an increased adoption of the content (information) in the ICT4D field. Moreover, it is the first time in the agricultural input information context. Little research has been done on this relationship, and this study has successfully addressed that gap in the context of use of ICT on agricultural input information.

Another contribution is the proposed constructs Cost and information Quality as influencing the use of ICT on agricultural input information. The Cost has been suggested in the revised UTAUT 2 as affecting behavioural intention. To the researcher knowledge again, this the first time that Cost has been established as positively affecting the use of ICT in developing countries in the cereal production context. That was supported the literature as we did not encounter any model in this context that has studied the Cost. This was the filling of the research gaps knowledge void and evaluation void. The cost was not studied very well in the context of cereal farmers' adoption of technology. Rather, it was examined in the context of 'impact' of technology. In this aim, it has emerged as an outcome of technology and not as an input for technology acceptance. This study was successful in addressing that knowledge void gap in the context of use ICT on agricultural input information. The evaluation void gap was highlighted in almost all the reviewed studies in the research gap section (section 2.6.1). This researcher confirms the results of these studies and goes beyond by presenting the significance of cost (lower cost) on use of ICT. In addition, the moderators Literacy and ICT Skills are other contribution made by this study. They were found to be moderating the positive effect of Lower Cost on Use of ICT on agricultural input information.

The study offers suggestive evidence that Social Influence is not a construct affecting the use of ICT on agricultural input information by small-scale farmers in developing. This confirmed the results of a study by Adegbidi et al. (2012) in Benin in the same context on rice producer in 2012. The final revised model is illustrated below in Figure 5.1

In addition, another contribution was the development or adaptation of new indicators to measure the construct used in this study. The development of these news items was based on the literature review on the subject, and they passed the reliability and validity test. Therefore, they can be applied in similar context.

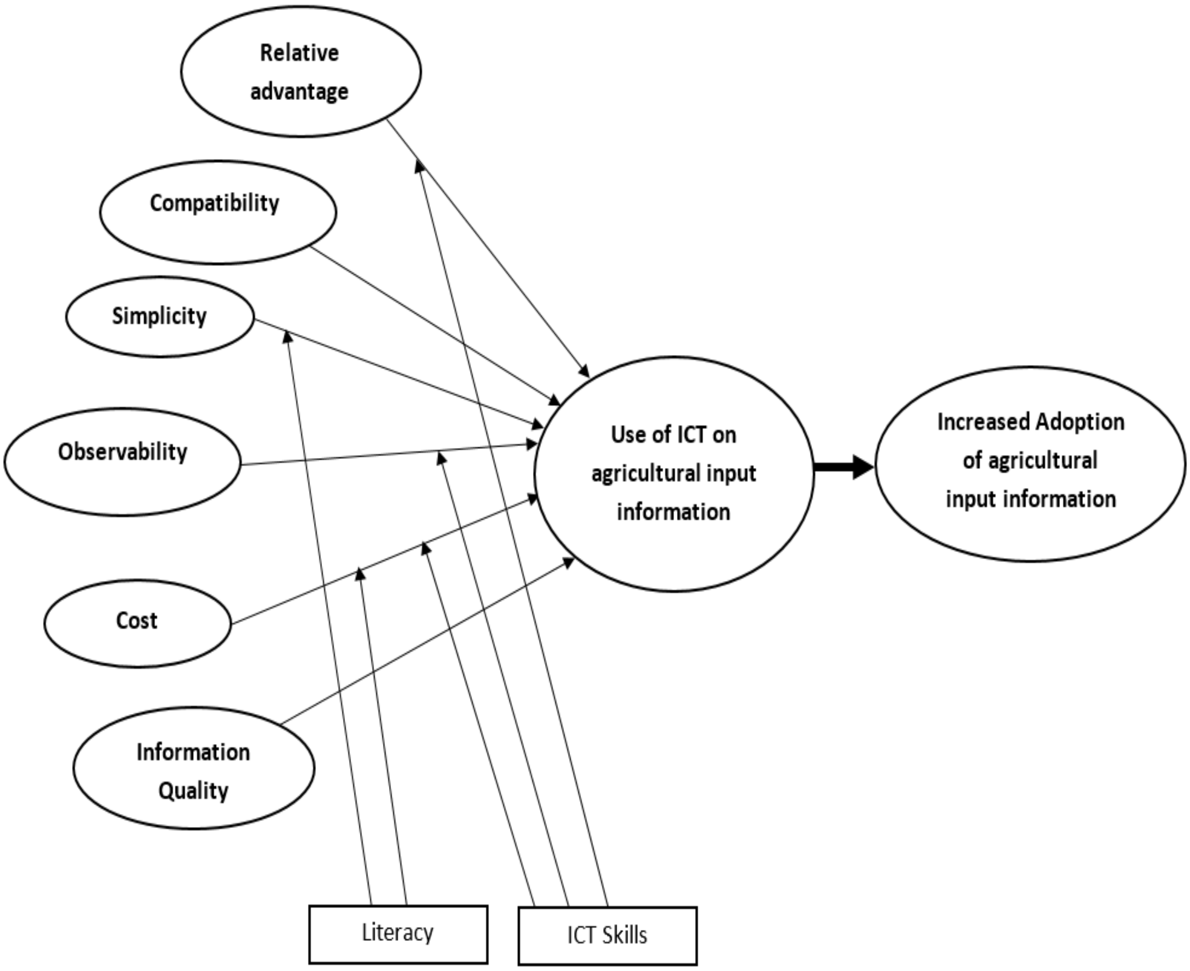


Figure 5.1 Final Revised Model for use of ICT on agricultural input information

The translation of the items from English to French and Nko (Bambara) constitutes another contribution. The data collection instrument (questionnaire) of these models are in English. For other speaking languages especially French and Bambara[7], these instruments need to be translated. The increasing need for non-English language data collection tools and other survey materials is evident given recent figures (Pan and de la Puente, 2005). The researcher developed a method for translating an English survey instrument on ICT on agricultural input information into French and Bambara (NKO). We believe that the developed methods for translating an English survey instrument on ICT on agricultural input information into French and Bambara formed an effective translation. This method was different to the method of another research (Forsyth *et al.*, 2006b). We have improved the guidelines of the Census Bureau Guidelines (Pan and de la Puente, 2005) by integrating into it the method ASQ (Ask the Same Question (Harkness, 2000) and the TRAPD (Translation, Review, Adjudication, Pre-testing and Documentation) method (Harkness, 2000). This translated instrument in NKO (Bambara) is one of the rarely translated survey instrument on ICT on agricultural input information. These translated items also passed the reliability and validity test and hence can be applied in similar context. That translation successfully addressed in the context of ICT on agricultural input information a methodological conflict gap from the literature.

5.3.2. Methodological Contribution

The methodology used in this study gives guidelines for researchers interested in the same area or connected.

The method that was used to translate the research instrument from English into French and Bambara was a contribution. This researcher assessed the translation methods that were available and come up with a method for translating. That is the first time to this researcher’s knowledge that a translation method has been proposed in the context of technology adoption in developing countries. Moreover, the writing system of Bambara (NKo) is different to the Latin alphabet writing system. We have brought new knowledge (terms) to the language

[7] Bambara is a language spoken in Mali.

(Bambara), which is also to the awareness of this researcher, the first time. Thus, the study has successfully filled a methodological conflict gap in the context of ICT on agricultural input information.

The literature review done using the grounded theory gives a view of how it should be conducted in the context of ICT4D. Using the analysis of the qualitative data of the literature to find out the gap according to the Grounded Theory, assures solid legitimised, in-depth analyses of the empirical facts and related insights. This includes the emergence of new themes (factors or constructs), issues (barriers) and opportunities (drivers); interrelationships and dependencies in or beyond a particular area (area of ICT on agricultural input information); as well as inconsistencies.

The identification of research gaps of this study is another contribution. Finding a consistent gap is always an issue. After systematically identifying the factors affecting use ICT on agricultural input information, there was a need to look for research gaps in this literature. A research gap arises when there is a gap in sets of information that is derived from a literature synthesis and requires further research to be resolved (Müller-Bloch and Kranz, 2015). This study analyses the literature according to that framework and comes up with 54 research gaps. The main contribution of this study is that it goes beyond the framework of Müller-Bloch and Kranz (2015). Their framework guides research gaps, while this study's framework guides systematic literature review and research gaps. Hence, we have addressed a methodological conflict gap in this case in the context of use of ICT on agricultural input information.

The validation through a pretest and pilot study of this study is another method that can be used in such context. The pre-test validated the research instrument completeness (content validity). The pilot-study validated the model and the survey instrument for the next phase of the study (main study).

The analysis of the data using PLS-SEM offers a guide that can be implemented. Most of the studies in IS applied the guidelines of another field such as Marketing or Management. In addition, the literature did not state clearly how PLS-SEM should be used in the case of exploratory or explanatory study. This researcher provides a guide for an exploratory study in the field of Information System such as ICT4D, taking into accounts the interpretability of PLS-SEM (explanatory). This guideline shows that PLS is in the ground middle of exploratory (predictive) and explanatory (confirmatory). Hence, PLS aims to maintain interpretability while engaging in predictive modelling. To the researcher knowledge, this is the first time that such contribution has been made.

In addition, the way this study established the constructs' validity is a contribution. Most of the research in the developing countries context using PLS-SEM establishes their discriminant validity through the Fornell-Larcker criterion and/or cross-loadings criterion. There is empirical evidence that while the use of these criteria is acceptable but they are not without biases. Many researchers recommend the use of the Heterotrait-Monotrait Ratio (HTMT) criterion. This study offers guidelines on how to use it in information systems research. Moreover, it provides the results of these criteria that could be utilised as a guideline too. The use of the Multigroup Analysis to assess the moderating effect is another contribution. This technique is consistently taking over in the assessment of the moderating effect. Moreover, in the current case, it revealed new findings that would not be possible without its use.

This research addressed some of the critics of PLS utilisation in an exploratory (predictive) study. It provides an updated guideline for the use of PLS in IS research for the exploratory study. This guidance document, to this researcher's knowledge, is the first combining model validity and model fitness. In doing so, the study has successfully filled a methodological conflict gap in this case in the context of use of ICT on agricultural input information.

5.3.3. Practical and Managerial Contribution

This study was exploratory (predictive). A predictive model may be easier to accept by decision makers and other stakeholders when it can be plausibly interpreted. Further, it may be simpler to determine the prediction boundaries, i.e. determine under what situations the model will hold and under what situations the model will break when a plausible substantive interpretation is available. Users of predictive models have more trust in its results, especially for unexpected or counterintuitive predictions, when there is a plausible interpretation possible.

Beyond researchers, the findings of this study have major practical significance. It proved that the deployment of an ICT service towards farmers because of the demand is not an acceptable standard. The drivers of the use of the technology should be understood before. The model provided helps to inform on which factors affect the use of technology. Moreover, the model gives the relative significance of each construct.

It is important for the managers to consider the constructs and moderators established in this study for deployment of their ICT services towards farmers.

5.4. STUDY LIMITATIONS

It should be borne in mind that this study has some limitations namely:

- There was no similar survey instrument translated in Bambara, which was the language of the most of the respondent in this study's area. This study uses a method to translate the instrument. However, it does suggest a direction for further investigation of this instrument.
- Some of the respondents could not fill the form, and they were helped to do so. That could be a question mark on the quality of the data. However, Bowling (2005) concluded that the legitimacy of a study is difficult to establish with some methods than others. In addition, three research assistants were formed on how to choose verbal descriptors as label according to Villar (2009). Moreover, the supervisor visited the field and could see how the farmers who could not fill were helped to do so.
- Broad application of the results

  This study was conducted in the district of Bougouni in the region of Sikasso in Mali in a specific domain of ICT on agricultural input information. The users of Bougouni, Sikasso may have different characteristics from other regions or countries. Therefore, it is not certain that the findings of this study could be applied broadly.

5.5. CONCLUSION

The overall objective of this research was to propose an ICT model for increased adoption of agricultural input information by cereals farmers in Sikasso, Mali. Table 5.1 summarises the conclusion from each one of the objectives of the study.

Table 5.1 Study's Results and Conclusions

Research Objective	Results	Conclusion
To establish farmers' perception of ICT on agricultural input information and to identify the effect of that perception on the use of these ICTs.	Compatibility, Simplicity, Relative Advantage are the perceived factors in the use of ICT on agricultural input information. They have a positive effect on use of ICT on agricultural input information.	Compatibility was the most perceived factor affecting use of ICT on agricultural input information. Relative Advantage and Simplicity followed as second and third.
To establish farmers' influence on each other in the use of ICT on agricultural input information and to identify the effect of that influence on the use of these ICTs.	Observability and Social Influence were established as farmers' influence on each other (peer influence). Observability has a positive effect on use of ICT on agricultural input information whereas Social Influence did not significantly affect their use.	Farmers' influence on each other is the main driver on use of ICT on agricultural input information. However, that influence was not any social pressure.
To establish the challenges faced by farmers in the use of ICT on agricultural input information and to identify the effects of these challenges in the use of ICT on agricultural input information.	Information Quality and Cost were established as (other) factors challenging the use of ICT. IQ and Lower Cost positively affect use of ICT. In addition, Literacy was found to be moderating the effect of Simplicity on use of ICT on agricultural input information. The factor ICT Skills was also found to moderate the effects of Observability, Simplicity,	The completeness, relevance and appropriateness of presentation of the information were positively affecting use of ICT on agricultural input information in this setting. The Cost of using ICT on agricultural input information was found to have reduced in addition; other challenges are Literacy and ICT Skills.

	Relative advantage and Cost on use of ICT in this context.	Literacy moderated the positive effect of Simplicity on Use of ICT on agricultural input information. An ICT skilled farmer was able to access/use the information he/she was seeking better than was an unskilled farmer, thus, making ICT skills a moderator on the effect of cost on use of ICT on agricultural input information. ICT Skills also moderated the effects of Simplicity, Observability, and Relative advantage on Use of ICT on agricultural input information.
To propose an ICT model for increased adoption of agricultural input information in developing countries using a case in Sikasso, Mali.	A model of 8 latent variables and 5 moderating effects was proposed for small-scale cereal farmers.	A model for cereal farmers in a developing country was proposed for the first time to the knowledge of this researcher. The two aspects (prediction and interpretability) of PLS were reported and achieved. The latent variables predict the use of ICT by 55.5%. Use predicts the increased adoption by 50.4%. The model explains Use of ICT 80.7% and Increased adoption 68.4%. In the model, the farmers' influence on each other has the strongest effect on use of ICT on agricultural input information, followed by their perceived compatibility and Information Quality.

5.6. RECOMMENDATIONS

This research has proposed an ICT model for increased adoption of agricultural input information in developing countries using the case of Sikasso in Mali by small-scale cereal farmers, although some orientations need further investigation. The study has proposed theoretical, methodological, practical and managerial and policy recommendation.

5.6.1. Theoretical Recommendations

This proposed model can be applied in another developing country for other crops. However, it might be advantageous for another study to test it. In such way, other factors could be found. This study used cereals like millet, sorghum, rice and fonio. Other cereals crops could be tested using the model.

The second aspect that might be further investigated is the social influence. The culture of developing countries may differ from each other. Other items could also be integrated into the measure of the construct, which was not applied in this study. That is an evaluation void and a knowledge void research gaps that need to be filled by future research.

Finally, an orientation that might be taken by further research is to apply another time horizon such as the longitudinal. This study used the cross-sectional as time horizon to explain how factors are related. The main strength of longitudinal research is the capacity that it has to study change and development. Adams and Schvaneveldt (1991) point out that in observing people or events over time, the researcher can exercise a measure of control over variables being studied, provided that they are not affected by the research process itself (Saunders, Lewis and Thornhill, 2009).

5.6.2. Methodological Recommendations

This study has provided a method for translating into French and Bambara (Nko). The method can be used for other languages. However, it might interest to take into account some cultural viewpoints of other local languages mainly African. Therefore, this researcher recommends future researchers to fill that evaluation void research gap.

Another recommendation is to test the updated guidelines of the use of PLS-SEM in an exploratory setting in Information System research. The use of PLS-SEM is increasing among IS researchers. However, the literature reports that how to use PLS-SEM and how to report the results is problematic. This research has brought a new guideline by extracting some criteria from explanatory studies. Nevertheless, it will be useful to assess this guideline and come up with other criteria or confirm the usefulness of this guideline. That another evaluation void research gap that needs to be filled by future inquiries.

5.6.3. Practical and Managerial Recommendation

The study has provided a model that needs to be taken into account by ICT services' designers. It recommends the integration of more social interaction with the farmers in the context of cereal production. The factor Observability that came up as the strongest in the model as affecting use of ICT on agricultural input information points to that direction.

5.6.4. Policy Recommendation

The proposed model can be used by government policymakers on ICT on agricultural services in developing countries to implement policies that speed up the use of ICT on agricultural input information. For instance, the Lower Cost has a significant effect on the use of ICT on agricultural input information and put into place an environment that will allow the ICT services designers to offer their services cheaper that will result in more use of these ICTs. That, in turn, will result in an increased adoption of agricultural input information and therefore more use of farm inputs. That is the one the basis for more agricultural productivity for better food security level.

REFERENCES

Adegbidi, A. *et al.* (2012) 'Determinants of ICT use by rice farmers in Benin : from the perception of ICT characteristics to the adoption of the technology', *Journal of Research in International Business and Management*, 2(11), pp. 273–284.

Advameg (2016) *Culture of Mali - history, people, traditions, women, beliefs, food, customs, family, social*, *everyculture.com*. Available at: http://www.everyculture.com/Ja-Ma/Mali.html (Accessed: 6 April 2016).

AGRA (2014) *Improving fertilizer supplies for African farmers*. Nairobi. Available at: http://iirr.org/wp-content/uploads/2015/09/Fertilizer-supply_print-1.pdf.

Aguirre-urreta, M. I. and Marakas, G. M. (2012) 'REVISITING BIAS DUE TO CONSTRUCT MISSPECIFICATION: DIFFERENT RESULTS FROM CONSIDERING COEFFICIENTS IN STANDARDIZED FORM', *MIS Quarterly*, 36(1), pp. 123–138.

Aker, J. C. (2008) 'Does Digital Divide or Provide? The Impact of Cell Phones on Grain Markets in Niger', *Center for Global Development Working Paper*, (February), p. 61. doi: 10.2139/ssrn.1093374.

Aker, J. C. (2011) 'Dial " A " for Agriculture : Using Information and Communication Technologies for Agricultural Extension in Developing Countries', *Agricultural Economics*, 42(6), pp. 631–647. doi: 10.1111/j.1574-0862.2011.00545.x.

Aker, J. C., Ghosh, I. and Burrell, J. (2016) 'The promise (and pitfalls) of ICT for agriculture initiatives', *Agricultural Economics (United Kingdom)*, 47, pp. 35–48. doi: 10.1111/agec.12301.

Al-Ghaith, W., Sanzogni, L. and Sandhu, K. (2010) 'Factors Influencing the Adoption and Usage of Online Services in Saudi Arabia', *Electronic Journal of Information Systems in Developing Countries*, 40(1), pp. 1–32.

Aleke, B., Egwu, P. and N, E. P. (2015) 'Strategic Women Empowerment through ICT Innovation Adoption : Case of Smallholder Rice Farmers in Nigeria Strategic Women Empowerment through ICT Innovation Adoption : Case of Smallholder Rice Farmers in Nigeria', in Systems, U. A. for I. (ed.) *UK Academy for Information Systems Conference Proceedings*. Oxford: AIS Electronic Library (AISeL). Available at: http://aisel.aisnet.org/ukais2015/29.

Amin, M. K. and Li, J. (2014) 'Applying Farmer Technology Acceptance Model to Understand Farmer's Behavior Intention to use ICT based Microfinance Platform: A Comparative Analysis between Bangladesh and China', in WHICEB2013 (ed.) *Fact Reports*. wuhan: AIS Electronic Library (AISeL), pp. 0–8. doi: 10.13140/RG.2.1.3832.9363.

Angelucci, F. *et al.* (2013) *Monitoring and analysing food and agricultural policies in Africa MAFAP Synthesis Report Series*.

Aparisi, A. M. (FAO) and Balie, J. (FAO) (2013) *Review of Food and Agricultural Policies Mali*

2005-2011. Rome.

Asyraf Afthanorhan, Nazim, A. and Ahmad, S. (2014) ‘A Parametric Approach To Partial Least Square Structural Equation Modeling of Multigroup Analysis (PLS-MGA)’, *International Journal of Economics, Commerce and Management United Kingdom*, II(10), pp. 1–15. doi: 10.9734/BJAST/2015/14380.

Atajeromavwo, E. J. *et al.* (2010) ‘An Evaluation of the Relevance of Information and Communication Technologies (ICT) to Agricultural and Rural Development in Niger Delta of Nigeria’, *African Research Review*, 4(1), pp. 401–414.

Atkinson, N. L. (2007) ‘Developing a questionnaire to measure perceived attributes of eHealth innovations’, *American Journal of Health Behavior*, 31, pp. 612–621. doi: 10.5993/AJHB.31.6.6.

Bagozzi, R. P. (2007) ‘The Legacy of the Technology Acceptance Model and a Proposal for a Paradigm Shift .’, *Journal of the Association for Information Systems*, 8(4), pp. 244–254.

Bakkabulindi, F. E. K. (2012) ‘Does Use of ICT Relate with the way it is Perceived ? Evidence from Makere University’, *International Journal of Computing and ICT Research*, 6(2), pp. 75–94.

Barakabitze, A. A. *et al.* (2015) ‘NEW TECHNOLOGIES FOR DISSEMINATING AND COMMUNICATING AGRICULTURE KNOWLEDGE AND INFORMATION: CHALLENGES FOR AGRICULTURAL RESEARCH INSTITUTES IN TANZANIA’, *The Electronic Journal of Information Systems in Developing Countries*, 70, pp. 1–22.

Barakabitze, A. A., Fue, K. G. and Sanga, C. A. (2017) ‘The Use of Participatory Approaches in Developing ICT-based Systems for Disseminating Agricultural Knowledge and Information for Farmers in Developing Countries: The Case of Tanzania’, *The Electronic Journal of Information Systems in Developing Countries*, 78(8), pp. 1–23.

Baron, R. M. and Kenny, D. a. (1986) ‘The Moderator-Mediator Variable Distinction in Social The Moderator-Mediator Variable Distinction in Social Psychological Research: Conceptual, Strategic, and Statistical Considerations’, *Journal of Personality and Social Psychology*, 51(6), pp. 1173–1182. doi: 10.1037/0022-3514.51.6.1173.

Bartelt, V. L. and Dennis, A. R. (2014) ‘NATURE AND NURTURE: THE IMPACT OF AUTOMATICITY AND THE STRUCTURATION OF COMMUNICATION ON VIRTUAL TEAM BEHAVIOR AND PERFORMANCE’, *MIS Quarterly*, 38(2), pp. 521–538.

Batchelor, S. *et al.* (2014) ‘Is there a role for mobiles to support sustainable agriculture in Africa?’, *2nd International Conference on ICT for Sustainability*, (Ict4s), pp. 272–280. doi: 10.2991/ict4s-14.2014.33.

Beardon, H. *et al.* (2005) *ICT for development : empowerment or exploitation? Learning from the Reflect ICTs project*, *Human Development*. London. Available at: reflect-action.org.

Benard, R. (2013) ‘Knowledge management & e-Learning understanding the knowledge sharing process among rural communities in Tanzania : areview of selected’, *Knowledge Management & E-Learning*, 5(2), pp. 205–217.

Bosch, M. *et al.* (2012) ‘Agriculture and ICT’, *eLac*, 18, pp. 1–12.

Bovaird, J. a *et al.* (2007) ‘Missing data and standard errors with partial least squares’, *115th Annual Meeting of the American Psychological Association*, p. 1.

Bowling, A. (2005) ‘Mode of questionnaire administration can have serious effects on data quality’, *Journal of public health*, 27(3), pp. 281–291. doi: 10.1093/pubmed/fdi031.

Briceño-Garmendia, C. and Estache, A. (2004) *Infrastructure Services in Developing Countries: Access, Quality, Costs, and Policy Reform*. World Bank Publications. Available at: https://books.google.com/books?hl=en&lr=&id=TULcB1co4-cC&pgis=1 (Accessed: 4 December 2015).

Bui, Q. (2015) ‘A Review of Innovation Diffusion Theories and Mechanisms’, in Technology, D. I. G. I. I. (ed.) *DIGIT 2015 Proceedings. Paper 11*. AISel, pp. 1–11. Available at: http://aisel.aisnet.org/digit2015 Recommended.

Bwalya, K. J. (2009) ‘FACTORS AFFECTING ADOPTION OF E-GOVERNMENT IN ZAMBIA’, *Electronic Journal of Information Systems in Developing Countries*, 38(4), pp. 1–13.

Bwalya, S., Asenso-Okyere, K. and Tefera, W. (2012) ‘Promoting ICT based agricultural knowledge management’, in *Increasing agricultural productivity and enhancing food security in Africa : New Challenges and Opportunities*. Addis Ababa: UNDP, p. 39.

Carrasco, L. (2003) *The American Community Survey (ACS) en Español : Using Cognitive Interviews to Test the Functional Equivalency of Questionnaire Translations Lorena Carrasco (Currently in the Decennial Management Division)* Statistical Research Division U . S . Bureau*, *Methodology*. Washington D.C.

Carter, L. and Belanger, F. (2004) ‘Citizen adoption of electronic government initiatives’, *37th Annual Hawaii International Conference on System Sciences, 2004. Proceedings of the*, 0(C), p. 10 pp. doi: 10.1109/HICSS.2004.1265306.

Carter, R. L. (2006) ‘Solutions for Missing Data in Structural Equation Modeling’, *Research and Practice Assessment*, 1(1), pp. 1–6.

Chilimo, W. L. and Sanga, C. (2006) ‘TOWARDS EFFECTIVE KNOWLEDGE MANAGEMENT PRACTICES FOR AGRICULTURAL INFORMATION SPECIALISTS IN TANZANIA’, in EASTERN, X. S. C. O., & C. & S. A. L., and ASSOCIATIONS, I. (eds) *Librarianship as a Bridge to an Information and Knowledge Society in Eastern, Central and Southern Africa*. Dar es Salam, pp. 124–140.

Chin, T. Y. (2006) ‘Mediator and Moderator Variables in Social Science Research’. Nebraska, USA, pp. 1–29. Available at:

http://www.cyfs.unl.edu/docs/CenterScope/ResearchMethodologySeries/Chin.pdf.

Chung, Y. S. (2015) *Case study : Tigo Kilimo, Tanzania*, *GSMA*. Edited by PUBmed. London. doi: 10.1016/S1360-8592(98)80013-2.

Churi, A. J. *et al.* (2012) 'Understanding Farmers Information Communication Strategies for Managing Climate Risks in Rural Semi-Arid Areas , Tanzania Description of the Study Area', *International journal of information and commication technology research*, 2(11), pp. 838–845.

CICC (2003) 'Success and Future Prospects of "Initiative for Multimedia Information Technology Toward 21', in, pp. 1–6.

Cox, A. J. and Sseguya, H. (2016) 'ICT supported extension services in conservation agriculture information access for small holder farmers in Laikipia County, Kenya', in *International Symposium on Technology and Society,*. doi: 10.1109/ISTAS.2015.7439408.

Csa (2007) 'Commissariat à la Sécurité Un Peuple – Un But – Une Foi REGION DE SIKASSO Synthèse régionale I . Introduction'. Bamako: Commissariat a la Securite Alimentaire, p. 19.

Dandedjrohoun, L., Diagne, a and Biaou, G. (2012) 'Determinants of diffusion and adoption of improved technology for rice parboiling in Benin', *Review of Agricultural and Environmental Studies*, 93(2), pp. 171–191. Available at: http://www.raestud.eu/pdf/171-191-ncho.pdf.

Dangi, N. and Singh, H. (2010) 'e-Choupal : Hope or Hype ? Neeraj Dangi and Harjit Singh Department of Management , Institute of Management Education , Sahibabad (Ghaziabad), India', *American Journal of Economics and Business Administration*, 2(2), pp. 179–184.

Davydov, A. (2005) *On Souleymane Kanté ' s ' Nko Grammar '*. Saint Petersbourg. Available at: http://mandelang.kunstkamera.ru/files/mandelang/davydov.pdf.

Dey, B. L., Prendergast, R. and Newman, D. (2008) 'How can ICTs be used and appropriated to address agricultural information needs of Bangladeshi farmers?', in GlobDev (ed.) *Proceedings Annual Workshop of the AIS Special Interest Group for ICT in Global Development*. Paris: AIS Electronic Library (AISeL). Available at: http://aisel.aisnet.org/globdev2008%5Cnhttp://aisel.aisnet.org/globdev2008/21.

Diallo, M. (2013) 'Deficit des politiques d'Interconnexion, cas du Mali', in *Forum Africain sur les Points d'echange internet 2-5 septembre 2013*. Casanblanca.

Dissanayeke, U. (2014) 'Mobile Based Information Communication Interactions Among Major agriculture Stakeholders : Sri lankan Experience', *Electronic Journal of Information Systems in Developing Countries*, 60(1), pp. 1–12.

Doss, D. C. (2006) 'Analysing technology adoption: Challenges and limitations of micro-studies.', *Agricultural Economics*, 34, pp. 207–219.

DRPSIAP (2011) *RAPPORT DE L ' ENQUETE SUR LA RECONNAISSANCE RAPIDE DES AXES ET CIRCUITS DE COMMERCIALISATION DES CEREALES DANS LA REGION DE SIKASSO*. Sikasso. Available at: fsg.afre.msu.edu/promisam_2/reconnaissance_bassin_Sikasso.pdf.

Evermann, J. and Tate, M. (2010) 'Testing Models or Fitting Models? Identifying Model Misspecification in PLS', in 2010, I. (ed.) *Thirty First International Conference on Information Systems (Icis)*. St. Louis: AIS, p. Paper 21.

Evermann, J. and Tate, M. (2012) 'COMPARING THE PREDICTIVE ABILITY OF PLS AND COVARIANCE MODELS', in *Proceedings of the 33rd International Conference on Information Systems (ICIS)*. Orlando, pp. 546–550.

Evermann, J. and Tate, M. (2014) 'Comparing the Predictive Ability of Pls and Covariance Models', in 2016, I. (ed.) *Thirty Fifth International Conference on Information Systems (Icis)*. Auckland: AISel, pp. 1–18.

Fang, Y. *et al.* (2014) 'TRUST, SATISFACTION, AND ONLINE REPURCHASE INTENTION: THE MODERATING ROLE OF PERCEIVED EFFECTIVENESS OF E-COMMERCE INSTITUTIONAL MECHANISMS', *MIS Quarterly*, 38(2), pp. 407–427.

Forsyth, B. H. *et al.* (2006a) 'Methods for Translating Survey Questionnaires', in *JSM Proceedings (Survey Research Methods Section)*, pp. 4114–4119.

Forsyth, B. H. *et al.* (2006b) 'Methods for Translating Survey Questionnaires', in *JSM Proceedings (Survey Research Methods Section)*, pp. 4114–4119.

Foucault, M. (1977) *Power/Knowledge*, *Power/Knowledge: Selected Interviews and Other Writings 1972-1977*. Edited by C. GORDON. New York: Pantheon Books.

Fung, H. P. (2015) *Is there any different between 'control variable' and 'moderating variable?* Available at: www.researchgate.net/post/Is_there_any_different_between_control_variable_and_moderating_variable2 (Accessed: 25 July 2017).

Garcia-Murillo, M. (2003) 'Patchwork Adoption of ICTs in Latin America Martha', *Electronic Journal of Information Systems in Developing Countries*, 15(1), pp. 1–9.

Garson, G. D. (2016) *Partial Least Squares: Regression & Structural Equation Models*. 2016 Editi. Asheboro: Statistical Associates Publishing.

Gefen, D., Straub, D. W. and Boudreau, M.-C. (2000) 'Structural Equation Modeling and Regression : Guidelines for Research Practice', *Communications of the Association for Information Systems*, 4(October), p. 7. doi: 10.1.1.25.781.

Glendenning, C. J. and Ficarelli, P. P. (2012) *The Relevance of Content in ICT Initiatives in*

Indian Agriculture, *International Food Policy Research Institute*.

Grant, R. (CMR) (1991) 'Ressource based theory of competitive advantage: Implications for strategy formulation', pp. 1–3. doi: 10.1017/CBO9781107415324.004.

Groeneveld, R. A. and Meeden, G. (1984) 'Measuring Skewness and Kurtosis', *Journal of the Royal Statistical Society*, 33(4), pp. 391–399.

GSMA (2012) *Annual Report 2012 The GSMA Mobile Money for the Unbanked Team*. London. Available at: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2012/10/2012_MMU_Annual-Report.pdf.

GSMA (2015) *Case study: Orange Senekela, Mali*. doi: 10.1016/S1360-8592(98)80013-2.

Gupta, S. (2014) 'SEM for Experimental Designs : An Information Systems Example', *Electronic Journal of Business Research Methods*, 12(1), pp. 27–40.

Hair, J. F. *et al.* (2014) 'Partial least squares structural equation modeling (PLS-SEM)', in *Sage Publisher*. Emerald Group Publishing Limited, pp. 1–329. doi: 10.1108/EBR-10-2013-0128.

Hair, J. F., Ringle, C. M. and Sarstedt, M. (2011) 'PLS-SEM: Indeed a Silver Bullet', *The Journal of Marketing Theory and Practice*, 19(2), pp. 139–152. doi: 10.2753/MTP1069-6679190202.

Han, W. *et al.* (2015a) 'CAMPUS EMERGENCY NOTIFICATION SYSTEMS: AN EXAMINATION OF FACTORS AFFECTING COMPLIANCE WITH ALERTS', *MIS Quarterly*, 39(4), pp. 909–929.

Han, W. *et al.* (2015b) 'CAMPUS EMERGENCY NOTIFICATION SYSTEMS: AN EXAMINATION OF FACTORS AFFECTING COMPLIANCE WITH ALERTS', *MIS Quarterly*, 39(4), pp. 909–929.

Harindranath, G. and Berna, G. (2009) *Challenges of ICT Adoption by South African SMEs : A study of Manufacturing and Logistics Firms*, *Royal University of London*.

Harkness, J. a. (2000) *Round 4 ESS translation strategies and procedures*, *Retrieved April*.

Harrod, J. and Jamsen, P. (2010) 'Farmer Organizations Work Better with ICT', in *ICT in Agriculture: Connecting Smallholders to Knowledge, Networks, and Institutions*, pp. 173–202.

Hatakka, M. and De, R. (2011) 'Development, capabilities and technology: an evaluative framework', *… Developing Countries: Partners for Development …*, (May 2011). Available at: http://www.diva-portal.org/smash/record.jsf?pid=diva2:486303.

Haug, R. and Tumbo, S. (2016) 'Mobile learning bridging the gap in agricultural extension service delivery: Experiences from Sokoine University of Agriculture, Tanzania Camilius Sanga and Malongo Mlozi Sokoine University of Agriculture, Tanzania', *International Journal of Education and Development using Information and Communication*

Technology, 12(3), pp. 108–127.

Heeks, R., Gao, P. and Ospina, A. (2010) 'Delivering Coherent ICT Policies in Developing Countries', *eDevelopment Briefing No 14*, (14), pp. 1–4.

Heeks, R. and Krishna, S. (2016) 'ICTS AND HOPE FOR DEVELOPMENT: A THEORETICAL FRAMEWORK', *Electronic Journal of Information Systems in Developing Countries*, 77(4), pp. 1–19.

Heeks, R. and Molla, A. (2009) *Development Informatics Compendium of Approaches, Assessment*. Manchester. Available at: http://www.sed.manchester.ac.uk/idpm/research/publications/wp/di/index.htm.

Heeks, R. and Molla, A. (2009) *Impact Assessment of ICT-for-Development Projects: A Compendium of Approaches*, *Development Informatics Working Paper No 36*. Available at: http://www.sed.manchester.ac.uk/idpm/research/publications/wp/di/index.htm.

Henseler, J. (2010) 'On the convergence of the partial least squares path modeling algorithm', *Computational Statistics*, 25(1), pp. 107–120. doi: 10.1007/s00180-009-0164-x.

Henseler, J. *et al.* (2014) 'Common Beliefs and Reality About PLS: Comments on Ronkko and Evermann (2013)', *Organizational Research Methods*, 17(2), pp. 182–209. doi: 10.1177/1094428114526928.

Henseler, J., Hubona, G. and Ash, P. (2016) 'Using PLS path modeling in new technology research : updated guidelines', *Industrial Management & Data Systems*, 116(1), pp. 2–20. doi: 10.1108/IMDS-09-2015-0382.

Henseler, J., Ringle, C. M. and Sarstedt, M. (2014) 'A new criterion for assessing discriminant validity in variance-based structural equation modeling', *Journal of the Academy of Marketing Science*, 43(1), pp. 115–135. doi: 10.1007/s11747-014-0403-8.

Hodge, V. J. and Austin, J. (2004) 'A Survey of Outlier Detection Methodoligies', *Artificial Intelligence Review*, 22(1969), pp. 85–126. doi: 10.1007/s10462-004-4304-y.

Hoffmeyer-Zlotnik, J. H. P. and Harkness, J. A. (2006) *Methodological Aspects in Cross-National Research*. Edited by J. H. P. Hoffmeyer-Zlotnik and J. A. Harkness. Mannheim: Druck & Kopie Hanel. doi: 16,19.

Hreats, A. V. V. A. T., Becker, J. and Ringle, C. M. (2013) 'DISCOVERING UNOBSERVED HETEROGENEITY IN STRUCTURAL EQUATION MODELS TO AVERT VALIDITY THREATS', *MIS Quarterly*, 37(3), pp. 665–694.

Hsieh, J. J. P. and Petter, S. (2012) 'IMPACT OF USER SATISFACTION WITH MANDATED CRM USE ON EMPLOYEE SERVICE QUALITY', *MIS Quarterly*, 36(4), pp. 1065–1080.

Hussein, R. *et al.* (2007) 'The influence of Organizational Factors on Information Systems

Success in E-Government Agencies in Malaysia', *The Electronic Journal on Information Systems in Developing Countries*, 29(1), pp. 1–17.

IFDC (2004) *Le marche des Intrants au Mali, Burkina Faso et Ghana*. Bamako. Available at: http://fsg.afre.msu.edu/promisam_2/references/IFDC_2004_Marche_Intrants_Mali_Burkina_Ghana.pdf.

Ifinedo, P. (2015) 'The Moderating Effects of Age and Computer Knowledge on Nurses ' Acceptance of Information Systems : A Canadian Study', in. International Conference on Information Resources Management (CONF-IRM). Available at: http://aisel.aisnet.org/confirm2015/29%0AThis.

INSTAT (2014) *ENQUETE NATIONALE AUPRES DES MENAGES (EMOP) RAPPORT D ' ANALYSE PREMIER PASSAGE 2014 POPULATION*. Bamako. Available at: http://www.instat-mali.org/contenu/eq/rana14pas1_eq.pdf.

INSTAT (2015) *INSTITUT NATIONAL AUPRES DES MENAGES (EMOP) RAPPORT D ' ANALYSE PREMIER PASSAGE 2015*. Bamako. Available at: http://www.instat-mali.org/contenu/eq/rana15pas1_eq.pdf.

Issa FOFANA (2010) *Memoire Online - L'utilisation de téléphone mobile et dynamiques des acteurs dans l'espace urbain de Bamako - Issa FOFANA*. Gaston Berger. Available at: http://www.memoireonline.com/10/12/6176/Lutilisation-de-telephone-mobile-et-dynamiques-des-acteurs-dans-lespace-urbain-de-Bamako.html.

Ituma-aleke, B. and Egwu, P. (2014) 'Social Network Adaptation , a Panacea to Information and Communication Technologies (ICTs), Innovation Diffusion : the Case of Small Scale Agribusinesses in Less Developed Countries', in *UK Academy for Information Systems Conference Proceedings*. AIS Electronic Library. Available at: http://aisel.aisnet.org/ukais2014/55.

Jacobs, R. L. (2011) *Developing a Research Problem and Purpose Statement*. FIRST EDIT. Edited by T. S. Rocco and T. Hatcher. San Francisco: Jossey-Bass.

Jarvis, C. B., Mackenzie, S. B. and Podsakoff, P. M. (2012) 'THE NEGATIVE CONSEQUENCES OF MEASUREMENT MODEL MISSPECIFICATION: A RESPONSE TO AGUIRRE-URRETA AND MARAKAS', *MIS Quarterly*, 36(1), pp. 139–146.

Joanes, D. N. and Gill, C. A. (1998) 'Comparing measures of sample skewness and kurtosis', *Journal of the Royal Statistical Society: Series D (The Statistician)*. Blackwell Publishers Ltd, 47(1), pp. 183–189. doi: 10.1111/1467-9884.00122.

Johnston, A. C., Warkentin, M. and Siponen, M. (2015) 'AN ENHANCED FEAR APPEAL RHETORICAL FRAMEWORK: LEVERAGING THREATS TO THE HUMAN ASSET THROUGH SANCTIONING RHETORIC', *MIS Quarterly*, 39(1), pp. 113–134.

Jorge, C. M. H. *et al.* (2003) 'Use of the ICTs and the perception of e-learning among University Students : a Differential Perspective according to Gender and Degree Year

Group .', *Interactive Educational Multimedia*, 7(7), pp. 13–28.

Kaba, B., Diallo, A. and Plaisent, M. (2006) 'Explaining the factors influencing cellular phones use in Guinea', *The Electronic Journal of Information Systems in Developing Countries*, 28(3), pp. 1–7. Available at: http://www.ejisdc.org/ojs2../index.php/ejisdc/article/view/341.

Kaddu, S. B. (2011) *INFORMATION AND COMMUNICATION TECHNOLOGIES' (ICTs) CONTRIBUTION TO THE ACCESS AND UTILISATION OF AGRICULTURAL INFORMATION BY THE RURAL WOMEN IN UGANDA*. Makerere University.

Kameswari, V. L. V., Kishore, D. and Gupta, V. (2011) 'ICTs for agricultural extension: a study in the Indian Himalayan region', *Electronic Journal of Information Systems in Developing Countries*, 48(3), pp. 1–12.

Kankanhalli, A., Ye, H. (Jonathan) and Teo, H. H. (2015) 'COMPARING POTENTIAL AND ACTUAL INNOVATORS: AN EMPIRICAL STUDY OF MOBILE DATA SERVICES INNOVATION', *MIS Quarterly*, 39(3), pp. 667–682.

Kante, M., Chepken, C. and Oboko, R. (2017) 'Methods for translating ICTs ' survey questionnaire into French and Bambara', in *Knowledge and Innovation for Social and Economic Development*. Njoro: Egerton University.

KANTE, M. and Myagro (2016) 'Synthese sur Maigro'. Bamako.

Kante, M., Oboko, R. and Chepken, C. (2016) 'Factors affecting the use of ICTs on agricultural input information by farmers in developing countries', *AIMS Agriculture and Food*, 1(3), pp. 315–329. doi: 10.3934/agrfood.2016.3.315.

Kante, M., Oboko, R. and Chepken, C. (2017) 'INFLUENCE OF PERCEPTION AND QUALITY OF ICT-BASED AGRICULTURAL INPUT INFORMATION ON USE OF ICTS BY FARMERS IN DEVELOPING COUNTRIES: CASE OF SIKASSO IN MALI', *Electronic Journal of Information Systems in Developing Countries*, 83(9), pp. 1–21. Available at: ejisdc.org.

Kapoor, K., Dwivedi, Y. K. and Williams, M. D. (2013) 'Role of Innovation Attributes in Explaining the Adoption Intention for the Interbank Mobile Payment Service in an Indian Context', in Brooks, L., Wainwright, D., and Wastell, D. (eds) *SOCIAL INFORMATION SYSTEMS*. Oxford: UK Academy for Information Systems Proceedings 2013, pp. 203–220. doi: 10.1007/978-3-642-38862-0.

Kilima, F. T. M., Sife, A. S. and Sang, C. (2016) 'Factors Underlying the Choice of Information and Communication Technologies among Small holder Farmers in Tanzania International Journal ICT Research', *International Journal of Computing and ICT Research*, 10(2), pp. 41–60.

Kinyangi, A. A. (2014) *Factors influencing the adoption of agricultural technology among smallholder farmers in kakamega north sub-county , kenya*. University of Nairobi.

Kiwanuka, A. (2015) 'Acceptance Process : The Missing Link between UTAUT and Diffusion of

Innovation Theory', *American Journal of Information Systems*, 3(2), pp. 40–44. doi: 10.12691/ajis-3-2-3.

Kline, R. B. (2013) *Principales and practice of Strutural equation modeling*. third, *Guilford Publications*. third. London: THE GUILFORD PRESS. doi: 10.1017/CBO9781107415324.004.

Kondo, F. N., Ishida, H. and Ghyas, Q. M. (2013) 'A DIFFERENCE BETWEEN JAPAN AND THE US IN THE CUSTOMER SATISFACTION MODEL FOR MOBILE UTILITARIAN INFORMATION SERVICES', in ICMB (ed.) *International Conference on Mobile Business International*. AISel, pp. 181–192.

KTM (2013) *Kenya Markets Trust - Agricultural Inputs*. Available at: http://www.kenyamarkets.org/what-we-do/the-market-assistance-programme/agricultural-inputs (Accessed: 18 January 2016).

de la Rive Box, J. *et al.* (2015) *Finance for Smallholders Colophon*. Available at: http://www.inclusivefinanceplatform.nl/documents/finance for smallholders- case studies report_1.pdf.

Li, L. (2010) 'A critical review of technology acceptance literature', *Southwest Decisino Sciences Institute*, p. 22. Available at: http://www.swdsi.org/swdsi2010/SW2010_Preceedings/papers/PA104.pdf.

Lim, S. *et al.* (2009) 'Theories Used in Information Systems Research : Identifying Theory Networks in Leading IS Journals', in ICIS (ed.) *International Conference on Information Systems*. AISel, p. 10. Available at: http://aisel.aisnet.org/icis2009.

Lio, M. and Liu, M. C. (2006) 'ICT and agricultural productivity: Evidence from cross-country data', *Agricultural Economics*, 34(3), pp. 221–228. doi: 10.1111/j.1574-0864.2006.00120.x.

Lwoga, E. T. (2010) 'BRIDGING THE AGRICULTURAL KNOWLEDGE AND INFORMATION DIVIDE: THE CASE OF SELECTED TELECENTERS AND RURAL RADIO IN TANZANIA', *Electronic Journal of Information Systems in Developing Countries*, 43(6), pp. 1–14.

Lwoga, E. T., Stilwell, C. and Ngulube, P. (2011) 'Access and use of agricultural information and knowledge in Tanzania', *Library Review*, 60(5), pp. 383–395. doi: 10.1108/00242531111135263.

MacVaugh, J. and Schiavone, F. (2010) 'Limits to the diffusion of innovation: A literature review and integrative model', *European Journal of Innovation Management*, 13(2), pp. 197–221. doi: 10.1108/14601061011040258.

MAIGA, A. (2009) *Community Telecentres in Mali*, *Telecentre.org*. Bamako. Available at: afriklinks.org.

Majchrzak, A., Wagner, C. and Yates, D. (2013) 'THE IMPACT OF SHAPING ON KNOWLEDGE REUSE FOR ORGANIZATIONAL IMPROVEMENT WITH WIKIS', *MIS Quarterly*, 37(2), pp.

455–469.
March, S. T. and Smith, G. F. (1995) ‘Design and Natural Science Research on Information Technology.’, *Decision Support Systems*, 15, pp. 251–266. Available at: http://search.ebscohost.com/login.aspx?direct=true&db=epref&AN=DSS.AE.BEA.MARCH.DNSRIT&site=ehost-live.

Marett, K., Otondo, R. F. and Taylor, G. S. (2013) ‘ASSESSING THE EFFECTS OF BENEFITS AND INSTITUTIONAL INFLUENCES ON THE CONTINUED USE OF ENVIRONMENTALLY MUNIFICENT BYPASS SYSTEMS IN LONG-HAUL TRUCKING’, *MIS Quarterly*, 37(4), pp. 1301–1312.

Marsh, H. W. *et al.* (2014) ‘Exploratory structural equation modeling: an integration of the best features of exploratory and confirmatory factor analysis.’, *Annual review of clinical psychology*, 10(Mimic), pp. 85–110. doi: 10.1146/annurev-clinpsy-032813-153700.

Maumbe, B. M. and Okello, J. (2010) ‘Uses of Information and Communication Technology (ICT) in Agriculture and Rural Development in Sub-Saharan Africa: Experiences from South Africa and Kenya’, *International Journal of ICT Research and Development in Africa*, 1(1), pp. 1–22. doi: 10.4018/jictrd.2010010101.

Meera, S. N., Jhamtani, A. and Rao, D. U. M. (2004) ‘INFORMATION AND COMMUNICATION TECHNOLOGY IN AGRICULTURAL DEVELOPMENT : A COMPARATIVE ANALYSIS OF THREE PROJECTS FROM INDIA Shaik . N . Meera , Anita Jhamtani , and D . U . M . Rao’, *Agricultural Research & Extension Network*, (135), pp. 2–15.

Michael D Myers and David Avison (1997) ‘Qualitative Research in Information Systems’, *MIS Quarterly*, 22(2), pp. 241–242. Available at: www.qual.auckland.ac.nz.

Mittal, S. and Mehar, M. (2012) ‘How Mobile Phones Contribute to Growth of Small Farmers ? Evidence from India’, *Quarterly Journal of International Agriculture*, 51(3), pp. 227–244.

Msoffe, G. E. P. and Ngulube, P. (2016) ‘Agricultural Information Dissemination in Rural Areas of Developing Countries : A Proposed Model for Tanzania’, *Electronic Journal of Information Systems in Developing Countries*, 26(2), pp. 169–187.

Mueller, B. and Urbach, N. (2013) ‘THE WHY, WHAT, AND HOW OF THEORIES IN IS RESEARCH’, in ICIS (ed.) *Thirty Fourth International Conference on Information Systems*. Milan: AISel, pp. 181–192.

Müller-Bloch, C. and Kranz, J. (2015) ‘A Framework for Rigorously Identifying Research Gaps in Qualitative Literature Reviews’, in *Thirty Sixth International Conference on Information Systems*. ICIS, pp. 1–19.

Murage, A. *et al.* (2013) ‘Potential uptake determinants of climate-smart push-pull technology in drier agro-ecological zones of eastern Africa’, in *the 4th International Conference of the African Association of Agricultural Economists,* p. 24. Available at: http://ageconsearch.umn.edu/bitstream/161511/2/Murage A.W., Midega C.A.O, Pittchar J.O., Khan Z.R.pdf.

Mwombe, S. O. L. *et al.* (2014) 'Evaluation of Information and Communication Technology Utilization by Small Holder Banana Farmers in Gatanga District, Kenya', *Journal of Agricultural Education and Extension*, 20(2), pp. 247–261. doi: 10.1080/1389224X.2013.788454.

Myagro (2016) *Myagro*, *myagro.org*. Available at: http://www.myagro.org/meet-our-farmers/ (Accessed: 2 December 2015).

Nakasone, E., Torero, M. and Minten, B. (2014) 'The Power of Information: The ICT Revolution in Agricultural Development', *Annual Review of Resource Economics*, 6(1), pp. 533–550. doi: 10.1146/annurev-resource-100913-012714.

Ndiege, J. R. A., Wayi, N. and Herselman, M. E. (2012) 'QUALITY ASSESSMENT OF INFORMATION SYSTEMS IN SMES: A STUDY OF ELDORET, KENYA', *Electronic Journal of Information Systems in Developing Countries*, 51(2), pp. 1–23.

Njelekela, C. and Sanga, C. (2015) 'Contribution of Information and Communication Technology in Improving Access to Market Information among Smallholder Farmers: The case study of Kilosa District', *International Journal of Management Science and Information Technology*, (17), pp. 56–71.

Odhiambo, F. (2014) 'Unlocking the market', in CTA (ed.) *Revolutionising finance for agri-value chains*. Nairobi: ICT4AG. Available at: http://ictupdate.cta.int/Feature-Articles/Unlocking-the-market.

Oodhue, G. *et al.* (2012) 'WHEN IMPRECISE STATISTICAL STATEMENTS BECOME PROBLEMATIC: A RESPONSE TO GOODHUE, LEWIS, AND THOMPSON', *MIS Quarterly*, 36(3), pp. 717–728.

Orange (2014) *services for agriculture in Africa*. Available at: www.orange.com/.../Catalogue_Orange_mAgri_JAN14_external.

Ouedrago, J. E. (2008) *evaluation des besoins en informations agricoles dans les etats du groupe afrique-caraibes-pacifique (acp), Centre Technique de cooperation Agricole et rurale (CTA)*. doi: 10.1017/CBO9781107415324.004.

Palmer, N. (2011) *Utiliser les TIC pour permettre aux petits exploitants d'accéder aux systèmes d'innovation agricole*.

Palmer, T. (2014) *mAgri Rapport initial sur Orange*. Available at: http://www.gsma.com/mobilefordevelopment/programme/magri/early-results-from-orange-senekela-data-and-insights-from-the-baseline-version-francaise-disponible.

Palmer, T. (2015) *Orange Sènèkèla Midline*. Available at: http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2015/09/GSMA_Senekela_Midline.pdf.

Pan, Y. and de la Puente, M. (2005) *Census Bureau guideline for the translation of data collection instruments and supporting materials: Documentation on how the guideline was developed*, *Survey Methodology*. Washington D.C.

Park, I., Sharman, R. and Rao, H. R. (2015) 'DISASTER EXPERIENCE AND HOSPITAL INFORMATION SYSTEMS: AN EXAMINATION OF PERCEIVED INFORMATION ASSURANCE, RISK, RESILIENCE, AND HIS USEFULNESS', *MIS Quarterly*, 39(2), pp. 317–344.

Pick, J. B. and Gollakota, K. (2010) 'Technology for rural telecenters In India: A model and exploratory study of diffusion of information for telecenter use and sustainability', in Amcis (ed.) *16th Americas Conference on Information Systems*. Lima: AISeL, pp. 3935–3946. Available at: http://www.scopus.com/inward/record.url?eid=2-s2.0-84870314918&partnerID=tZOtx3y1.

Presser, S. *et al.* (2004) *Methods for testing and evaluating survey questions*, *Public Opinion Quarterly*. doi: 10.1093/poq/nfh008.

Products, F. (2014) 'Mali Cereals Production', (August), p. 2014.

Promisam (2007) *Synthese des plans communaux de securite alimentaire du cercle de Bougouni 2007-2011*. Bamako. Available at: http://fsg.afre.msu.edu/mali_fd_strtgy/plans/sikasso/bougouni/psa_cercle_bougouni.pdf.

PROMISAM (2012) 'Plan de securite alimentaire commune rurale de Zantiebougou 2008-2012', pp. 1–17.

Pshenichnaya, N. and Clause, V. (2013) *mAgri Case Study: Nokia Life Agriculture Service*. Available at: http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2013/03/GSMAmAgri_Nokia_Case_Study.pdf.

van Raaij, E. M. and Schepers, J. J. L. (2008) 'The acceptance and use of a virtual learning environment in China', *Computers & Education*, 50(3), pp. 838–852. doi: 10.1016/j.compedu.2006.09.001.

Rezaei-Moghaddam, K. and Salehi, S. (2010) 'Agricultural specialists' intention toward precision agriculture technologies: Integrating innovation characteristics to technology acceptance model', *African Journal of Agricultural Research*, 5(March), pp. 1191–1199. doi: 10.5897/AJAR09.506.

RGPH (2013) *4 ème Récensement General de la Population et de l'Habitat du Mali (RGPH). Résultats définitifs. Tome 0: Répertoire des villages*. Bamako.

Richardson, D. (2005) 'How Can Agricultural Extension Best Harness ICTs to Improve Rural Livelihoods in Developing Countries?', *In ICT in Agriculture: Perspectives of Technological Innovation*, p. 14.

Ringle, C. M., Wende, S., and Becker, J.-M. (2015) 'SmartPLS 3'. Boenningstedt: SmartPLS GmbH. Available at: http://www.smartpls.com.

Ringle, C. M., Sarstedt, M. and Straub, D. W. (2012) 'EDITOR'S COMMENTS', *MIS Quarterly*, 36(1).

Rogers, E. M. (1983) *DIFFUSION OF Third Edition*. Third Edit. New York: Macmillan Publishing. doi: 82-70998.

Rogers, E. M. (1995) *Diffusion of innovations*, *Macmillian Publishing Co.* doi: citeulike-article-id:126680.

Rogers, E. M. (2014) *Diffusion of Innovations Theory*. doi: 10.1111/j.1467-9523.1970.tb00071.x.

Rönkkö, M., Parkkila, K. and Ylitalo, J. (2012) 'Use of Partial Least Squares as a Theory Testing Tool - An Analysis fo Information Systems Papers', in ECIS (ed.) *European Conference on Information Systems (Ecis)*. AISeL, p. Paper 145.

Rouse, A. C. and Corbitt, B. (2008) 'There ' s SEM and " SEM ": A Critique of the Use of PLS Regression in Information Systems Research', in *the 19th Australasian Conference on Information Systems (ACIS)*. Christchurch: ACIS, pp. 845–855. doi: 10.1177/1094428106296642.

Sanga, C. ., Kalungwizi, V. J. ; and Msuya, C. P. (2013) 'Building an agricultural extension services system supported by ICTs in Tanzania : Progress made , Challenges remain', *International Journal of Education and Development using Information and Communication Technology*, 9(1), pp. 80–99.

Sathye, M. *et al.* (2015) 'Determinants of intention to use mobile value added services: The case of women-owned micro enterprises in Fiji', in Kankanhalli, A., Jones, A. B., and Teo, T. (eds) *IT and Open Innovation*. Singapore: PACIS 2015 Proceedings. Available at: https://www.scopus.com/inward/record.uri?eid=2-s2.0-85011024220&partnerID=40&md5=fd60f3843dc1c59bd6a297f45a0612d9.

Saunders, M., Lewis, P. and Thornhill, A. (2009) *Research methods for business students fifth edition*. fifth. Pearson. Available at: https://is.vsfs.cz/el/6410/leto2014/BA_BSeBM/um/Research_Methods_for_Business_Students__5th_Edition.pdf.

Schmitz, K. W., Teng, J. T. C. and Webb, K. J. (2016) 'CAPTURING THE COMPLEXITY OF MALLEABLE IT USE: ADAPTIVE STRUCTURATION THEORY FOR INDIVIDUALS', *MIS Quarterly*, 40(3), pp. 663–686.

Sen, S. and Choudhary, V. (2011) 'ICT Applications for Agricultural Risk Management', *ICT in Agriculture Sourcebook*, pp. 259–284. Available at: http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:ICT+APPLICATIONS+FOR+AGRICULTURAL+RISK+MANAGEMENT#0.

Setia, P., Ventkatesh, V. and Joglekar, S. (2013) 'LEVERAGING DIGITAL TECHNOLOGIES: HOW

INFORMATION QUALITY LEADS TO LOCALIZED CAPABILITIES AND CUSTOMER SERVICE PERFORMANCE', *MIS Quarterly*, 37(2), pp. 565–590.

Silva, H. De (2008) *Using ICT to reduce transaction costs in agriculture through better communication: A case study from Sri Lanka*, *LIRNEasia, Colombo, Sri Lanka,*. Available at: http://unpan1.un.org/intradoc/groups/public/documents/UNPAN/UNPAN037348.pdf%5CnSilva_2008_Using ICT to reduce transaction costs in agriculture through better communication A case study from Sri Lanka (2).pdf.

Simin, M. and Janković, D. (2014) 'Applicability of Diffusion of Innovation Theory in Organic Agriculture', *Economics of Agriculture*, 2014(61), pp. 517–531. doi: 10.5937/ekoPolj1402517T.

Singh, M. *et al.* (2016) 'Mobile Phone Technology-An Eminent ICT Tool for Better Family Farming Mobile Phone Technology- An Eminent ICT Tool for Better Family Farming', in *Family Farming and Rural development*, pp. 287–291.

Siraj, M. (2010) *A model for ICT based services for agriculture extension in Pakistan*. Available at: http://r4d.dfid.gov.uk/PDF/Outputs/Misc_Infocomm/60818-extensionmodel-Pakistan.pdforg.

Siyao, P. O. (2012) 'Barriers in accessing Agricultural Information in Tanzania With a Gender Perspective : the Case study of small-scale sugar Cane growers in Kilombero District', *Electronic Journal of Information Systems in Developing Countries*, pp. 1–19.

Sousa, F., Nicolay, G. and Home, R. (2016) 'Information technologies as a tool for agricultural extension and farmer- to-farmer exchange: Mobile-phone video use in Mali and Burkina Faso', *International Journal of Education and Development using Information and Communication Technology*, 12(3), pp. 19–36.

Souter, D. (2010) 'ICTs and Development in Zambia : Challenges and Opportunities', *Thetha Regional ICT Discussion Forum Project*.

Staatz, J. and Temé, B. (2015) *WHAT WOULD IT TAKE TO INCREASE THE PRODUCTIVITY OF THOSE ENGAGED IN THE PRIMARY SECTOR IN MALI ? In answering the question , we need to consider :* Michigan State University. Available at: http://fsg.afre.msu.edu/srai2/What_would_it_take_to_increase_the_productivity_5.pdf.

Sukhpal, S. (Indian I. of (2004) 'Leveraging ICT for Agricultural Development: A case study of e-Choupals of ITC', *Journal of IMT*, VIII(1), pp. 1–6.

Surendran, P. (2012) 'Technology Acceptance Model : A Survey of Literature', *International Journal of Business and Social Research*, 2(4), pp. 175–178.

Sylvester, G. (2013) *Information and communication technologies for sustainable agriculture Indicators from Asia and the Pacific*. Bangkok. Available at: www.fao.org/publications.

Traoré, A. *et al.* (2011) 'Quelles évolutions des systèmes de production céréaliers au Mali ?', pp. 54–56.

Traore, S. M. *et al.* (2012) *4 ème RECENSEMENT GENERAL DE LA POPULATION ET DE L ' HABITAT DU MALI (RGPH-2009) : Etat et structure de la population*, *Institut national de la statistique*. Bamako. Available at: http://www.unfpa-mali.org/sites/default/files/Rapport_Etat_Structure_Version 22 Dec 2011.pdf.

Ueno, T. and Yoshida, K. (2012) *Nikkei BP Consulting, Inc. | Newsrelease*. Available at: http://consult.nikkeibp.co.jp/english/news/120420/ (Accessed: 1 February 2016).

United Nations Population Division (2015) *World population prospects: The 2015 revision*. The 2015 R. Edited by D. Edition. Available at: http://esa.un.org/unpd/wpp/DVD/.

Urbach, N. and Ahlemann, F. (2010) 'Structural equation modeling in information systems research using partial least squares', *Journal of Information Technology Theory and Application*, 11(2), pp. 5–40. doi: 10.1037/0021-9010.90.4.710.

Urquhart, C. and Fernández, W. (2013) 'Using grounded theory method in information systems: the researcher as blank slate and other myths', *Journal of Information Technology*, 28(3), pp. 224–236. doi: 10.1057/jit.2012.34.

Vaughan, R. (2008) 'Conceptual Framework'. Available at: bournemouth.ac.uk.

Venkatesh, V., Thong, J. Y. L. and Xu, X. (2012) 'CONSUMER ACCEPTANCE AND USE OF INFORMATION TECHNOLOGY: EXTENDING THE UNIFIED THEORY OF ACCEPTANCE AND USE OF TECHNOLOGY', *MIS Quarterly*, 36(1), pp. 157–178.

Ventkatesh, V. *et al.* (2003) 'USER A CCEPTANCE OF I NFORMATION T ECHNOLOGY : TOWARD A UNIFIED VIEW', *MIS Quarterly*, 27(3), pp. 425–478.

Villar, A. (2009) *Agreement answer scale design for multilingual surveys: Effects of translation-related changes in verbal labels on response styles and response distributions*, *Survey Research and Methodology program (SRAM)-Dissertations & Theses*. University of Nebraska. Available at: http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1002&context=sramdiss.

Wainwright, D. W. and Waring, T. S. (2007) 'The application and adaptation of a diffusion of innovation framework for information systems research in NHS general medical practice', *Journal of Information Technology*. Palgrave Macmillan UK, 22(1), pp. 44–58. doi: 10.1057/palgrave.jit.2000093.

Wang, E. T. G., Tai, J. C. F. and Grover, V. (2013) 'EXAMINING THE RELATIONAL BENEFITS OF IMPROVED INTERFIRM INFORMATION PROCESSING CAPABILITY IN BUYER–SUPPLIER DYADS', *MIS Quarterly*, 37(1), pp. 149–173.

Wang, W. . and Peng, G. . (2008) 'The service models and technical models of agricultural informationization in China', in Pacific Asia Conference on Information Systems (ed.)

Leveraging ICT for Resilient Organizations and Sustainable Growth in the Asia Pacific Region. suzhou: AIS Electronic Library (AISeL). Available at: http://www.scopus.com/inward/record.url?eid=2-s2.0-84862915402&partnerID=40&md5=521e6c1af582f3a5176d4e82a98dbf8a.

Webster, J. and Watson, R. T. (2002) 'Analyzing the Past to Prepare for the Future: Writing a Literature Review.', *MIS Quarterly*, 26(2), pp. xiii–xxiii. doi: 10.1.1.104.6570.

Weigel, F. K. *et al.* (2014) 'Diffusion of innovations and the theory of planned behavior in information systems research: A metaanalysis', *Communications of the Association for Information Systems*, 34(1), pp. 619–636. Available at: http://aisel.aisnet.org/cais/vol34/iss1/31/%5Cnpapers3://publication/uuid/75BAEF77-7E49-467E-B445-8A2FE649FBA8.

Williams, B. B. M. (2013) 'An Evaluation of the Farmer-Training Programme in Jamaica: Opportunities for use of ICTs in training delivery and in farming activities', in Systems, P. of the N. A. C. on I. (ed.) *AMCIS 2013 Proceedings*. Chicago: AISeL, pp. 1–11. Available at: http://aisel.aisnet.org/amcis2013/ICTCaribbean/RoundTablePresentations/3.

Wolfswinkel, J. F., Furtmueller, E. and Wilderom, C. P. M. (2011) 'Using grounded theory as a method for rigorously reviewing literature', *European Journal of Information Systems*. Nature Publishing Group, 22(1), pp. 45–55. doi: 10.1057/ejis.2011.51.

Wollni, M. and Qaim, M. (2014) *Traditional Food Crop Production and Marketing in Sub-Saharan Africa : The Case of Finger Millet in Western Kenya*. Gottingen. Available at: https://ediss.uni-goettingen.de/bitstream/handle/11858/00-1735-0000-0022-5E54-4/Traditional Food Crop Production and Marketing in Sub-Saharan Africa - The Case of Finger Millet in Western Kenya.pdf?sequence=1.

Wong, K. K.-K. (2014) *Partial Least Squares Structural Equation Modeling (Pls-Sem)*.

Wood, T. G. and Cowie, R. H. (2001) 'Assessment of On-Farm Losses in Cereals in Africa Due to Soil Insects', *International Journal of Tropical Insect Science*. Cambridge, UK: Cambridge University Press, 9(6), pp. 709–716. doi: 10.1017/S1742758400005580.

Woosley, J. M. and Ashia, K. (2011) 'Comparison of Contemporary Technology Acceptance Models and Evaluation of the Best Fit for Health Industry Organizations .', *International Journal of Computer Science Engineering and Technology*, 1(11), pp. 709–717.

World Bank (2011) 'ICT in agriculture: connecting amallholders to knowledge, networks, and institutions', *World*, (64605), p. 424. doi: 64605.

Wu, S. P., Straub, D. W. and Liang, T.-P. (2015) 'HOW INFORMATION TECHNOLOGY GOVERNANCE MECHANISMS AND STRATEGIC ALIGNMENT INFLUENCE ORGANIZATIONAL PERFORMANCE: INSIGHTS FROM A MATCHED SURVEY OF BUSINESS AND IT MANAGERS', *MIS Quarterly*, 39(2), pp. 497–518.

Wulystan, P. M. and Andrew, C. M. (2013) 'Using Information and Communication

Technologies for Enhancing the Accessibility of Agricultural Information for Improved Agricultural Production in Tanzania', *Electronic Journal of Information Systems in Developing Countries*, 56(1), pp. 1–14.

Wyk, B. van (2012) 'Research design and methods: Part 1'. Cape town, p. 16.

Xu, J. D., Benbasat, I. and Cenfetelli, R. T. (2014) 'THE NATURE AND CONSEQUENCES OF TRADE-OFF TRANSPARENCY IN THE CONTEXT OF RECOMMENDATION AGENTS', *MIS Quarterly*, 38(2), pp. 379–406.

Zavala-Rojas, D. (2014) *A procedure to prevent differences in translated survey items using SQP*. 38. Available at: http://www.upf.edu/survey/_pdf/RECSM_wp038.pdf.

Zewge, A. and Dittrich, Y. (2017) 'SYSTEMATIC MAPPING STUDY OF INFORMATION TECHNOLOGY FOR DEVELOPMENT IN AGRICULTURE (THE CASE OF DEVELOPING COUNTRIES)', *Electronic Journal of Information Systems in Developing Countries*, 82(2), pp. 1–25.

APPENDICES

APPENDIX 1. QUESTIONNAIRE

Questionnaire Number………………… **Date (dd/mm/yyyy): …………../………../2016**

Section A: Introduction

My name is:……………………………………………………………………………….

Thank you for accepting to complete this questionnaire. This study aims to propose an ICT model for increased adoption of agricultural input information for cereals' producer in Sikasso region. Participation in this study is voluntary, and the information will be used to advise the government, policy-making bodies and other stakeholders on how efficiently provide farm inputs information to cereal farmers in developing countries and more so in Sikasso. This information will not be used in any other way other than this.

Merci d'accepter de remplir ce questionnaire. La présente étude vise à proposer un modèle Tics pour une plus grande adoption des informations sur les intrants agricoles des producteurs de céréales de la région de Sikasso. La participation à l'étude est volontaire et l'information qui en résultera servira à conseiller le gouvernement, les organes/institution décisionnels et autres acteurs sur la manière d'offrir avec efficience les informations sur les intrants agricoles aux producteurs de céréales des pays en voie de développement et en particulier ceux de Sikasso. L'information issue de cette étude ne sera utilisée qu'à cette fin.

[illegible]

Section B: Demographic information (**Information démographique)**

1. District (Cercle): Bougouni

2. **Commune**: Zantiebougou

3. Village: Sirakoro Zantiebougou Monzondougou koloni Oure

Section C: Identification (Identification)

1. Name (nom): Surname (Prénom):………………. Age (Age):…………………
   Gender (Genre): M F
2. Are you the head of this family (Êtes-vous le chef de cette famille ?): Yes (oui) No (Non)

3. If no who are you (Sinon, qui êtes vous?): ....
4. Size of household (Taille de la famille): ....
5. Which cereals do you produce (Quelles céréales produisez-vous : Millet(Mil) ☐ Maize(Mais) ☐ Sorghum (Sorgho) ☐ Rice (Riz) ☐ Fonio (Fonio) ☐
6. Do you use ICTs to get information on agricultural inputs (Utilisez-vous les TICs pour obtenir de l'information sur les intrants agricoles)? ....
7. For how long have been using ICTs (Depuis quand ou combien de temps utilisez-vous les TIC)? Less than a year (moins d'une année) ☐ One year (une année) ☐ more than a year (Plus d'une année) ☐
8. Which ICTs do you use (Quelles TICs utilisez-vous)?

Mobile phone (Telephone portable) ☐ Telecentre (Telecentre) ☐

Section D: Moderators

1=strongly agree, 2=agree, 3= neutral, 4=disagree, and 5=strongly disagree.

LITERACY (NIVEAU D'ALPHABÉTISATION)

[illegible]

Please tick one (Veuillez Cocher une case)

[illegible]

	Yes Oui [illegible]	No Non [illegible]
1. I can read and understand alphabets letters Je peux lire et comprendre les lettres de l'alphabet [illegible]		
2. I can read to learn and apply my understanding *Je peux lire pour apprendre et appliquer cette compréhension* [illegible]		

3. I can write the alphabet letters and numbers *Je peux écrire les lettres de l'alphabet et les chiffres* [illegible]		
4. I can write a personal letter, a brief description of an event or image *Je peux écrire une lettre personnelle, une brève description d'un évènement ou d'une image* [illegible]		
5. I can fill out a simple form *Je peux remplir un formulaire simple* [illegible]		
ICT Skills (for all the respondents) / **Compétences d'utilisation des TIC (pour tous les répondants)** [illegible]	Yes (Oui) 	No (Non) 
6. I can turn on a computer *Je peux allumer un ordinateur* [illegible]		
7. I can name parts of a computer and connect devices to a computer *je peux citer les noms des parties de l'ordinateur et y brancher des appareils* [illegible]		

8. I can create, modify and delete a folder on a computer *Je peux créer, modifier et effacer un dossier sur un ordinateur* [illegible]		
9. I can use Word processing *Je peux utiliser le traitement de textes* [illegible]		
10. I have an email address, I can read and write an email *Je possède une adresse email, je peux écrire et lire un email* [illegible]		
11. I can use a browser and find online the information I am looking for *Je peux utiliser un navigateur et trouver l'information dont j'ai besoin* [illegible]		
12. I can write an SMS on a mobile phone *Je peux écrire un message SMS sur un téléphone portable* [illegible]		
13. I can a follow up procedure given by a customer care on a mobile phone *Je peux suivre une procédure donnée par un agent d'un centre d'appel sur mon téléphone* [illegible]		

14. I can take pictures with my mobile phone or download a video on my phone *Je peux prendre des photos ou télécharger une vidéo avec mon mobile.* [illegible]		

Section E: Determinants (for those who have used ICTs to adopt agricultural input information) / **Déterminants** (pour ceux qui ont utilisé les TICs pour obtenir et utiliser des informations sur les intrants agricoles)

[illegible]

Cost (Coût) / [illegible]	Please tick one Veuillez choisir [illegible] 1 2 3 4 5 ߁ ߂ ߃ ߄ ߅				
1. The transaction cost such as airtime, bundles for N'gasene/Senekela is not expensive *Les coûts de transaction tels que les cartes de recharge téléphonique (crédit), forfaits* N'gasene/Senekela *n'est pas cher* [illegible]					
2. I use N'gasene/Senekela because it is cheaper *J'utilise* N'gasene/Senekela *parcequ'ils sont moin chers* [illegible]					

3. Getting agricultural input information through other means such as radio, TV, community meetings, newspaper is expensive than using N'gasene/Senekela *Il est plus cher d'obtenir des informations sur les intrants agricoles à travers les media tels que la radio, la TV, les réunions communautaires, les journaux que par N'gasene/seenekela.* [illegible]					
[illegible] **Relative advantage / Avantage relative/**	1 ߁	2 ߂	3 ߃	4 ߄	5 ߅
4. N'gasene/Senekela is better than using books or newspaper to get AIIagricultural input information *Les* N'gasene/Senekela *est mieux que les livres ou les journaux pour obtenir les informations sur intrants agricoles.* [illegible]					
5. N'gasene/Senekela is more interesting than other source of information that I have used to get agricultural input information N'gasene/Senekela *est plus intéressant que d'autres sources d'information que j'ai utilisée pour obtenir des informations sur les intrants agricoles* [illegible]					

6. Using N'gasene/Senekela made contribution to the access and use of agricultural input information than it would be possible without the it for me *L'utilisation* N'gasene/Senekela *a apporté une contribution à l'accès et l'utilisation de ces informations qui ne serait pas possible sans lui pour moi.* [illegible] [illegible]					
Compatibility/ Compatibilité/ [illegible]	1 ߁	2 ߂	3 ߃	4 ߄	5 ߅
7. N'gasene/Senekela is suitable to the way I like to get information to the access and use of agricultural input information *Les* N'gasene/Senekela *est conforme à la manière dont j'aimerais obtenir l'information sur les intrants agricoles* [illegible] [illegible]					
8. I think other farmers should use N'gasene/Senekela to access/use agricultural input information *Je pense que les autres agriculteurs (paysans) doivent utiliser* N'gasene/Senekela [illegible] [illegible]					
9. Using N'gasene/Senekela made what I was doing about agricultural input information seem more relevant *L'utilisation* N'gasene/Senekela *a rendu ce que je faisais concernant les informations sur les intrants plus pertinent.*					

[illegible]					
Simplicity/ Simplicité/ [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10. When using N'gasene/Senekela, I had no difficulty finding the information that I wanted *En utilisant* N'gasene/Senekela*, je n'ai eu aucune difficulté à obtenir l'information que je voulais.* [illegible]					
11. I had no difficulty understanding how to get around in N'gasene/Senekela *Je n'ai aucune difficulté à me servir de* N'gasene/Senekela. [illegible]					
12. When using N'gasene/Senekela to access agricultural input information, I had no difficulty implementing the information that I got *En utilisant les* N'gasene/Senekela *pour accéder à l'information sur les intrants agricoles, je n'ai aucune difficulté à mettre en œuvre l'information que j'ai obtenue à travers l'utilisation de* N'gasene/Senekela. [illegible]					

Observability (Observabilité) [illegible]	1 ߁	2 ߂	3 ߃	4 ߄	5 ߅
13. Other farmers seemed interested in N'gasene/Senekela when they saw me using it *Certains agriculteurs/paysans en me voyant utiliser les* N'gasene/Senekela *semblaient intéresser.* [illegible]					
14. People can tell that I know more about access and use of agricultural input information since I have used N'gasene/Senekela *Des gens peuvent témoigner que je connais mieux l'accès et l'utilisation des informations sur les intrants agricoles parce que j'ai utilisé* N'gasene/Senekela. [illegible]					
15. Other farmers using N'gasene/Senekela liked using it, i.e. they found from satisfactory *D'autres agriculteurs/paysans utilisant* N'gasene/Senekela, *les apprécient (Ils sont satisfait)* [illegible]					
Social influence (for all the respondents) / Influence sociale (pour tous les répondants) [illegible]	1 ߁	2 ߂	3 ߃	4 ߄	5 ߅
16. My neighbours (village mates, friends) think I should start using/keep using N'gasene/Senekela					

Mes voisins (compagnon de village, les amis) pensent que je dois commencer/continuer à utiliser N'gasene/Senekela. [illegible]					
17. My friends and parents use N'gasene/Senekela *Mes amis et parents utilisent* N'gasene/Senekela [illegible]					
18. Using N'gasene/Senekela makes me feel higher reputation than those who do not *Je sens que l'utilisation* N'gasene/Senekela *me confère un statut particulier que les personnes qui ne les utilisent pas.* [illegible]					
Information Quality / Qualité de l'information/ [illegible]					
19. The information I got from N'gasene/Senekela was complete, i.e. all the data necessary to meet the current need for farm input information is provided by the ICTs and correct for my need for information on agricultural input. *L'information que j'ai obtenue grâce a* N'gasene/Senekela *était complète et exacte c'est-à-dire que toutes les données nécessaires pour répondre aux besoins actuels d'information sur les intrants agricoles sont fournies par* N'gasene/Senekela *et conforme à mes besoins d'informations sur les intrants agricoles.*					

[illegible]					
20. The information I got from N'gasene/Senekela was relevant, i.e. the information is suitable for the current need, and I got it when needed it. *L'information que j'ai obtenue grâce a* N'gasene/Senekela *relative aux informations sur les intrants agricoles était pertinente c'est-à-dire qu'elle était adaptée à mes besoins actuels je l'ai reçue au moment opportun.* [illegible]					
21. The information I got from N'gasene/Senekela was appropriate i.e. in the suitable format (local language) and quantity *L'information que j'ai obtenue grâce* N'gasene/Senekela *était appropriée, c'est-à-dire qu'elle était présentée dans un format convenable et en quantité satisfaisante* [illegible]					

Section F: Endogenous variables (for those who have used ICTs to access and use agricultural input information) / *Variables endogènes*

[illegible]

	1	2	3	4	5
Use of N’gasene/Senekela **(All the respondents) / Utilisation de** N’gasene/Senekela **(Tous les répondants)./** [illegible]	߁	߂	߃	߄	߅
22. I use/plan to use N’gasene/Senekela regularly when preparing to plant my crops *J’utilise/j’envisage d’utiliser régulièrement* N’gasene/Senekela *lorsque je me prépare à planter mes cultures.* [illegible]					
23. I intend to use/continue to use N’gasene/Senekela *J’entends continuer à utiliser les* N’gasene/Senekela [illegible]					
24. I recommend farmers to use N’gasene/Senekela *Je recommande aux agriculteurs/paysans d’utiliser* N’gasene/Senekela. [illegible]					
Increased adoption ofagricultural input information (For those using ICT) / *Adoption accrue des informations sur les intrants agricoles (pour ceux qui ont utilisé les TIC pour accéder à l’information sur les intrants agricoles et l’utiliser)/* [illegible]	1 ߁	2 ߂	3 ߃	4 ߄	5 ߅
25. Before I started using N’gasene/Senekela, I found it difficult to access agricultural input information					

Avant que je ne commence à utiliser N'gasene/Senekela*, j'avais des difficultés à accéder à l'information sur les intrants agricoles* [illegible]					
26. Before I started using N'gasene/Senekela, I found it difficult to use agricultural input information *Avant que je ne commence à utiliser les* N'gasene/Senekela*, j'avais des difficultés à utiliser les informations sur les intrants agricoles* [illegible]					
27. After I started using N'gasene/Senekela, I found it easier to access agricultural input information and I have more access to agricultural input information *Après que j'ai commencé à utiliser* N'gasene/Senekela*, il est devenu plus facile pour moi d'accéder à l'information sur les intrants agricoles et j'ai plus accès a ces dites informations.* [illegible]					
28. After I started using N'gasene/Senekela, I found it easier to use agricultural input information and I have improved the use of agricultural input information *Après que j'ai commencé à utiliser les* N'gasene/Senekela*, il est devenu plus facile pour moi d'utiliser les informations sur les intrants agricoles et j'ai amélioré l'utilisation de ces dites informations.*					

[illegible] [illegible]					

APPENDIX 2. INSTRUMENT TRANSLATION AND PRE-TEST REPORT

1. Introduction

Information and Communication Technology (ICT)[8] has seen an exponential development in the dissemination of information, especially in agriculture. Researchers have used many instruments to gather data on the subject. These tools are based on some theories. The most technology acceptance models are Technology Acceptance Model (TAM), Diffusion of Innovation Theory (DOI) and the Unified Theory of Acceptance and Use of Technology (UTAUT) (Woosley and Ashia, 2011). The data collection instrument (questionnaire) of these models are in English. For other speaking languages especially French and Bambara9, these tools need to be translated. There is an increasing demand for these tools to be brought from English to other languages (Pan and de la Puente, 2005). Information on ICTs' survey translation methods or procedures is limited to the translation process from English to French and Bambara. For instance, developing a guideline for translation from English to Spanish, a study arguing that there is limited information on the translation procedure (Pan & de la Puente, 2005). Therefore, there is need to provide a method to translate ICTs' survey instrument into French and Bambara.

Factors affecting ICTs' use in accessing and using agricultural input information in developing countries was provided by researchers (Kante, Oboko and Chepken, 2016). The Diffusion of Innovation Theory was the basis of our proposed model. We need to collect data in Sikasso, Mali using the data collection instrument adapted from researchers (Ventkatesh et al., 2003; Atkinson, 2007). Nevertheless, there two remaining questions: a) Can we propose a method for translating this questionnaire into French and Bambara? b) What lessons have we learned? The literature describes two approaches, which is adoption and adaptation to translate a survey questionnaire. The adoption method is where the instrument to collect data is directly translated from the source language to the targeted one regardless to the linguistic of cultural nuances, which can impact the intended meaning of the question (Carrasco, 2003). Adaptation, on the other hand, allows the contextualization of the instrument taking into account the cultural deficiencies (Hoffmeyer-Zlotnik and Harkness, 2006). Adaptation admits and answers for any differences that exist crosswise languages.

2. Materials and Method

We used the adaptation method following the guideline of the Census Bureau guidelines (Pan and de la Puente, 2005). Using the adaptation, we modified or altered the components of the survey question for contextualization of the instrument for fielding in French and Bambara. The guidelines propose five steps in translating a questionnaire which is: Prepare, Translate, Pre-test, Revise and Document (Pan and de la Puente, 2005). However, we modified the

[8] By ICT, we mean Mobile phone and telecentres
[9] Bambara is a language spoken in Mali.

guidelines to integrate some translating rules from TRAPD (Translation, Review, Adjudication, Pre-testing and Documentation) (Harkness, 2000) and the model ASQ (Ask the Same Question (Harkness, 2000; Presser et al., 2004).

2.1. Prepare

The translation process started by establishing the statement of work, documentation and subject matter contact.

2.1.1 Statement of work

The purpose of this translation is to transfer the meaning of a questionnaire of fifty-one items in English into French and Bambara. The translation has to preserve the meaning, style and effect of the source text and at the same time respecting the sentence structure, vocabulary and meaning values of French and Bambara languages.

2.1.2 Documentation:

We defined our keys terms to the translators:

- ICT: This questionnaire refers to ICT as Information Communication Technology such as Mobile phone and telecentres.

- Household head: A head of the household is an individual in one family setting who supplies actual support and maintenance to one or more people who are connected to him/her (Advameg, 2016). Domestic units are barely limited to the nuclear family in ‘collectivist societies’ that characterise most societies of developing countries. The household head will be someone who is leading the agricultural activities of the family and therefore using ICTs in this questionnaire. In other words, it is an informant.

- Relative advantage: Relative advantage (or superiority) is the degree to which an innovation is perceived as being better than the idea it supersedes (Rogers, 1983), and is often expressed in this questionnaire regarding convenience and/ or satisfaction (Adegbidi *et al.*, 2012).

- Compatibility: It is the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters (Rogers, 1983).

- Complexity/Simplicity: complexity is the degree to which an innovation is perceived as relatively easy to understand and use (Rogers, 1983).

- Observability: Observability, also known as communicability, demonstrability or describability, is the degree to which results of an innovation are visible to others (Adegbidi *et al.*, 2012).

- Social Influence: It is defined as the degree to which an individual perceives that important others believe he or she should use the new system (Ventkatesh *et al.*, 2003).

2.1.3: Subject-matter contact: Translators had access to one of the authors for further explanation.

2.2. Translate

The committee or team approach has gained exposure in the literature for survey translation (Harkness, 2000; Presser et al., 2004; Pan and de la Puente, 2005). We formed our translation team constituted of two translators for each language. The two translators of each language worked independently to produce the target language translation. The subject-matter contact was the translation coordinator for each one of the languages. The translators documented their work so that we could see their specific challenges and their decisions to deal with these difficulties. The two translators and the coordinator reviewed the translation together. Where the translator identified a problem, the coordinator suggested a solution and the three could agree on it or reject it. A first document was then accepted for each language.

2.3 Pre-test:

The widely pretesting technique cognitive interview applies for the pre-test of translated language data collection instrument (Pan and de la Puente, 2005). Cognitive interviews are structured, open-ended interviews, designed to gather detailed information about the cognitive thought processes respondents use to understand and answer survey questionnaire (Presser et al., 2004). We produced an English language cognitive interview. One respondent, skilled in the field of ICT4D (ICT for Development) studies were selected for each language. He/she was asked to describe the way he/she comprehended particular question and answer to see if he had difficulty in recalling.

2.4 Revise

With the cognitive interview pre-test, we revised the first document to get a new one. That was the second paper for each targeted language.

2.5 Document

We described all of these steps in the document. A document was produced by each one of the translators, the team coordinator. The minutes of the meetings were also documented.

3. Results

This process led us to produce a questionnaire that could be filled by an English speaker, a French or a Bambara speaker. Our translation process provided some lessons (Table 1).

Table I: Lessons from the translation process

Language	Translation errors	Cultural issues	General problems
French	We had to decide between two or three French words for one English word. The choice was based on the results of our cognitive interview. For instance, the English word 'can' could be translated into French as "can" or "know". We chose can as "can" in some items and "know" in some others based on	Issues related to differences in cultural viewpoint were infrequent. Only one item made an exception. The item was "Using ICT on agricultural	The biggest problem came out with choice of "article" such as "the", "a"; "determiner/pronoun" such as "this", "those". We used the grammar and vocabulary as well as the cognitive interview

	the results of the cognitive interview. The sentence structure was also an issue during the process. The sentence was constructed in such a way that it was free of spelling and grammatical errors. Doing so, ten items structure was changed but with the same meaning.	input information makes me feel higher in reputation than those who do not use it". That was not appropriate for the Malian culture. So, we changed it "I feel that using ICT on agricultural input information gives me a particular status than those who do not use it".	to decide which word to use.
Bambara (NKO)	The main issue was that the English or even French "word(s)" does not have their equivalent in Bambara. For instance, the abbreviation "ICT" is very hard to translate in Bambara; we, therefore, decided to use the name of the ICT services in the area as ICT. Thereby, "Senekela" or "Ngasene" meant ICT on agricultural input information as these are the only ICTs operating in the area. As the writing system strongly differs from English or French, the sentence construction also was different. That made all the items sentence structure to change but giving out the meaning intended by the sentence.	The cultural viewpoints were frequent in Bambara. While the future tense appeared in an item, we had to add "By God/Allah willing. For instance, the item 46 in English was "I intend to use/continue to use ICT on agricultural input information", and in Bambara, we added, "By Allah's willing, I intend to use/continue to use ICT on	The general issue once again was how to translate the "articles" or "determinant". There is no "article" in NKO used to write the Bambara language in this instrument. The "noun" is divided into two parts, and one of it is the "article" (Davydov, 2005). The main issue coming out from the translators was related to the tense. We adopted wherever needed, the advice from the coordinator.

	agricultural input information”.

4. Discussion and Conclusion

We believe that our methods for translating English survey instrument on ICTs into French and Bambara formed an effective translation. It proposed five steps that are Prepare, Translate, Pre-test, Revise and Document. The method was different to that of another research (Forsyth et al., 2006b). Although, the cognitive interview and reviews were similar to that research. We have improved the guidelines of the Census Bureau Guidelines (Pan and de la Puente, 2005) by integrating into it the method ASQ (Ask the Same Question (Harkness, 2000) and the TRAPD (Translation, Review, Adjudication, Pre-testing and Documentation) method (Harkness, 2000). Our translated instrument in Bambara is one of the rare translated survey instrument on ICTs. We learned that ICTs’ survey instruments translation should be done regarding the culture of the target population language. Also, due to the absence of some terms in local languages, the term ICT can be replaced by the name of an ICT’s service in the area. We are currently conducting research in Mali with this instrument. A further line of inquiry could be to test the method or to modify it taking into account some cultural viewpoints of others local languages.

Acknowledgement

We would like to thank the translation teams and respondents of the cognitive interviews. We also thank Adama Coulibaly for his assessment of the translation.

APPENDIX 3. PILOT STUDY REPORT

1. Introduction

Agriculture constitutes the backbone of the economy of developing countries. For instance, it was argued that agriculture is the mainstay of the economy of Ethiopia (Bwalya, Asenso-Okyere and Tefera, 2012), Mali (Angelucci *et al.*, 2013) and Tanzania (Siyao, 2012).

Small-scale farmers dominate the agricultural activities in developing countries. Small-scale farmers dominate for instance the Tanzanian agriculture (Siyao, 2012). In addition, in Mali, the agriculture sector is dominated by small family farms (68%) (Angelucci *et al.*, 2013). Moreover, in Ethiopia, in the year 2010/11, over 96 percent of cereals were produced by smallholder farmers (Bwalya, Asenso-Okyere and Tefera, 2012).

Cereals constitute the main food item in these countries. For instance, in Mali, cereals constitute the main part of the agricultural production (millet 41%, maize and rice 15%, sorghum 26%, fonio 3%) which occupy 72% of the total agricultural area (Aparisi and Balie, 2013). It is a defining economic activity for the majority living in the countryside, with small-scale farming dominating production (Aparisi and Balie, 2013). Cereal crops are essential for food security in Africa (developing countries (Murage *et al.*, 2013).

Nevertheless, these agricultural activities are marked by low productivity ((IFDC, 2004)-(Products, 2014)-(AGRA, 2014)). Agricultural inputs such as seeds, fertiliser and advice are essential to increase yields and hence production.

Durable agricultural intensification cannot be achieved without a greater adoption of appropriate (agricultural) inputs, which permit the growth of the yield (IFDC, 2004). That was also confirmed by another researcher (Kinyangi, 2014) who argued that the use of agricultural technologies (farm inputs) affect the rate of increase in agricultural output. In general, farmers could realise higher yields if they access and use agricultural inputs.

Agricultural inputs access and use depend largely on the availability of information. For instance, in Tanzania, farmers’ decision to adopt input is greatly influenced by the amount of information that is available (Msoffe and Ngulube, 2016). Moreover, the experience of some of the rapidly growing economies such as China has shown that improvement in information services was one of the strategies used to achieve agricultural transformation (Siyao, 2012). Therefore, ICTs have a determinant role in the dissemination of agricultural input information. Moreover, well-informed farmers make wise decisions, which in turn are responsible for improving agricultural productivity.

1.1. Background Information

ICT on Agricultural Input Information (AII) is any ICT resource that allows farmers to access, send and utilise information on agricultural inputs. Agricultural input information is on crop planning (identify the best time to plant, higher yield crops information), buying seeds (seed diverseness, the source of inputs), planting (use better fertiliser, apply better techniques) (Aker, 2011).

The most dominantly used ICT channel to get access to agricultural information in Mali and elsewhere is the mobile phone. The mobile phone was introduced in Mali in the 1990s with only one telecom operator. The use of mobile telephone has grown since then regarding a number of network providers, coverage, subscriptions and services offered. For instance, in 1999, there were 6,375 mobile phone subscribers, 4.5 million subscribers in 2009 and 10.3 million in 2014 (Issa FOFANA, 2010; GSMA, 2015).

ICT services on a mobile phone for farmers started in 2013. Orange Mali (telecom operator) launched the ICT Value Added Service (VAS) Senekela in 2014 in the region of Sikasso. Myagro (N'gasene), another ICT service for farmers started to disseminate information on agricultural input for farmers in 2011. The service is concentrated in the region of Sikasso. These are the two ICT services disseminating agricultural input information in Mali towards cereal producers.

Senekela relies on a call-centre with agronomists who advise the farmers – in French and Bambara (A local language) – on all their daily questions in the agricultural domain including planting methods, the seeds to use, sowing time and application of fertilisers. The service had 180,000 customers in 2014 (GSMA, 2015).

Myagro enables farmers to purchase high-quality agricultural inputs (certified seeds and fertiliser) on layaway (agreement in which the seller reserves an item for a consumer until the consumer completes all the payments necessary to pay for that item) through an SMS-based platform and a network of local vendors. It helps farmers to get information that would increase their crop yields by using modern planting techniques and providing access to simple agricultural machines that can make their work more efficient and effective and eventually enhance their profitability. The service started with approximately 3,500 customers. It has reached over 18,000 customers by the year 2016.

1.2. Study Objectives

The main aim of this study was to propose an ICTs model for cereal farmers in accessing and using agricultural input information in developing countries.

The specifics objectives are:

a. To validate the survey instrument;

b. To establish the model predictability.

1.3. Literature review

ICTs have been set up in developing countries such as India, Indonesia, Pakistan, China, Tanzania, Uganda, Zambia, Uganda, Benin, Nigeria, Burkina Faso and Mali (Kante, Oboko and Chepken, 2016) to disseminate agricultural input information. Therefore, farmers have been exposed to ICT on agricultural input information.

In spite the availability of diverse communication channels, access and use of agricultural input information services. For instance, the main challenge faced by many (cereal) farmers in Mali is access to selected seeds and fertilisers (de la Rive Box *et al.*, 2015). In addition, KTM (2013) concluded that in Kenya, still, an improvement is necessary since a large number of smallholder farmers (3.5 million) work without basic farm inputs. Moreover, in Tanzania, ICTs have not benefited the agricultural sector (Wulystan and Andrew, 2013).

Previous studies ((AGRA, 2014)-(Aker, 2011)-(Msoffe and Ngulube, 2016)-(Rezaei-Moghaddam and Salehi, 2010)-(Sanga, Kalungwizi and Msuya, 2013)) concur that ICTs contribution to access and use of agricultural (input) information would be applicable to farmers in developing countries only if certain conditions were met. Without addressing these conditions (factors) and finding the way to overcome them, there will be less use of ICTs to access and use information on agricultural inputs. Therefore, farmers will not adopt agricultural inputs resulting in a low productivity.

In conclusion, though efforts have been made to apply ICTs in the farm input information sector, the contribution of ICTs to the access and use of agricultural input information is far from expectation. It was emphasised that ICTs have not yet been able to create an impact as expected (Mittal and Mehar, 2012). An investigation needs to be conducted into these factors affecting farmers' access and use of agricultural inputs and their relationships (hence a model) to inform the design and delivery of this information service to small-scale cereal growers.

Studies picked out that the perception of ICTs by farmers influence their use of ICTs. For instance, in Kenya, it was emphasised that farmers found the access to production information via mobile phone complicated (Odhiambo, 2014). In Tanzania, a study noticed that the use of agricultural value added service (VAS) known as Tigo Kilimo[10] was difficult for farmers (Chung, 2015). The same observation was made in Mali (Palmer, 2014). Finally, in Benin, researchers conclude that the use of ICT needs positive attitude from the actors (Adegbidi *et al.*, 2012). Therefore, farmers' perception of ICTs is a factor in the use of ICT on agricultural input information and this study will identify its effects on the use of ICT on agricultural input information.

Farmers are known to share information among themselves. Previous studies have highlighted that fact. For instance, it was argued that the primary sources of information for farmers were predominantly local (neighbours, friends and family) (Lwoga, 2010). Therefore, the interaction among farmers affects ICTs' use.

The content delivered to farmers is important to them. For instance, it was reported that farmers voiced the need to improve the quality, reliability and timeliness of the information delivered to them (Mittal and Mehar, 2012). Information is seen as a valuable and useful tool to people in their attempts to cope with life, but the value of information depends on many conditions including accessibility, relevance, accuracy and currency ((Chilimo and Sanga, 2006)-(Heeks and Alemayehu Molla, 2009)). Therefore, it is important for information providers to ensure that they disseminate information that satisfies farmers' need and is appropriate to their farming practices (Msoffe and Ngulube, 2016). A farmer who is satisfied with information will keep using ICTs to get information on agricultural inputs, thus leading to an adoption or use of agricultural inputs.

1.3.1. Farmers' Perception

[10] Tigo Kilimo is an ICTs' service in Tanzania that disseminates agricultural (input) information

ICTs' use depends on the perceptions of the user. It was highlighted by many studies on ICTs adoption/use in different fields such as education (Jorge *et al.*, 2003), health (Atkinson, 2007), agriculture (Kameswari, Kishore and Gupta, 2011), e-government (Carter and Belanger, 2004) and others.

The perceived attitudes (relative advantage, simplicity, observability, compatibility and trialability) are critical in the adoption and use of ICTs/Innovation(Rogers, 1983). However, it was emphasised that compatibility, relative advantage and complexity are the most perceived construct in the use of ICTs (Carter and Belanger, 2004). Moreover, conducting a literature review on ICT on Agricultural Input Information (AII) in developing countries over the last 15 years, researchers found empirical evidence of these factors as affecting the use of ICTs on AII (Kante, Oboko and Chepken, 2016). We hypothesise that:

H1. Relative advantage has a positive effect on the use of ICTs on AII.

H2. Compatibility has a positive effect on the use of ICTs on AII

H3. Simplicity has a positive effect on the use of ICTs AII.

1.3.2. Farmers' Influence on Each Other

Any community is composed of people who interact on a regular basis around a common set of issues, interests or needs (Benard, 2013). That was also emphasised by other researchers whose findings conclude that 67% of farmers found families, friends and neighbours' information very effective (Lwoga, Stilwell and Ngulube, 2011). Therefore, sharing of information accessed through ICTs is a major key to the success of that source (ICT) of information.

A study on ICTs service (Senekela) in Mali observed that almost all users interviewed in the field said that other farmers come to them every month for farming advice (Palmer, 2015). This finding means that the information seekers were satisfied with the information given to them by their fellow Senekela' users. Satisfaction of farmers has an impact on information usage, for the reason that farmers who are satisfied with the information are likely to use it (Msoffe and Ngulube, 2016) or keep using it. The non-ICT users would try to get the information directly from the source, which is ICTs. Therefore, farmers influence each other in the use of ICT on agricultural input information.

This influence is among the community. Repeat users are influential in their communities, providing advice to other farmers (Palmer, 2015). That can be interpreted as the way the influential ICT users can describe (Observability) their results achieved to other farmers. Thereby, the non-users get knowledge on this ICT and its visible results (Observability). It can also be interpreted as the community pressure (Social Influence) on non-users to use ICT. We conclude that there is a relation between the observability, social influence and the use of ICT on agricultural input information. Thus, this study postulates that:

H4. Observability has a positive effect on the use of ICTs on AII

H5. Social influence has a positive effect on the use of ICTs on AII.

1.3.3. Cost

The high cost of ICTs' services constitutes a barrier to its use on agricultural input information. For instance in Tanzania, the cost of mobile phone services is a barrier for many farmers in using these services (Chung, 2015). In Mali, 95% of Senekela users find that the cost is prohibitive (Palmer, 2014). Moreover, in Tanzania, the cost was a barrier to the uptake of ICTs on agricultural input by farmers (Barakabitze *et al.*, 2015). We, therefore, conclude that the high cost is a barrier to the use of ICTs in agricultural input information context.
On the other hand, other studies argued the cost or transaction cost is positively related to the use of ICT. That was observed in Niger (Aker, 2008), Sri Lanka (Dissanayeke, 2014). However, it is necessary that a working definition of transaction cost is specified (Silva, 2008). In our context, we referred to the cost of the search, access and use of information on agricultural inputs. In addition, we argued that:
H6. Cost has a negative effect on the use of ICTs on AII

1.3.4. Information Quality

There are some characteristics related to the agricultural input information quality affecting its use. For instance, in Uganda, it was argued that the value of information depend on many characteristics including accessibility, relevance, accuracy and currency (Kaddu, 2011). In addition, in a study on ICT for development in developing countries, it was argued that the participants say that for information to be useful or valuable, it needs to be timely, understandable, directed, from a trusted source, inclusive and non-subversive (Beardon *et al.*, 2005). Moreover, in Mali, it was reported that participants in the case study on Senekela revealed that the agronomy and market price advisory provided by Sènèkèla might not meet all of their information needs (GSMA, 2015). Therefore, some characteristics are affecting the use of information accessed through ICTs. They need to be established and to identify their effect on ICTs' use. This study argues that:
H7. Information quality has a positive effect on the use of ICTs on AII

1.3.5. Literacy and ICT Skills

The adoption of Innovations in agriculture is linked to an appropriate level of education (Simin and Janković, 2014). In addition, it was argued that educational deficiencies negatively affect a broader adoption of IT (Garcia-Murillo, 2003). Moreover, the adopter of new technology has an appropriate level of education (Al-Ghaith, Sanzogni and Sandhu, 2010).
A moderating variable is an anteceding common direct or indirect cause of two variables further down in the causal model (Saunders, Lewis and Thornhill, 2009). We summarise the expecting contributions of the moderating effects Literacy (education) and ICT Skills.
H3a: ICT Skills moderates the positive effect of simplicity on use of ICTs AII.
H3b: Literacy moderates the positive effect of simplicity on use of ICTs on AII
H4a: Literacy moderates the positive effect of observability on use of ICTs on AII
H7a: ICT Skills moderates the positive effect of information quality on use of ICTs on AII
H7b: Literacy moderates the positive effect of information quality on use of ICTs on AII

1.4 Research Conceptual Model

Using the factors that affect AII, this study aimed to propose a model for ICTs' contribution to the access and use of agricultural input information. Technology Acceptance Model (TAM), Diffusion of Innovation Theory (DOI) and the Unified Theory of Acceptance and Use of Technology (UTAUT) are the three most popular contemporary technology acceptance models (Woosley and Ashia, 2011). TAM needs to be expanded to include social and human factors (Li, 2010). UTAUT is a well-meaning and thoughtful presentation, but that it presents a model with 41 independent variables for predicting intentions and at least eight independent variables for predicting behaviour, and that it contributed to the study of technology adoption "reaching a stage of chaos" (Bagozzi, 2007).

Due to these drawbacks of TAM and UTAUT, we chose to rely on the Diffusion of Innovation Theory (DOI). It attempts to predict the behaviour of individuals and social groups in the process of adoption (use) of innovation, considering their characteristics, social relations, time factor and the features of the innovation (Simin and Janković, 2014). It has been applied in different field such as agriculture, health and education in developing countries. The DOI has five characteristics which determine the rate of adoption: relative advantage, compatibility, complexity, trialability and observability (Rogers, 1983). However, the Relative Advantage, Compatibility, and Complexity are the most relevant constructs to adoption research (Carter and Belanger, 2004). The observability was found to be an important factor in this context. Thus we included it.

The DOI does not have the constructs Information Quality, Cost or Social Influence that were supported empirically. We relied on the DIKDAR model (Heeks and Alemayehu Molla, 2009) to extract the constructs Information Quality and Cost; on the UTAUT (Ventkatesh *et al.*, 2003) to remove the construct Social Influence; on the Theory of Knowledge (Foucault, 1977) to remove the construct power. The Theory of Knowledge argues that whoever has the information will have the power. In our case, we assume that well-informed farmers will use agricultural inputs, which will result in better productivity. Therefore, we used Power as Contribution in the access and use of AII.

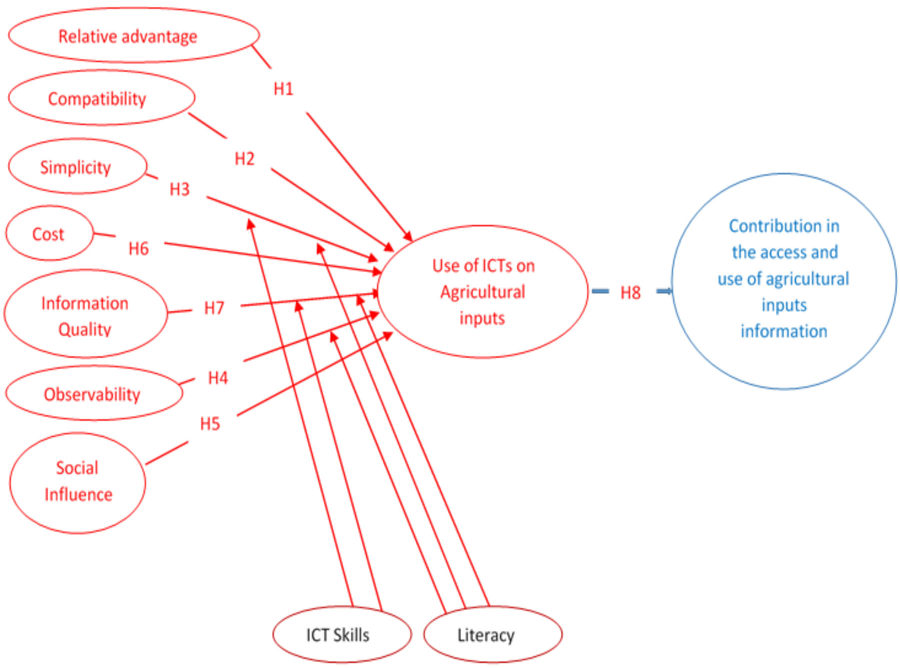


Fig. 1. Research Conceptual Framework

2. Materials and Methods

This section describes the study's methodology. The research was conducted through quantitative methods. Information Systems (IS) research is classified as positivism if there was evidence of formal propositions, quantifiable measures of variables, hypothesis testing, and the drawing of inferences about a phenomenon from the sample to a stated population (Michael D Myers and David Avison, 1997). Thus, we adopted a positivist paradigm.

The study was exploratory with a cross-sectional survey strategy.

2.1. Model Construction and Instrument Development

A model is a set of propositions or statements expressing relationships among constructs (March and Smith, 1995). It has two inter-models: The measurement model that answers the question how to measure a construct and the structural model that deals with the relationship between these constructs.

We conducted and published a literature review (Kante, Oboko and Chepken, 2016).

The model construction and instrument development require the development of the structural model, the measurement model, survey instrument and a pre-tests/pilot-study (Urbach and Ahlemann, 2010). After establishing empirical evidence of our constructs, we established their theoretical evidence (see conceptual framework).

An initial survey instrument was adapted from researchers ((Atkinson, 2007)-(Ventkatesh *et al.*, 2003)) to refer to ICT on agricultural input information. More than three items for each construct were proposed on a 5-point Likert scale arranging from strongly agree to disagree strongly.

In addition, we conducted a pre-test of our instrument to get empirical feedback with five researchers grounded in the field of ICT4D. It consisted of cognitive interview. Each one of the respondents was asked to describe how he/she understood particular question and response to see if he/she had difficulty in recalling. The Pre-test allows the researcher to receive empirical feedback from a controlled sample (Urbach and Ahlemann, 2010). An instrument of thirty-six items was validated during this phase.

2.2. Data Source

We purposively selected the village of Lobougoula in the district of Sikasso, Mali from the five villages in which we were supposed to conduct the next phase of the study. It was argued that a sample size larger than 30 was enough for testing a model using PLS-SEM (Hair, Ringle and Sarstedt, 2011). A stratified systematic sampling, which is a combination of stratified sampling and systematic sampling, was used to select 40 respondents (cereal farmers), which was above the minimum sample size. Stratified random sampling is a modification of random sampling in which you divide the population into two or more relevant and significant strata based on one or some attributes (Saunders, Lewis and Thornhill, 2009). It is suitable for all sizes and accurate.

Systematic sampling is a probability sampling procedure in which the initial sampling point is selected at random, and then the cases are chosen at regular intervals (Saunders, Lewis and Thornhill, 2009). This sampling was applied to the cereal farmers' respondent to get the sampling fraction. We divided the sample size by the total of households (999) (RGPH, 2013) in the village. Our sampling fraction (guide) is approximately 1/25. The respondent was the head of the household (someone who is aware of the agricultural activities and use of the ICTs). We replaced the phrase 'ICTs on AII' by 'Ngasene/Senekela' as Ngasene/Senekela are the ICTs services in Sikasso on AII.

2.3. Data Analysis

The data entered into SPSS V20 for descriptive analysis and data management. The data was then taken from SPSS to SMARTPLS 3.2.4 for the model assessment.

2.3.1. Partial Least Square Structural Equation Modelling (PLS-SEM)

Structural Equation Modelling (SEM) techniques are second generation data analysis methods highly recommended and used IS research (Gefen, Straub and Boudreau, 2000). Contrary to the first generation statistical tools such as regression, SEM enables researchers to answer a set of the interrelated research question in a: a) single, b) systematic, and comprehensive analysis by modelling the relationship between multiple independent and dependent constructs simultaneously. This capability for simultaneous analysis differs greatly from most first generation regression models such as linear regression, LOGIT, ANOVA, and MANOVA, which can analyse only one layer of linkages between independent and dependent variables at a time (Gefen, Straub and Boudreau, 2000).

There are two major techniques in SEM. The Partial Least Squares (PLS) and linear structural relations (LISREL) known as covariance based (CB). CB-SEM requires a sound theory base and confirmatory research while PLS does not need a sound theory base and support a confirmatory or exploratory research. Information System research is the main user of the PLS technique for estimating structural equation models (Evermann and Tate, 2014).

We selected PLS-SEM as the art for analysing our data. It was argued that PLS had been accepted as an important statistical method in the MIS (Management Information System field (Evermann and Tate, 2014). PLS should be favoured for small-sample research (Evermann and Tate, 2010) in Information system research.

It is important first to understand the vocabulary in PLS-SEM. The structural model of PLS-SEM has two types of latent variables (Wong, 2014). There are two models in PLS-SEM. The measurement model of the outer model and the inner model or structural model. The outer model gives an overview of how the constructs are measured. The inner model deals with the relationship between the constructs.

The inner model also has two types of variables: Exogenous and Endogenous. An exogenous latent variable is an LV that is not the effect of any other latent variable in the model (there are no incoming arrows from other latent variables). An endogenous latent variable it is an LV that is an effect of at least one other latent variable (Garson, 2016). In our case, we have only two endogenous latent variables (Use of ICTs on agricultural inputs information and Contribution to the access and use of agricultural inputs information). As no other variables predict the other latent variables, they are exogenous latent variables. PLS-SEM has six steps (Urbach and Ahlemann, 2010) like SEM (Kline, 2013). These steps are slightly different. We adopted the steps of PLS-SEM by a study (Urbach and Ahlemann, 2010): a) problem definition and research design; b) theoretical foundation; c) model construction and instrument development; d) data collection; e) model validation and f) interpretation.

2.3.2. Survey Instrument Validation

The instrument is validated when the measurement model is established. PLS-SEM algorithm was run, and the results such as convergent validity and discriminant validity were reported.

The type of reliability coefficient reported most often in the literature is coefficient alpha also called Cronbach's alpha (Kline, 2013). This statistic measures internal consistency reliability, the degree to which responses are consistent across the items within a measure. It varies between 0.4 to 0.7 for exploratory study (Urbach and Ahlemann, 2010). We also measured the extent to which a given construct is different from other constructs also known as discriminant validity in PLS-SEM. Each construct AVE (Average Variance construct) should be larger than its correlation with other constructs, and each item should load more highly on its assigned construct than on the other constructs (Gefen, Straub and Boudreau, 2000).

The discriminant validity measures the extent to which constructs differ from each other. Many methods have been used to assess the discriminant validity. In PLS-SEM, methods such AVE of Fornell-Larcker, Cross-loading, Heterotrait-Monotrait Ratio (HTMT) are used to evaluate the discriminant validity (Garson, 2016). Although testing of cross-loadings and use of the Fornell-Larcker criterion are accepted methods for evaluating the discriminant validity of a PLS model, they have deficiencies (Garson, 2016). Simulation studies demonstrated that the heterotrait-monotrait (HTMT) detect better the lack of discriminant validity than that criterion (Henseler, Ringle and Sarstedt, 2014). Moreover, in Information System research, it was argued that Discriminant validity should be assessed by the Heterotrait-Monotrait Ratio (HTMT) (Henseler, Hubona and Ash, 2016).

The recommended threshold for a well-fitted model is an HTMT ratio below 1.0 (Garson, 2016), 0.90 or 0.80 (Henseler, Ringle and Sarstedt, 2014).

2.2.3. Structural Model

The model's quality evaluation is based on its capability to anticipate the endogenous constructs. Some criteria can be used in the assessment: Coefficient of determination (R^2) (Urbach and

Ahlemann, 2010), predictive relevance (Q^2) (Evermann and Tate, 2014), and path coefficients (Garson, 2016).

As stated, this is an exploratory study. PLS path modelling can be used both for explanatory and predictive research. Depending on the analyst's aim – either explanation or prediction – the model assessment will be different. If the analyst seeks to predict, the assessment should focus on blindfolding and the model's performance on holdout samples (Evermann and Tate, 2014).

It was argued that while in traditional regression models the R^2 proportion of explained variance is an indicator of the predictive strength of the model, researchers have recently advocated the use of blindfolding for assessing the predictive strength of structural equation models (Evermann and Tate, 2014).

In IS research, it is recommended to use redundancy-based blindfolding to evaluate the predictive relevance of one's "theoretical/structural model" (p. 680) and suggests that a value of Q2 > 0.5 is indicative of a predictive model (Evermann and Tate, 2012). Hence, this pilot study assessed the structural model validity by the predictive relevance.

3. Results and Discussion

This section describes and discusses the results.

3.1. Descriptive Statistics

The data were entered into MS Excel. It was compared to completed data files for entry errors. We exported a copy of the entered data to SPSS V20 for manipulation and descriptive analyses. Data screening showed that there were no incorrect data but missing values. There were 25 missing data distributed throughout the nine variables. We replaced those missing data by the method of mean replacement whereby missing score are replaced with the overall sample mean. This method is the most basic when dealing with missing data in Structural Equation Modelling (Kline, 2013).

Table 1. ICTs' use distribution

		ICTs' use		Total
		Yes	No	
Gender	Male	20	10	30
	Female	0	0	0
Age	< 18	1	0	1
	18-40	6	5	11
	> 40	13	5	18

Table 1 summarises the ICTs' use distribution. All of the respondents were men. That should not mean that women do not use ICT in the village. It is explained by the fact that we were targeting household head and men were mainly the head of the household. This is highlighted by another study, which argues that 86.9% of the household head in a rural area in Mali are men (Traore *et al.*, 2012). We also noticed that the respondents above 40 years old were the majority in the use of ICT. The explanation is that most of the household head were above that age. The skills distribution is showed in Table 2.

Table 2. Skills' distribution

Skills		Respondents	
		Frequency	Percentage
Literacy	Able to read and write alphabet letters and numbers	26	86.67%

	Able to write a personal letter or a brief description of an event	10	33.33%
	Fill out a form	6	20%
Mobile phone's skills	Write an SMS	10	33.33%
	Call and follow up instruction given by a customer care centre	23	76.67%
	Take a picture or download a video	20	66.67%

Table 3. Descriptive statistics of the variables

Items **(indicators)**	Mean	Std. deviation	Skewness Std. Error .524	Kurtosis Std. Error 1.014
C1. The transaction cost such as airtime**,** bundles for Ngasene/Senekela services are not expensive	*2,33*	*1,807*	*-,086*	*-1,312*
C2. I use Ngasene/Senekela because the service is cheaper	*2,13*	*1,525*	*-,552*	*-1,416*
C3. Getting AII through other means is expensive than using Ngasene/Senekela	*2,10*	*1,470*	*-,602*	*-1,305*
RA1. Ngasene/Senekela are better than using books or newspaper to get AII	*1,33*	*1,061*	*,192*	*-,343*
RA2. Ngasene/Senekela are more interesting than another source of information that I have used to get AII	*1,40*	*1,037*	*-,310*	*-1,276*
RA3. Using Ngasene/Senekela contributed to the access and use of AII than it would be possible without the ICTs for me	*1,30*	*1,088*	*,210*	*-1,231*
RA4. I had more access and use of AII because of using Ngasene/Senekela	*1,40*	*1,070*	*-,174*	*-1,312*
RA5. Ngasene/Senekela made it easier to get AII	*1,43*	*1,194*	*-,026*	*-1,556*
CA1. Ngasene/Senekela is suitable to the way I like to get information to the access and use of AII	*1,43*	*1,278*	*,690*	*,336*
CA2. I think other farmers should use ICTs to access/use AII	*1,33*	*1,093*	*,289*	*-,461*
CA3. Using Ngasene/Senekela made what I was doing about AII seem more relevant	*1,37*	*1,066*	*,099*	*-,413*
CA4. Ngasene/Senekela helped me to have more access and use of AII	*1,53*	*1,167*	*-,086*	*-,907*
SIMP1. When using Ngasene/Senekela, I had no difficulty finding the information that I wanted	*2,30*	*1,841*	*-,191*	*-1,601*

SIMP2. I had no difficulty understanding how to get around in Ngasene/Senekela	2,13	1,737	-,092	-1,427
SIMP3. I had no difficulty understanding how Ngasene/Senekela technically worked	2,60	2,111	-,208	-1,729
SIMP4. When using ICTs to access AII, I had no difficulty implementing the information that I got	1,63	1,377	,042	-1,419
Ob1. Other farmers seemed interested in Ngasene/Senekela when they saw me using it	1,30	1,119	,146	-1,374
Ob2. People can tell that I know more about access and use of AII since I have used Ngasene/Senekela	1,23	1,006	-,070	-1,388
Ob3. Other farmers using Ngasene/Senekela liked using them i.e. they found from satisfactory	1,17	,986	,107	-1,249
Ob4. I would have no difficulty in telling friends what Ngasene/Senekela are to make them understand the ICTs	1,13	,973	,198	-1,142
Ob5. I would have no difficulty in telling others the way using Ngasene/Senekela improved my access and use of AII	1,13	1,008	,366	-,977
Ob6. After telling my friend about Ngasene/Senekela, he/she seemed to like using Ngasene/Senekela	1,60	1,329	-,136	-1,810
SI1. My neighbours (village mates. friends) think I should start using/keep using Ngasene/Senekela	1,46	,669	1,253	,504
SI2. My friends and parents use Ngasene/Senekela	2,21	,760	,617	,672
SI3. Using Ngasene/Senekela makes me/will make me feel higher reputation than those who do not	3,66	1,267	-,811	-,131
IQ1. The information I got from ICTs AII was complete	1,43	1,194	,234	-,989
IQ2. The information I got from Ngasene/Senekela was accurate	1,10	1,029	,602	-,686
IQ3. The information I got from Ngasene/Senekela was relevant	1,40	1,221	,249	-1,078
IQ4. The information I got from Ngasene/Senekela was timeliness	1,43	1,357	,728	,077
IQ5. The information I got from Ngasene/Senekela was appropriate	1,43	1,357	,550	-,865
Use1. I use Ngasene/Senekela regularly when preparing to plant my crops	1,31	1,105	,008	-1,434

Use2. I intend to use/continue to use Ngasene/Senekela	,97	,809	,063	-1,454
Use3. I recommend farmers to use ICTs on agricultural input information	1,00	,910	,589	-,364
CO1. Before I started using ICTs, I found it difficult to access AII	1,30	1,119	,304	-,594
CO2. Before I started using ICTs, I found it difficult to use AII	1,47	1,224	,083	-1,145
CO3. After I started using ICTs, I found it easier to access AII, and I have more access to AII	,97	,964	1,306	2,307
CO4. After I started using ICTs, I found it easier to use AII, and I have improved the AII	1,03	,999	1,040	1,300

As shown in Table 3, some of our variables absolute skew value were above +1 as suggested (Groeneveld and Meeden, 1984). Absolute values from about -1 to over +1 of this index are described as indicating "extreme" kurtosis. Our data distribution was not satisfying these two rules. This justifies our use of PLS-SEM again.

3.2. Instrument validation (measurement model validity)

The measurement model (outer model) assessment results are presented and discussed in this sub-section.

3.2.1 Internal consistency reliability, indicator reliability and Convergent validity

The reliability is defined the truthiness to which a question extends in its claim to measure what it wants to measure. Reliability assessment is the insurance that the block of items selected for a given construct is suitable operationalisation for that construct in PLS-SEM. The internal consistency is used to assess the internal consistency reliability, and it is preferred to the traditional Cronbach's alpha. Indicator reliability is the square of the measurement loading (Hair *et al.*, 2014).

As shown in Table 4, the 36 items were loadings enough their latent variable. The indicator loading should be between 0.6 to 0.7 for exploratory research (Hair, Ringle and Sarstedt, 2011). This criterion was satisfied as all of the indicator reliability was above 0.7 except the item iq40 (0.591). The Cronbach's alpha of all of our latent variables satisfied the condition of being above 0.9. We can conclude that our construct was reliable.

The internal consistency of the latent variable was established as very reliable according to (Urbach and Ahlemann, 2010). Our latent variables composite reliability was above 0.7, 0.8 and 0.9 which are respectively good, very good and excellent (Kline, 2013).

The convergent validity was established for all of the latent variables as their AVE values were above 0.500.

As shown in Table 4, some of the constructs had more than three items. That was voluntarily done x so that we could later choose the most appropriate items. The researcher can use many indicators so that he/she can choose the ones that measure well the construct (Urbach and Ahlemann, 2010). Based on the reliability of an item, and the cognitive interview conducted during the translation process of the instrument, we drop the items compatibility26; iq40; iq42; ob33; ob34; ob35; simp29; ra21; ra22. These droppings were also based on the predictability of these elements done through the Q^2 of the indicator cross-validated communality. In addition, it was argued that in Information System Research context, a median of 3.5 indicators were reported in the literature for each reflective construct (Evermann and Tate, 2014).

Table 4. Model's reliability and validity

Construct	Items	Loadings	Indicator Reliability ($Loadings^2$)	Cronbach's Alpha	Composite reliability	AVE
Compatibility	compatibility_23	0.918	0.843	0.953	0.877	0.877
	compatibility_24	0.924	0.854			
	compatibility_25	0.963	0.927			
	compatibility_26	0.942	0.887			
Contribution	contribution_48	0.946	0.895	0.953	0.966	0.878
	contribution_49	0.918	0.843			
	contribution_50	0.944	0.891			
	contribution_51	0.939	0.882			
Cost	cost_15	0.947	0.897	0.955	0.971	0.918
	cost_16	0.975	0.951			
	cost_17	0.951	0.904			
Information Quality	iq_40	0.769	0.591	0.928	0.946	0.778
	iq_41	0.915	0.837			
	iq_42	0.876	0.767			
	iq_43	0.908	0.824			
	iq_44	0.933	0.870			
Observability	observability_31	0.920	0.846	0.956	0.965	0.821
	observability_32	0.934	0.872			
	observability_33	0.963	0.927			
	observability_34	0.904	0.817			
	observability_35	0.883	0.780			
	observability_36	0.932	0.869			
Relative advantage	ra_18	0.954	0.910	0.957	0.967	0.854
	ra_19	0.942	0.887			
	ra_20	0.891	0.794			
	ra_21	0.941	0.885			
	ra_22	0.890	0.792			
Social Influence	si_37	0.891	0.794	0.922	0.949	0.861
	si_38	0.945	0.893			
	si_39	0.945	0.893			
Simplicity	simplicity_27	0.967	0.935	0.970	0.978	0.918
	simplicity_28	0.981	0.962			
	simplicity_29	0.958	0.918			
	simplicity_30	0.925	0.856			
Use	u_i_o_aif_45	0.902	0.814	0.906	0.941	0.842
	u_i_o_aif_46	0.938	0.880			
	u_i_o_aif_47	0.912	0.832			

3.2.2 Discriminant validity

As shown in figure 2, our latent variables discriminant validity were established except for the Use of AII on Information Quality according to (Garson, 2016).

However, the HTMT value below 0.9 could not be achieved by some latent variables. This could be due to the sample size.

	contribution	cost	cp	iq	ob	ra	si	simp
contribution								
cost	0.474							
cp	0.742	0.740						
iq	0.918	0.665	0.785					
ob	0.883	0.701	0.826	0.963				
ra	0.794	0.777	0.987	0.845	0.878			
si	0.291	0.218	0.141	0.289	0.322	0.153		
simp	0.731	0.751	0.679	0.771	0.910	0.791	0.315	
u_i_aif	0.903	0.662	0.905	1.014	0.987	0.933	0.324	0.839

Figure 2. Discriminant validity

3.3. Structural Model Validity

3.3.1 Model Predictive Relevance

From figure 3, we concluded that the Cost, Compatibility (cp), Information Quality (iq), Observability (ob), Relative Advantage (ra), Social Influence (si) and Simplicity (simp) are highly predicting the use of AII as Q^2 of their endogenous latent variable use of ICT on AII (0.594). The Use of AII (u_i_aif) is also highly predicting its endogenous latent variable contribution (0.715). He further argued that Q^2 is approximately 0.35. On this basis, the latent variables of our model are highly predicting the use of ICTs on AII. In addition, the use of ICTs on AII is also highly predicting the Contribution.

Total | Case1 | Case2 | Case3 | Case4 | Case5

	SSO	SSE	Q^2 (=1-SSE/SSO)
contribution	120.000	48.765	0.594
cost	90.000	90.000	
cp	120.000	120.000	
iq	150.000	150.000	
ob	180.000	180.000	
ra	150.000	150.000	
si	90.000	90.000	
simp	120.000	120.000	
u_i_aif	90.000	25.659	0.715

Figure 3. Predictive relevance results

3.3.1 Endogenous Variables

The variance for the first endogenous variable (Use of ICT on AII –u_i_aif) was 0.832. That means that the seven latent variables of Relative Advantage, Compatibility, Simplicity, Cost, Information Quality, Observability and Social Influence explained 83.2% of the variance in Use of ICT on agricultural input information. In addition, Use explained 25.7% of the variance in Contribution of ICT on AII (figure 4).

3.3.3 Paths coefficient

We found that Information Quality has the strongest effect on Use of ICT on agricultural input information (0.576), followed by the Compatibility (0.401). The Social Influence comes as the third latent variable having the strongest effect on Use of ICT on AII (0.159). The Use of ICT on AII has a strong effect on Contribution of ICT in the AII sector (0.842) (figure 4).

Surprisingly, the cost has a negative effect on the Use of ICT on AII (-0.034). We argued that the high cost has a negative effect on the use of ICT on AII, but the findings showed that farmers found the cost cheaper. Moreover, this cheaper cost is negatively affecting the use of ICTs. This is explained by the fact that the farmers in this study from Lobougoula are more using radio/television as ICTs instead of mobile phone or telecentres as we expected.

Another unexpected result is the adverse effect of Relative Advantage on Use of ICTs. This can be explained by the fact that we were looking at ICT such as Mobile phone and Telecentres, but in the commune of Lobougoula, farmers use Radio and Television mainly to get information on AII. All of our other latent variables were supported as expected.

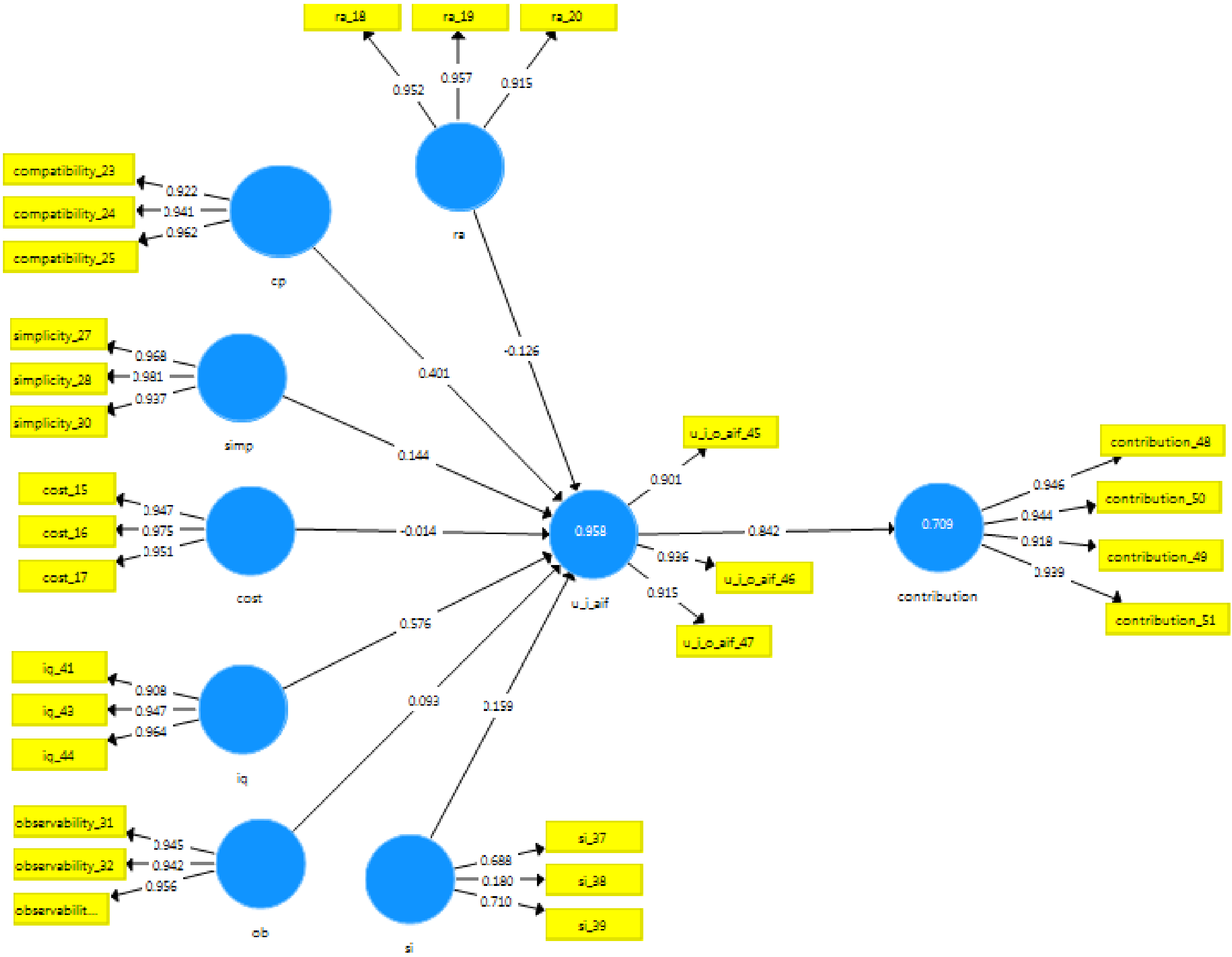


Figure 4. PLS-SEM results

4. Conclusion

This study aimed to propose a model for cereal farmers in the context of access and use of agricultural input information. This paper discussed the results of the pilot-study to validate the survey instrument and the model predictability. They were instrumental in confirming the predictability of our proposed model (Kante, Oboko and Chepken, 2016).
Moreover, the instrument was validated. The use of PLS-SEM through SMARTPLS software ensured the validity and reliability of our measurement and structural model. Although, we dropped some items to enhance the reliability and validity of the model. Due to our interest in ICTs such as Mobile phones and Telecentres, the study area should be changed to cover these ICTs. In addition, the high cost should be modified into the lower cost as it affects ICTs' use positively.
The results showed that the constructs Relative Advantage, Compatibility, Observability, Simplicity, Cost, Information Quality were highly predicting the endogenous latent variable Use of ICT on AII (0.715). The Use was highly predicting the Contribution of ICTs to the access and use of AII (0.594) in the measurement and structural model through the Q^2.
In addition, the assessment of R^2 suggested the same highly prediction of these two endogenous latent variables 95.8% and 70.9%. However, the tiny sample of this pilot-study phase could be biased. Nonetheless, it helped us to refine our research instrument for the next step of this research that is to gather data from 300 cereal farmers in the Sikasso region, Mali. This sample will enable us to test the moderating effects such as Literacy and ICT Skills and the path coefficient significances.

Acknowledgement

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APPENDIX 4: PARTIAL LEAST SQUARE STRUCTURAL EQUATION MODELLING' USE IN INFORMATION SYSTEMS: AN UPDATED GUIDELINE IN EXPLORATORY SETTINGS.

1. Introduction

The purpose of many studies in the field of Information Systems (IS) research is to analyse causal relationship between variables. Structural Equation Modelling (SEM) is a statistical technique for testing and estimating that causal connection based on statistical data and qualitative causal assumption. Partial Least Square Structural Equation Modelling (PLS-SEM) is the technique that is mostly used in IS research. It has been subject to many reviews either in confirmatory or exploratory settings. However, it has recently emerged that PLS occupies the middle ground of exploratory and confirmatory settings. Thus, this paper intends to propose an updated guideline for the use of PLS-SEM in Information Systems Research in exploratory settings maintaining interpretability. A systematic literature review of 40 empirical and methodological studies published between 2012 and 2016 in the leading journal of the field guides future empirical work.
The purpose of many studies in the field of Information Systems (IS) research is to analyse causal relationship between variables. Several techniques allow researchers to evaluate their models such as regression, structural equation modelling (SEM). SEM is a statistical technique for testing and estimating those causal relationship based on statistical data and qualitative causal assumption (Urbach and Ahlemann, 2010). Contrary to the first generation statistical tools such as regression, SEM enables researchers to answer a set of an interrelated research question in an a) single, b) systematic, and comprehensive analysis by modelling the relationship between multiple independent and dependent constructs simultaneously. This capability for simultaneous analysis differs greatly from most first generation regression models such as linear regression, LOGIT, ANOVA, and MANOVA, which can analyse only one layer of linkages between independent and dependent variables at a time (Gefen, Straub and Boudreau, 2000).

SEM is highly recommended and used in the field of IS research. Quantitative research in Information System (IS) frequently uses structural equation modelling, allowing researchers to represent latent constructs, observations and their relationship in a single statistical model (Evermann and Tate, 2014). SEM has two major techniques: The Partial Least Squares (PLS) and the Covariance Based (CB). CB-SEM requires a sound theory base and confirmatory research while PLS does not need a sound theory base and support a confirmatory or exploratory research (Hair, Ringle and Sarstedt, 2011).

Partial Least Square Structural Equation Modelling (PLS-SEM) is the most SEM technique used in IS research. PLS is regarded as the most fully developed and general system (Henseler, Hubona and Ash, 2016). IS was identified as the primary user of PLS (Evermann and Tate, 2014).

Rönkkö et al. (2012) argue that the use of partial least squares path modelling as a tool for theory testing has been increasing in the late 90's and PLS is one of the most common quantitative data analyses methods in the top IS journals. However, they emphasise that reliance on PLS method has possibly resulted in producing and publishing a large number of studies, whose results are invalid. These critics have been addressed by the literature (Henseler et al., 2014).

The technique has been subject to many reviews (Rouse and Corbitt, 2008; Urbach and Ahlemann, 2010; Evermann and Tate, 2012; Henseler, Hubona and Ash, 2016). That has resulted in the production of guidelines for the use of PLS-SEM in IS research. Most of these guidelines focus on either explanatory (confirmatory) or exploratory research. Henseler et al. (2016) propose an updated guideline for the use of PLS in IS research in confirmatory settings. On the other hand, Urbach & Ahlemann (2010) come up with a guideline for the use of the technique in exploratory contexts.

The literature provides three purposes of any research: exploratory, descriptive or explanatory (confirmatory). An exploratory study is a valuable means of finding out what is happening; to seek new insights; to ask questions and to assess phenomena in a new light (Saunders, Lewis and Thornhill, 2009). Exploratory research goes with a predictive model (Evermann and Tate, 2014).The object of descriptive research is to portray an accurate profile of persons, events or situations (Saunders, Lewis and Thornhill, 2009). Studies that establish causal relationships between variables may be termed explanatory research (Saunders, Lewis and Thornhill, 2009). Explanatory research goes with the causal model (confirmatory) model. Nevertheless, Evermann & Tate (2014) argue that the causal and predictive modelling does not form a dichotomy but that there is a middle-ground between the two extreme positions. A predictive model may be easier to accept by decision makers and other stakeholders when it can be plausibly interpreted. Further, they state that it may be simpler to determine the prediction boundaries, i.e. determine what situations the model will hold and under what situations the model will break, when a plausible substantive interpretation is available. Users of predictive models have more trust in its results, especially for unexpected or counterintuitive predictions, when there is a plausible interpretation possible (ibid.). In contrast to explanatory modelling, the plausible interpretations in this context do not entail a rigorous formal statistical testing of all posited relationships and model constraints as in causal- explanatory modelling (Evermann and Tate, 2014).

PLS path modelling was developed to occupy this middle ground and to straddle the traditional divide between causal-explanatory and predictive modelling at the extremes. It aims to maintain interpretability while engaging in predictive modelling (Evermann and Tate, 2014). Therefore, there is a need to review the guidelines of exploratory research by taking into account the middle ground. That justifies the purpose of this paper.

The objective of this article was to propose an updated guideline for the use of PLS-SEM in Information Systems Research in exploratory settings maintaining interpretability. It updated the paper of Urbach & Ahlemann (2010) that is mainly for exploratory settings.

2. Material and Methods

This section describes the methods that were used to conduct the study.
To efficiently perform the systematic literature, search criterion for inclusion in the dataset was defined. Table 1 provides the criterion.

Table 1: Criterion for inclusion/exclusion in the dataset

Inclusion	Criteria
Time of publication	Published between 2012 and 2016
Appropriate source	Researchgate.com, aisnet.org, webofscience.com, google scholar
Search terms	Information Systems, Information System, Information System research, Use of Structural Equation Modelling, Use of Partial Least Square Equation Modelling, Use of PLS-SEM, Guidelines for the use of PLS-SEM, PLS-SEM use in IS, Research methods using PLS-SEM

We had papers from proceedings and journals. Management Information Systems Quarterly (MISQ), Information Systems Research (ISR), Journal of Management Information Systems (JMIS) and Journal of the Association for Information Systems (JAIS) were identified as the four leading journals in the field of IS (Evermann and Tate, 2010). This paper is restrained to MISQ as it is recognised as the leading journal. We had for 26 research papers from MISQ:

- Eight papers in 2012: two empirical studies and six methodological papers
- Five papers in 2013: four empirical papers and one methodological study.
- Three papers in 2014: all of them were empirical studies.
- Six studies in 2015: one methodological paper and five empirical studies.
- One empirical study in 2016.

On the proceeding papers, we selected four papers from the conferences that were hosted or organised by the Association for Information Systems and its affiliated organisations. In conclusion, the data set was a sample size of 40 studies. From the data set, it was extracted: 1) reason for choosing PLS-SEM, 2) research epistemology, 3) research approach, 4) research strategy, 5) Model characteristics and 6) Model evaluation.

3. Results and Discussion

This section presents the in-depth analyses of the papers.

3.1 The reasons for choosing PLS

Urbach & Ahlemann (2010) argue that overall, PLS can be an adequate alternative to CBSEM if the problem has the following characteristics:

- The phenomenon to be investigated is relatively new, and measurement models need to be newly developed.
- The structural equation model is complex with a large number of LVs and indicator variables.
- Relationships between the indicators and LVs have to be modelled in different modes (i.e., formative and reflective measurement models).
- The conditions relating to sample size, independence, or normal distribution are not met, and/or. CB requires a large sample size while PLS does not require large sample size. If the sample size is small, PLS is recommended in Information System research (Evermann and Tate, 2014), in Marketing research (Hair, Ringle and Sarstedt, 2011).

Table 2 gives an overview of the reason that underlines studies from our dataset to choose PLS.

Table 2. Reason for choosing PLS-SEM

Reason	Authors	Years
Small sample sizes	(Wang, Tai and Grover, 2013; Bartelt and Dennis, 2014; Ifinedo, 2015)	2013; 2014; 2015
Non normality	(Wang, Tai and Grover, 2013; Xu, Benbasat and Cenfetelli, 2014; Ifinedo, 2015; Park, Sharman and Rao, 2015)	2013; 2014; 2015
Exploratory research objective/ predictive purposes	(Fang *et al.*, 2014; Johnston, Warkentin and Siponen, 2015; Park, Sharman and Rao, 2015)	2014; 2015
Analyse formative and reflective constructs	(Majchrzak, Wagner and Yates, 2013; Han *et al.*, 2015a)	2013; 2015
Analyse formative constructs	(Kankanhalli, Ye and Teo, 2015)	2015
Number of interaction terms	(Venkatesh, Thong and Xu, 2012)	2012
Mediated Models	(Bartelt and Dennis, 2014)	2014

None of the studies used the small sample sizes criterion to justify the use of PLS-SEM. Instead, each one had another argument to justify their use of the technique. The use of small sample size for PLS-SEM is not recommended. For instance, Oodhue, Ewis, Hompson, Marcoulides, & Chin (2012) argue that when determining the minimum sample size to obtain adequate power, use Cohen's approach (regardless of the technique to be used). Do not rely on the rule of 10 (or the rule of 5) for PLS (ibid.). In addition, Kline (2013) argues that a "typical" sample size in studies where SEM was used is about 200 cases. Moreover, Garson (2016) quoting (Chin & Newsted, 1999) agrees with the same sample size. Therefore, we conclude that a sample size of 200 or above is the good sample size in using PLS-SEM.

3.2 Research epistemology

Many philosophical positions characterise information System research. Saunders et al. (2009) draw a comparison of the four research philosophies, which can be applied in information management research (Positivism, realism, interpretivism and pragmatism).

In Information System research, Urbach & Ahlemann (2010) argue that SEM researchers commonly adopt a positivist epistemological belief. Furthermore, they report that the positivist researcher plays a passive, neutral role and does not intervene in the phenomenon of interest. Epistemologically, the positivist perspective is concerned with the empirical testability of theories. In other words, these theories are either confirmed or rejected. None of the paper that we reviewed had addressed the philosophical point of view. Therefore, we are consistent with Urbach & Ahlemann (2010) who argue that research that applies SEM (including PLS) follows a positivist epistemological belief.

3.3 Research approach

The extent to which the researcher is evident about the theory at the beginning of his/her research raises an important question concerning the design of the research project (Saunders, Lewis and Thornhill, 2009). That is whether the research should use the deductive approach, in which the researcher develops a theory and hypothesis (or hypotheses) and design a research strategy to test the hypothesis, or the inductive approach, in which you would collect data and develop a theory as a result of your data analysis (ibid.). None of the paper that we reviewed had reported their research approach. Nevertheless, the purpose of the empirical studies we reviewed was to gather data and test their hypotheses. This is a deductive approach, and thus, we conclude that studies using PLS-SEM apply a deductive approach.

3.4 Research strategy

Saunders et al. (2009) argued that survey is a popular and shared strategy in business and management research and is most frequently used to answer who, what, where, how much and how many questions. It, therefore, tends to be used for exploratory and descriptive research. Our dataset reveals that PLS-SEM studies applied survey as a strategy. This was also consistent as these studies were mainly done in exploratory settings.

3.5 Model characteristics

A Structural equation model consists of two models. The structural model (or inner model) comprises the relationship between the latent variables, which has to be derived from theoretical considerations. The second model is called the measurement model (or outer). This model deal with "how do you measure your latent variables?"

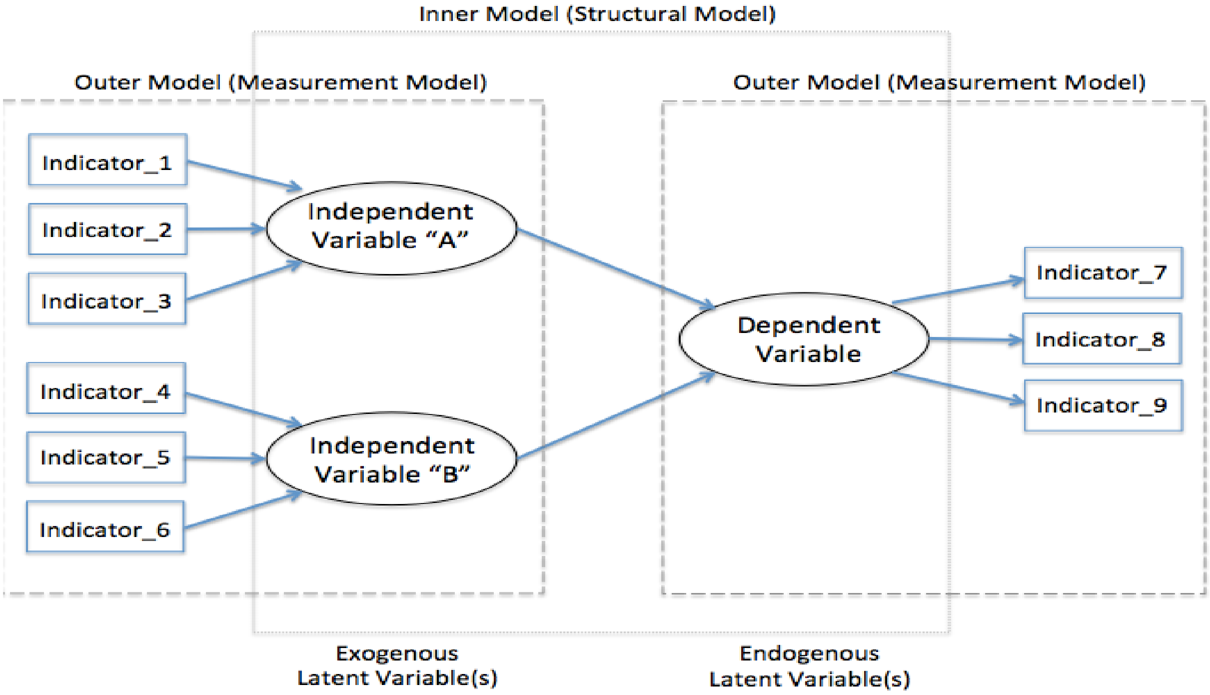

Figure 1. Inner vs Outer Model in a SEM Diagram
Source: Wong (2014)

3.5.1. Outer Model

Measurement model specification requires the consideration of the nature of the relationship between constructs and measures. Latent variable measurement concerns the process of ensuring that local independence is satisfied for a selected set of observed variables or indicators and this can be done via the use of a model such as a common factor model (Oodhue *et al.*, 2012). There are two types of measurement models: reflective and formative (Figure 2) (Hreats, Becker and Ringle, 2013). Formative and reflective are thus the two currently accepted ways of specifying the relationship between latent constructs and observed variables that are causally related to them (Aguirre-urreta and Marakas, 2012).

Criteria	Formative Model	Reflective Model
1. Direction of causality from construct to measure implied by the conceptual definition	*Direction of causality is from items to construct.*	*Direction of causality is from construct to items.*
Are the indicators (items) (a) defining characteristics or (b) manifestations of the construct?	Indicators are defining characteristics of the construct.	Indicators are manifestations of the construct.
Would changes in the indicators/items cause changes in the construct or not?	Changes in the indicators should cause changes in the construct.	Changes in the indicator should not cause changes in the construct.
Would changes in the construct cause changes in the indicators?	Changes in the construct do not cause changes in the indicators.	Changes in the construct do cause changes in the indicators.
2. Interchangeability of the indicators/items	*Indicators need not be interchangeable.*	*Indicators should be interchangeable.*
Should the indicators have the same or similar content? Do the indicators share a common theme?	Indicators need not have the same or similar content/indicators need not share a common theme.	Indicators should have the same or similar content/indicators should share a common theme.
Would dropping one of the indicators alter the conceptual domain of the construct?	Dropping an indicator may alter the conceptual domain of the construct.	Dropping an indicator should not alter the conceptual domain of the construct.
3. Covariation among the indicators	*Not necessary for indicators to covary with each other*	*Indicators are expected to covary with each other.*
Should a change in one of the indicators be associated with changes in the other indicators?	Not necessarily	Yes
4. Nomological net of the construct indicators	*Nomological net of the indicators may differ.*	*Nomological net of the indicators should not differ.*
Are the indicators/items expected to have the same antecedents and consequences?	Indicators are not required to have the same antecedents and consequences.	Indicators are required to have the same antecedents and consequences.

Figure 2. Overview of reflective/formative models
Source: adapted from Urbach & Ahlemann (2010)

In reflective measures, changes in the construct are reflected in variations in all of its indicators, and the direction of causality is from the construct to the indicators (Garson, 2016). Reflective indicators are assessed regarding their loadings, which entails the simple correlation between the indicator and the construct (Hreats, Becker and Ringle, 2013). The reflective model were reported by some reviewed empirical studies (Bartelt & Dennis, 2014; Fang et al., 2014; Han, Ada, Sharman, & Rao, 2015; Johnston et al., 2015; Kankanhalli et al., 2015; Marsh, Morin, Parker, & Kaur, 2014; Setia, Ventkatesh, & Joglekar, 2013; Xu et al., 2014).

In formative measures, the indicators do not reflect the underlying construct but are combined to form it without any assumptions about the intercorrelation patterns among them (Garson, 2016). The direction of causality is from the indicators to the construct, and the weights of formative indicators represent the importance of each indicator in explaining the variance of the construct (Hreats, Becker and Ringle, 2013). Reviewed empirical studies reported the use of formative model (Han et al., 2015; Jarvis, Mackenzie, & Podsakoff, 2012; Kankanhalli et al., 2015; Majchrzak et al., 2013; Marett, Otondo, & Taylor, 2013; Schmitz, Teng, & Webb, 2016; Setia et al., 2013; Venkatesh et al., 2012; Wang et al., 2013; Wu, Straub, & Liang, 2015).

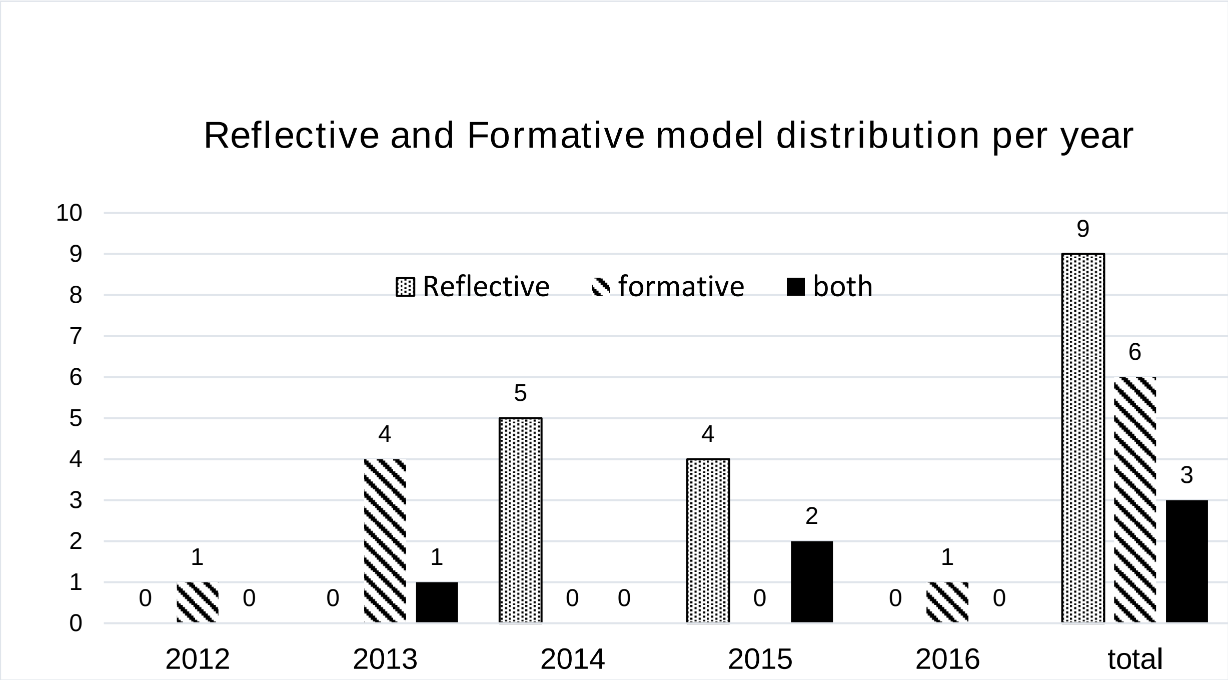

Figure 3. Model distribution per year

3.5.2 Inner model or structural model

The inner model (structural model) has also two types of variables: Exogenous and Endogenous (see figure 1). An exogenous latent variable is an LV that has no income arrow from any other LV in the model (Garson, 2016). An endogenous latent variable is an LV that has at least one income arrow from another LV in the model (Garson, 2016).

The inner model can also have other variables such as moderating variable, mediating variable and controlling variable. A moderator is a qualitative (e.g., sex, race, class) or quantitative (e.g., level of reward) variable that affects the direction and strength of the relation between an independent or predictor variable and a dependent or criterion variable (Baron and Kenny, 1986). They further argue that the relationship between two variables changes as a function of the moderator variable. In other words, moderator effect = interaction effect.

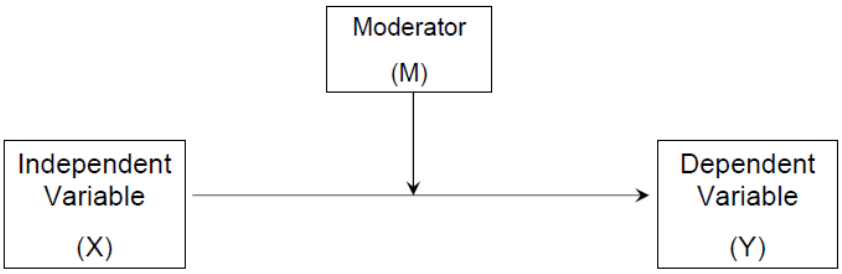

Figure 4. Conceptual diagram for moderating variable

Source: adapted from Chin (2006)

A mediator (or mediating variable) accounts for the relationship between the predictor and the criterion (Baron and Kenny, 1986). It is an intervening variable (Garson, 2016).
An intervening variable (mediator) transmits the effect of an independent variable to a dependent variable (Chin, 2006).

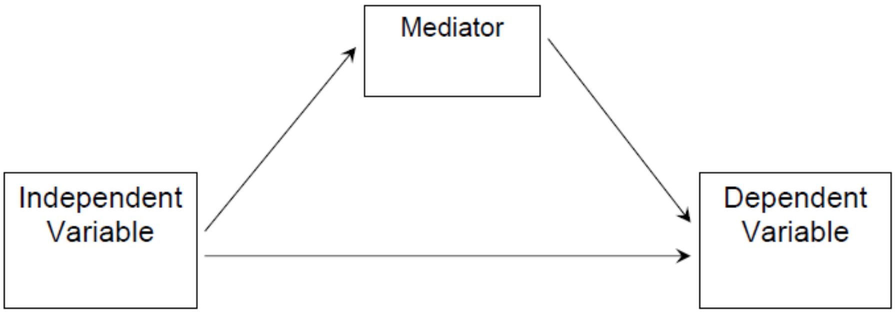

Figure 5. Conceptual diagram for mediating variable
Source: adapted from Chin (2006)

Control variable (controlling) is a variable that is not the focus or planned as part of a research study. However, its existence has a positive impact over Dependent Variable (DV) that cannot be ignored in which it is included in the research model testing together with other Independent Variables (IVs) (Fung, 2015). Hence it is called control variable, i.e. it is kept under "controlled", "monitored" or "constant" to observe whether it has minimal impact on the relationships between the independent variable and dependent variable (Fung, 2015). Usually, the control variable is not included as part of a hypothesis statement.

3.6 Model evaluation

The model evaluation requires the assessment of the two inter-related models: measurement model (outer model) and structural model (inner model).

3.6.1 Outer model fit evaluation

a. Reflective outer model fit evaluation

The measurement model should be tested for least internal consistency reliability, indicator reliability, convergent validity, and discriminant validity by applying standard decision rules from the IS research literature.

Urbach & Ahlemann (2010) argued that the traditional criterion for assessing internal consistency reliability is Cronbach's alpha (CA), whereas a high alpha value assumes that the scores of all items with one construct have the same range and meaning (Cronbach 1951). However, Garson (2016) argued that Composite reliability is preferred to Cronbach's alpha in testing the convergent validity of a reflective model. Regardless of which coefficient is used for assessing internal consistency, values above .700 are desirable for exploratory research (Urbach and Ahlemann, 2010).

Convergent validity entails the degree to which individual items reflecting a construct converge in comparison to items measuring different constructs. Urbach & Ahlemann (2010) argued that a commonly applied criterion of convergent validity is the average variance extracted (AVE) proposed by Fornell and Larcker (1981). It measures the percent of variance captured by a construct by showing the ratio of the sum of the variance captured by the construct and measurement variance (Gefen, Straub and Boudreau, 2000). Its value should be above .5 (Urbach and Ahlemann, 2010; Garson, 2016).

Finally, discriminant validity involves the degree to which the measures of different constructs differ from one another. Whereas convergent validity tests whether a particular item measures the construct it is supposed to measure, discriminant validity tests whether the items do not unintentionally measure something else (Urbach and Ahlemann, 2010). In SEM using PLS, two measures of discriminant validity are commonly used: Cross loading criterion and Fornell–Larcker (Urbach and Ahlemann, 2010). However, simulation studies demonstrated that the heterotrait-monotrait (HTMT) detects better the lack of discriminant validity (Henseler, Ringle and Sarstedt, 2014). Moreover, in Information System research, it was argued that Discriminant validity should be assessed by the Heterotrait-Monotrait Ratio (HTMT) (Henseler, Hubona and Ash, 2016). Table 3 summarises the measurement model assessment.

Table 3. Reflective measurement model assessment

Validity type	Criterion	Description	Literature
Indicator reliability	Indicator loading > .600	Loadings represent the absolute contribution of the indicator to the definition of its latent variable.	(Urbach and Ahlemann, 2010; Setia, Ventkatesh and Joglekar, 2013; Wang, Tai and Grover, 2013; Fang *et al.*, 2014; Han *et al.*, 2015b)
Internal consistency reliability	Cronbach's α > 0.6	Measures the degree to which the MVs load simultaneously when the LV increases.	(Urbach and Ahlemann, 2010; Wang, Tai and Grover, 2013; Fang *et al.*, 2014; Han *et*

			al., 2015b; Garson, 2016)
Internal consistency reliability	Composite reliability > 0.6	Attempts to measure the sum of an LV's factor loadings relative to the sum of the factor loadings plus error variance. Leads to values between 0 (completely unreliable) and 1 (perfectly reliable).	(Urbach and Ahlemann, 2010; Wang, Tai and Grover, 2013; Fang *et al.*, 2014; Han *et al.*, 2015b; Garson, 2016)
Convergent validity	Average Variance Extracted (AVE) > 0.5	It involves the degree to which individual items reflecting a construct converge in comparison to items measuring different constructs.	(Urbach and Ahlemann, 2010; Venkatesh, Thong and Xu, 2012; Wang, Tai and Grover, 2013; Majchrzak, Wagner and Yates, 2013; Setia, Ventkatesh and Joglekar, 2013; Bartelt and Dennis, 2014; Han *et al.*, 2015a, 2015b; Kankanhalli, Ye and Teo, 2015; Garson, 2016; Henseler, Hubona and Ash, 2016)
Discriminant validity	Cross-loadings	requires that the loadings of each indicator on its construct are higher than the cross-loadings on other constructs	(Gefen, Straub and Boudreau, 2000; Urbach and Ahlemann, 2010; Wang, Tai and Grover, 2013)
Discriminant validity	Fornell-Larcker	Requires an LV to share more variance with its assigned indicators than with any other LV. Accordingly, the AVE of each LV should be greater	(Urbach and Ahlemann, 2010; Venkatesh, Thong and Xu, 2012; Bartelt and Dennis, 2014;

		than the LV's highest squared correlation with any other LV.	Fang *et al.*, 2014; Xu, Benbasat and Cenfetelli, 2014; Han *et al.*, 2015b; Ifinedo, 2015; Kankanhalli, Ye and Teo, 2015)
Discriminant validity	Heterotrait-Monotrait Ratio (HTMT)	(Garson, 2016).	HTMT < 1 (Garson, 2016)

Source: adapted from Urbach & Ahlemann (2010)

b. Formative outer model fit evaluation

The validation of formative measurement models requires a different approach than the one applied to reflective models (Urbach and Ahlemann, 2010). Conventional validity assessments do not apply to formative measurement models, and the concepts of reliability and construct validity are not meaningful when employing such models (Urbach and Ahlemann, 2010). Whereas reliability becomes an irrelevant criterion for assessing formative measurement, the examination of validity becomes crucial (Diamantopoulos 2006). Accordingly, Urbach & Ahlemann (2010) quoting Henseler et al. (2009) argue that assessing the validity of formative constructs on two levels: the indicator and the construct levels.

To assess indicator validity, the researcher should monitor the significance of the indicator weights using bootstrapping (Urbach and Ahlemann, 2010; Venkatesh, Thong and Xu, 2012; Garson, 2016). Their weights should be the main concern in formative models (Garson, 2016). A significance level of at least.050 suggests that an indicator is relevant for the construction of the formative index and, thus, demonstrates a sufficient degree of validity (Urbach and Ahlemann, 2010). Weights vary from 0 to an absolute maximum lower than 1 (Urbach and Ahlemann, 2010; Garson, 2016). In addition, the degree of multicollinearity among the formative indicators should be assessed by calculating the variance inflation factor (VIF). The VIF indicates how much of an indicator's variance is explained by the other indicators of the same construct (Urbach and Ahlemann, 2010; Garson, 2016; Henseler, Hubona and Ash, 2016). That said, Urbach & Ahlemann (2010) report that values below the commonly accepted threshold of 10 indicate that multicollinearity is not an issue (Diamantopoulos and Siguaw 2006; Gujarati 2003).

The first step for assessing construct validity could be a test for nomological validity (Urbach and Ahlemann, 2010). In this context, nomological validity means that, within a set of hypotheses, the formative construct behaves as expected. Accordingly, those relationships between the formative construct and other models' constructs, which have been sufficiently referred to in prior literature, should be robust and significant (Henseler et al. 2009; Peter 1981; Straub et al. 2004). Urbach & Ahlemann (2010) further propose assessing construct validity by checking discriminant validity. Correlations between formative and all other constructs of less than .700 indicate sufficient discriminant validity (Urbach and Ahlemann, 2010).

Table 4. Formative measurement model assessment

Validity type	Criterion	Description	Literature
Indicator validity	Indicator weights	Significance at the .050 level suggests that an indicator is relevant for the construction of the formative index and, thus, demonstrates a sufficient degree of validity. Some authors also recommend path coefficients greater than .100 or .200.	(Urbach and Ahlemann, 2010; Venkatesh, Thong and Xu, 2012; Marett, Otondo and Taylor, 2013; Han *et al.*, 2015b; Wu, Straub and Liang, 2015)
Indicator validity	Variance inflation factor (VIF)	Indicates how much of an indicator's variance is explained by the other constructs' indicators and, thus, indicates how redundant the indicator's information is. Acceptable values are below 10.	(Urbach and Ahlemann, 2010; Venkatesh, Thong and Xu, 2012; Han *et al.*, 2015b; Kankanhalli, Ye and Teo, 2015; Garson, 2016; Schmitz, Teng and Webb, 2016)
Construct validity	Nomological validity	Means that, within a set of hypotheses, the formative construct behaves as expected. Relationships between the formative construct and other models' constructs, which have been sufficiently referred to in prior literature	(Urbach and Ahlemann, 2010; Wu, Straub and Liang, 2015)
Construct validity	Inter-construct correlations	If the correlations between the formative and all the other constructs are less than .700, the constructs differ sufficiently from one another.	(Urbach and Ahlemann, 2010)

Source: adapted from Urbach & Ahlemann (2010)

3.6.2 Inner model fit evaluation

Once the reliability and validity of the outer models established, several steps need to be taken to evaluate the hypothesised relationships within the inner model. The assessment of the model's quality is based on its ability to predict the endogenous constructs. The following criteria facilitate this evaluation: Coefficient of determination (R2) (Urbach and Ahlemann, 2010), predictive relevance (Q2) (Evermann and Tate, 2014), and path coefficients (Garson, 2016).

Evermann & Tate (2012) argue that while in traditional regression models the R2 proportion of explained variance is an indicator of the predictive strength of the model, researchers have recently advocated the use of blindfolding for assessing the predictive strength of structural equation models (Chin, 2010; Ringle et al., 2012). The purpose is to calculate cross-validated measures of model predictive accuracy (reliability), of which there are four: Construct cross-validated redundancy, Construct cross-validated communality, Indicator cross-validated redundancy and Indicator cross-validated communality (Garson, 2016).

However, in IS research, Evermann & Tate (2012) quoting Chin (2010) recommend to use redundancy-based blindfolding to assess the predictive relevance of one's "theoretical/structural model" and suggests that a value of $Q^2 > 0.5$ is indicative of a predictive model.

R^2 is the measure of the proportion of the variance of the dependent variable about its mean that is explained by the independent variable(s) (Gefen, Straub and Boudreau, 2000). Urbach & Ahlemann (2010) quoting Chin (1998b) considers values of approximately .670 substantial, values around .333 average, and values of .190 and lower weak. Nevertheless, the "significant value" of R^2 depends on fielding (Garson, 2016). The path coefficients should also be assessed. Urbach & Ahlemann (2010) reports that some authors argue that path coefficients should exceed .100 to account for a certain impact within the model (e.g., Huber et al. 2007). The paths coefficient significance test and p-value should be done using the bootstrapping technique.

Finally, the model fitness should be assessed. Henseler et al. (2016) argued that currently, the only approximate model fit criterion implemented for PLS path modelling is the standardised root mean square residual (SRMR). They further claimed that as can be derived from its name, the SRMR is the square root of the sum of the squared differences between the model-implied and the empirical correlation matrix, i.e. the Euclidean distance between the two matrices. By convention, a model has a good fit when SRMR is less than .08 (Hu & Bentler, 1998). Some use the more lenient cut-off of less than .10 (Garson, 2016). Table 5 gives an overview of the assessment of formative models. Four papers report the use of indicator weights to assess indicator validity while five reports the VIF for the same purpose. Only one paper reports the formative construct validity assessment.

Table 5. Structural model assessment

Validity type	Criterion	Description	Literature
Model Predictability	Predictive relevance $Q^2 > 0.05$	By systematically assuming that a certain number of cases are missing from the sample, the model parameters are estimated and used to predict the omitted values. Q^2 measures the extent to which this prediction is successful.	(Urbach and Ahlemann, 2010; Garson, 2016; Henseler, Hubona and Ash, 2016)
Model validity	Effect size (f^2)	Measures if an independent LV has a substantial impact on a dependent LV. Values of .020, .150, .350 indicate the predictor variable's low, medium, or large effect in the structural model.	(Urbach and Ahlemann, 2010; Venkatesh, Thong and Xu, 2012; Fang *et al.*, 2014; Xu, Benbasat and Cenfetelli, 2014; Johnston, Warkentin and Siponen, 2015; Garson, 2016; Schmitz, Teng and Webb, 2016)
Model validity	Model fit SRMR < 0.08	SRMR is a measure of close fit of the researcher's model.	(Garson, 2016; Henseler, Hubona and Ash, 2016)
Model validity	$R^2 > 0.100$	Coefficient of determination	(Urbach and Ahlemann, 2010; Hsieh and Petter, 2012; Setia, Ventkatesh and Joglekar, 2013; Wang, Tai and Grover, 2013; Majchrzak, Wagner and Yates, 2013; Marett, Otondo and Taylor, 2013; Bartelt and Dennis, 2014; Fang *et al.*, 2014; Xu, Benbasat and Cenfetelli, 2014; Ifinedo, 2015; Kankanhalli, Ye and Teo, 2015; Park, Sharman and Rao, 2015; Garson, 2016;

			Schmitz, Teng and Webb, 2016)
Model validity	Path coefficients Critical t-values for a two-tailed test are 1.65 (significance level = 10 percent), 1.96 (significance level = 5 percent), and 2.58 (significance level = 1 percent).	Structural path coefficients are the path weights connecting the factors to each other.	(Urbach and Ahlemann, 2010; Hsieh and Petter, 2012; Setia, Ventkatesh and Joglekar, 2013; Wang, Tai and Grover, 2013; Majchrzak, Wagner and Yates, 2013; Marett, Otondo and Taylor, 2013; Bartelt and Dennis, 2014; Fang *et al.*, 2014; Xu, Benbasat and Cenfetelli, 2014; Ifinedo, 2015; Kankanhalli, Ye and Teo, 2015; Park, Sharman and Rao, 2015; Garson, 2016; Schmitz, Teng and Webb, 2016)

Source: adapted from Urbach & Ahlemann (2010)

4. Conclusion

Partial Least Square Structural Equation Modelling has been applied in the field of Information Systems and is characterised as the primary user of that technical statistic. Nevertheless, its use is subject to critics. This review has updated the guidelines for the use of PLS-SEM in IS settings by integrating new criterion for assessing the measurement and the structural model. Nevertheless, this update is a non-technical point of view. The further inquiry could be taken to show how to reports the results of these provided criterions.

APPENDIX 5. CORRELATIONS BETWEEN THE VARIABLES

	cost_15	cost_16	cost_17	ra_18	ra_19	ra_20	cp_21	cp_22	cp_23	sp_24	sp_25	sp_26	ob_27	ob_28	ob_29	si_30	si_31	si_32	iq_33	iq_34	iq_35	u_i_o_aif_36	u_i_o_aif_37	u_i_o_aif_38	ctr_39	ctr_40	ctr_41	ctr_42
cost_15	1																											
cost_16	,756**	1																										
cost_17	,794**	,759**	1																									
ra_18	,589**	,587**	,611**	1																								
ra_19	,630**	,665**	,667**	,777**	1																							
ra_20	,522**	,609**	,557**	,749**	,763**	1																						
cp_21	,595**	,643**	,605**	,731**	,795**	,747**	1																					
cp_22	,597**	,632**	,625**	,650**	,710**	,711**	,700**	1																				
cp_23	,572**	,645**	,571**	,641**	,674**	,657**	,659**	,689**	1																			
sp_24	,413**	,405**	,367**	,377**	,455**	,376**	,397**	,347**	,378**	1																		
sp_25	,359**	,356**	,353**	,382**	,450**	,346**	,387**	,332**	,306**	,807**	1																	

sp_26	,426**	,409**	,349**	,379**	,417**	,379**	,395**	,345**	,306**	,797**	,781**	1												
ob_27	,590**	,665**	,642**	,673**	,746**	,706**	,700**	,680**	,652**	,343**	,409**	,382**	1											
ob_28	,599**	,635**	,588**	,703**	,762**	,743**	,751**	,734**	,686**	,359**	,323**	,348**	,742**	1										
ob_29	,572**	,593**	,587**	,685**	,729**	,718**	,748**	,692**	,657**	,295**	,325**	,298**	,752**	,796**	1									
si_30	,115	,052	,028	,080	,064	,056	,113	-,006	,089	-,143*	-,083	-,107	,115	,081	,118	1								
si_31	,088	,015	,050	-,039	,007	-,059	,028	-,060	-,007	-,150*	-,079	-,113	,077	-,017	,073	,802**	1							
si_32	,078	,018	,026	-,044	,035	-,046	,058	,011	,028	-,097	-,089	-,128	,068	,065	,143*	,718**	,759**	1						
iq_33	,516**	,565**	,544**	,657**	,721**	,670**	,662**	,626**	,538**	,280**	,291**	,274**	,653**	,726**	,632**	,075	,018	,042	1					
iq_34	,531**	,578**	,539**	,643**	,679**	,643**	,667**	,595**	,570**	,334**	,302**	,364**	,671**	,662**	,585**	,083	,035	,046	,656**	1				
iq_35	,562**	,653**	,591**	,703**	,723**	,718**	,769**	,668**	,656**	,355**	,338**	,383**	,673**	,694**	,711**	,007	-,036	-,028	,658**	,705**	1			
u_i_o_aif_36	,550**	,563**	,543**	,604**	,638**	,602**	,642**	,623**	,639**	,441**	,446**	,467**	,612**	,620**	,583**	,049	-,003	,023	,582**	,571**	,659**	1		
u_i_o_aif_37	,508**	,562**	,538**	,550**	,662**	,576**	,606**	,564**	,567**	,338**	,380**	,336**	,616**	,659**	,613**	,044	-,070	-,020	,591**	,601**	,625**	,525**	1	
u_i_o_aif_38	,534**	,641**	,594**	,705**	,731**	,674**	,714**	,699**	,677**	,381**	,404**	,372**	,723**	,704**	,707**	-,008	-,076	-,045	,626**	,605**	,681**	,630**	,659**	1

ctr_39	,543**	,599**	,551**	,619**	,653**	,610**	,661**	,578**	,572**	,290**	,348**	,312**	,639**	,677**	,625**	,096	-,013	-,038	,564**	,554**	,670**	,615**	,610**	,623**	1			
ctr_40	,530**	,588**	,581**	,654**	,724**	,666**	,727**	,630**	,605**	,337**	,384**	,353**	,659**	,690**	,630**	,012	-,064	-,045	,635**	,628**	,684**	,622**	,602**	,671**	,750**	1		
ctr_41	,497**	,629**	,597**	,625**	,687**	,692**	,645**	,634**	,627**	,357**	,305**	,305**	,609**	,689**	,658**	,042	-,029	,009	,587**	,573**	,710**	,581**	,627**	,686**	,663**	,643**	1	
ctr_42	,554**	,632**	,599**	,583**	,686**	,666**	,660**	,618**	,615**	,435**	,369**	,367**	,585**	,666**	,629**	,044	-,021	-,006	,560**	,594**	,683**	,577**	,614**	,669**	,687**	,629**	,865**	1

APPENDIX 6. RESEARCH APPROVAL LETTER

UNIVERSITY OF NAIROBI

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P. O. Box 30197
00100 GPO
Nairobi, Kenya

Our Ref: UON/CBPS/SCI//PhD/2015

18 April 2016

TO WHOM IT MAY CONCERN

Dear Sir/Madam

RE: <u>MACIRE KANTE REG. NO. P80/50081/2015</u>

The above named is a bona fide student pursuing a Ph.D degree in Information Systems at the School of Computing and Informatics, University of Nairobi.

As part of the course, students are required to undertake a research project. Hence, Mr. Macire is currently carrying out his research on the project entitled: ***"A Model for ICTs' Contribution to the Access and use of Agricultural Inputs Information in Developing Countries: Case of Sikasso Mali."*** Under the supervision of Dr. Robert O. Oboko and Dr. Christopher K. Chepken of SCI.

We would be grateful if you could assist Mr. Macire as he gathers data for his research. If you have any queries about the exercise please do not hesitate to contact us.

Yours faithfully

School of Computing & Informatics
University of NAIROBI
P. O. Box 30197
NAIROBI

PROF. W. OKELO-ODONGO
DIRECTOR
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Nos réf : UON/CBPS/SCI/PhD/2015

18 AVRIL 2016

A l'attention des personnes concernées

Monsieur / Madame,

RE: MACIRE KANTE REG. NO. P80/50081/2015

Le ci-dessus nommé est un étudiant régulier poursuivant un doctorat en systèmes d'information à l'école d'informatique et des systèmes d'information de l'université de Nairobi (**SCHOOL OF COMPUTING AND INFORMATICS, UNIVERSITY OF NAIROBI)**

Dans le cadre de leur formation, les étudiants sont tenus d'entreprendre un projet de recherche. Par conséquent, Monsieur Macire conduit actuellement sa recherche dans un projet intitulé : **" A model for ICTs' contribution to the access and use of agricultural inputs information in Developing Countries : case of Sikasso Mali."** , sous la supervision des Dr Robert O. Oboko et Christopher K. Chepken DE LA SCI.

Nous vous serions reconnaissants de toute assistance que vous accorderez à Monsieur MACIRE dans la collecte de données pour sa recherche. Si vous avez des requêtes ou besoin d'informations supplémentaires n'hésitez pas à nous contacter.

Professeur W.OKELO-ODONDO

DIRECTOR

SCHOOL OF COMPUTING AND INFORMATICS

BEST CENTER
LE GÉRANT
ANGLAIS - INFORMATIQUE

APPENDIX 7. MODE OF DATA COLLECTION EFFECT ON DATA

1. The impersonality of the method: while an interviewer can enhance motivation to respond as well as response accuracy, self-administration methods increase perceived impersonality and may encourage reporting of some sensitive information (e.g. in interview situations there may be fear of embarrassment with the exposure of weakness, failure or deviancy in the presence of a stranger).
2. The cognitive burden imposed by the method: different methods make different demands on respondents, including reading, listening, following instructions, recognising numbers and keying in responses. Face-to-face interviews make the least demands, while the lack of visual support in telephone interviews may make the task more complex.
3. The legitimacy of the study: this may be more difficult to establish with some methods than others. In contrast to paper or electronic communications, telephone contacts limit the possibilities for establishing the survey's credentials. This might affect initial response and the importance respondents place on the study, and their motivation to answer questions accurately.
4. The control over the questionnaire varies: interviewers have the highest level of control over question order; in self-administered paper questionnaire modes there is little control over question order.
5. Rapport: rapport between respondent and interviewer may be more difficult to establish in self-administration and telephone interview than in face-to-face modes, as there is no visual contact. This can adversely affect motivation to respond, although social desirability bias may be reduced as there is less need for approval.
6. Communication style: more information may be obtained in interview than other situations, as interviewers can motivate respondents, pause to encourage (more, longer) responses, and clarify questions; interviewers can also lead to interviewer and social desirability bias.

Source: (Bowling, 2005)