



ASSESSING FACTORS THAT INFLUENCE THE SUCCESS OF AGRICULTURE
MOBILE INFORMATION SYSTEMS: A VALIDATION WITH THE DELONE AND
MCLEAN MODEL

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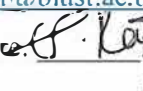
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A Dissertation/Thesis Submitted to the College of ICT in Partial Fulfilment of the
Requirements for the Award of the Degree of Master of Science in Information Systems of
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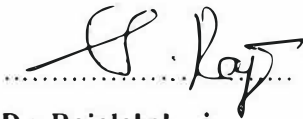
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CERTIFICATION

The undersigned certifies that he/she has read and hereby recommends for acceptance by the College of Science a dissertation/thesis titled: *Assessing Factors That Influence The Success Of Agriculture Mobile Information Systems: A Validation With The DeLone And McLean Model*, in fulfilment of the requirements for the degree of Master of Science in Information Systems at BIUST.



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DEDICATION

This thesis is dedicated to my beloved mom Lucy Phalaagae and dad Andrew Thapedi Phalaagae who have nurtured me to become the woman I have become. I want to especially thank her for giving me courage and wisdom throughout my research. A special dedication of this thesis goes to my late mother Lembi Bernadette Ipinge, I want to thank her for bringing me to this world and May her soul rest in everlasting peace. I also dedicate this thesis to my beloved grandmother Dumilano Gloria Ipinge and aunt Fanny Ipinge who have continuously prayed for the success of this thesis. Most importantly I dedicate this thesis to my almighty father for he has given me the wisdom, strength and courage to successfully complete my thesis.

ACKNOWLEDGEMENT

The completion of this thesis would not have been possible without the guidance and support of the Almighty God and the support of family, colleagues and friends. First I would like to thank my supervisor Dr. Selvaraj Rajalakshmi and my co-supervisor Dr. Malatsi Galani for thier guidance, patience, the sharing of her knowledge and overall support towards the completion of my thesis. I would also like to thank Dr. Dimane Mpoeleng for giving me an insight on the behavioral science area of research and its application and implication on information systems. I would also like to thank Professor Irina Zlotnikova for guiding us through the research process and enlightening us on how to do research through graduate seminars. I would like to thank the Botswana International University of Science and Technology for giving me the opportunity to pursue my masters.

Abstract

The purpose of this study is to assess the factors that influence the success of agriculture mobile information systems in Botswana. Agriculture mobile information systems have been widely adopted in the commercial and subsistence agricultural sector however little research has explored the success of agricultural mobile information systems. Firstly the factors that influence the success of agricultural mobile information system were identified and adopted from the DeLone and McLean model. The factors are; system quality, information quality, service quality, use, user satisfaction and Net benefits. The model has been widely adopted and used by previous researchers to measure Information system success in different contexts. DeLone and Mclean stated that Information system success is a multi-dimensional construct and as such the factors identified should be measured or examined and further validated in different contexts. The success factors were then adapted and applied to measure the success of agriculture mobile information systems in Botswana. A quantitative study was conducted using a 5 likert scale questionnaire to collect data from a random sample of 150 commercial and subsistence farmers across Botswana with experience using the mAgri mobile App using a thirty two item questionnaire adopted from prior validated studies. Statistical analysis was performed using the Smart MPLS program for validating the IS success factors using the measurement model and the structural model. The measurement model was used to test for the reliability and validity of the factors as suitable instruments for measuring IS success in the context of Agriculture. The structural model was used to test the overall fit of the model and the inter-relationships between the factors in the model. The results from the measurement model depicted that all the six factors and their observed variables were valid and reliable measures to be used for assessing agriculture mobile information system success. The results from the structural model show that the seven hypotheses were supported however the relationship between information quality and user satisfaction and information quality and use were not supported

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Synonyms

ICT	Information Communication Technology
IS	Information Systems
IT	Information Technology
D&M	DeLone & McLean
MIS	Mobile Information Systems
GDP	Gross Domestic Product
MOA	Ministry of Agriculture
USSD	Unstructured Supplementary Service Data
SMS	Short Message Service
TAM	Technology Acceptance Model
SPSS	Statistical Program Software
CFA	Confirmatory Factor Analysis
PLS	Partial Least Squares
SEM	Structural Equation Modeling
U	Use
US	User Satisfaction
SVQ	Service Quality
NB	Net Benefits
SQ	System Quality
IQ	Information Quality
AVE	Average Variance

CR	Composite Reliability
App	Application
mAgri	Mobile Agriculture
Agri	Agriculture
VIF	Variance Inflation Factor
E-HRM	Electronic Human Resource Management
PLS SEM	Partial Least Squares Structural Equation Modeling

Chapter 1

1.0 Introduction

Agricultural information systems play a pivotal role in the success or failure of farming practices and enterprises. Gaining a competitive advantage is crucial for all farmers. Agricultural information systems provide a competitive edge to farming businesses and practices by providing improved services, quality of information, consequently leading to efficiency in the agricultural sector of the economy. Agricultural farmers adopt competitive strategies such as the use of innovation and automated systems in an attempt to improve and radically transform their day to day farming activities, services and the entire agricultural sector [1]. Information system innovations in the agricultural sector involve mobile and internet applications which comprise of the linking of disparate systems and software in such a way that they become self-acting and self-regulating by reducing human intervention.

The mobile telephony industry has experienced an exponential growth on the use and adoption of mobile phones which have been proven to be the core of telecommunication and for connecting vast communities. Mobile enabled information services provide an effective way to improve information dissemination to the knowledge intensive agriculture sector and help to bridge the gaps between availability and delivery of agricultural inputs and infrastructure [1]. According to Maningas [2] information within the hands of the farmers means empowerment through control over their resources and the making of better and informed decisions. The increasing prevalence of mobile information systems in the agriculture domain has led to a growing need to measure their success.

DeLone and McLean [3] comprehensively reviewed six variables for measuring information system success and proposed a model illustrating the interrelationships between them namely: 1)'system quality', 2)'information quality', 3)'service quality', 4)'use', 5)'user satisfaction' and 6)net benefits. Information system success is a multi-dimensional construct and as such the factors identified should be measured or examined and further validated in different contexts [4]. In this digital age, it is essential to strengthen the use of information systems for stimulating information dissemination through e-learning, agricultural extension services and marketing to enhance agricultural sustainability. The success of such an information system is therefore imperative to be evaluated for effective functioning of the mobile information system to meet the needs of the farmer. The effective functioning of a system requires the information system to be applicable and acceptable to the users. System

developers must however recognize factors that influence the successful use and adoption of the information system.

1.1 Background Information

Agriculture contributes 2.5% to the Botswana Gross Domestic Product (GDP) [5]. According to Central Statistics Office (CSO) annual agricultural survey report 2014 [6]; the number of traditional active farmers in Botswana increased by 0.3% from 119,936 in 2013 to 120,317. Subsistence farming is a norm in Botswana with less than 1000 farmers active in commercial farming[7]. Major challenges facing the sector include production volumes and efficiency. Lack of infrastructure and support services hamper production but are themselves a result of a number of systemic gaps. Many of the production farms are scattered apart making it difficult to provide services such as roads, electricity, water, telecommunications and extension services [8]. Two mobile applications: Modisar[9] and mAgri[10], were developed for disseminating agriculture information to Botswana farmers in an effort to try alleviating the communication gap between farmers and extension services.

1.1.1 Modisar

The 'modisar' mobile App was developed in Botswana to revolutionize farming practices and to provide a platform for livestock farmers to manage their farms for profitable farming. The application was designed to stimulate development of the livestock industry in Botswana and cultivate interest in livestock farming among younger generations by associating modern technologies with the nation's passion for farming [9]. The mobile app operates on android phones and is web based. Modisar provides a livestock management platform offering services such as livestock farming knowledge base and market insights. In addition, Modisar services include farm/ranch management, animal management, health management, collaboration with farm employees and farm financials management [9].

1.1.2 mAgri

The 'mAgri' agricultural mobile app which was designed specifically to disseminate agriculture information to farmers such as marketing information, weather updates and alerts among subsistence and commercial farmers living in Botswana. The mobile farming app uses USSD technology which allows farmers using feature phones to have equal access to information as those with smart phones. The mAgri mobile app enables farmers to chat, have access to the mobile market place where farmers can buy and sell on the app. Other services include Agri tips, Wikipedia search and email as tools for disseminating and accessing

agricultural information to address the information needs of farmers. This mobile app transforms the entire Agri community as it extends to the underserved communities by using technological innovations and giving the users effortless access to timely information [10].

The benefits of the mAgri mobile App is that it addresses the concerns of farmers such as inadequate access to extension services and their information literacy needs by seamlessly taking the services to the farmers and equipping them with the necessary information for fundamental best farming practices. The mAgri mobile App was adapted as the research locale as it is widely used by various farmers in Botswana for crop production and animal husbandry disciplines and targets the entire agriculture community in Botswana. The mAgri app is unbiased and provides a more generalizable agriculture population that serves as a basis for investigating agriculture mobile information system success in Botswana.

The purpose of this study is to apply, measure and to validate the applicability of the DeLone and McLean IS model to agriculture mobile information systems in Botswana. The IS success factors were identified and adopted from the DeLone and McLean model. The factors adopted from the DeLone and McLean IS success model are; system quality, information quality, service quality, use, user satisfaction and Net benefits. DeLone and McLean 1994 stated that the IS success factors should be measured or examined and further validated in different contexts. The study serves an important role by responding to the quest of DeLone and McLean [3] by adapting the IS success model and applying it in the context of agriculture to measure the success of agriculture mobile information systems in Botswana. The study further tested the overall fit of the model and examined the inter-relationships between the underlying IS success factors.

1.2 Theoretical Background

Researchers have derived a number of attempts to explain what makes an information system a success. Though empirical early studies by researchers have adopted multiple measures of IS success, the true meaning of IS success has always been ambiguous and remains a controversial issue among IS researchers due to the complex, interdependent and multi-dimensional nature of Information system success [11]. The ambiguity is a result of success being a multidimensional concept that can be evaluated at different levels and has several assessment criteria [12].

In an attempt to address this problem [13] comprehensively reviewed six variables of IS success and proposed a model illustrating the interrelationships between them namely: 'system quality', 'information quality', 'use', 'user satisfaction', 'individual impact' and 'organisational impact'. Several empirical studies have been made and the findings of these studies provided important implications for using the D&M model in research and practice.

Later after the publication of the success taxonomy, information system researchers proposed modifications and extension to the proposed model. Accepting the call for further development and validation of the model [14] added service quality as a quality factor to the DeLone and McLean model. Seddon and Kiew [15] studied a portion of the model and in their evaluation they modified the construct 'use' stating that the underlying success construct that researchers have been trying to study is usefulness instead of use. Seddon's concept of usefulness was derived from the Technology Acceptance Model (TAM) by Davis [16]. Seddon and Kiew [15] argued that use is an appropriate measure for voluntary systems whereas usefulness is a right measure for an instance where use is mandatory. DeLone and McLean responded that, even in mandatory systems there can still be variability in the use therefore the construct use deserves to be retained.

Seddon [17] further claimed that use is not a success measure but a behavior and re-specified it with 'perceived usefulness' which serves as a general perceptual measure of the net benefits of information system use. DeLone & McLean argued that Seddon's reformulation of the model into two partial variance models (IS success model and partial behavioral model of IS use complicates the success model and contraries the intent of the original model. Later [18] revised their model and made minor adjustments to it by re-defining their updated model. DeLone and McLean [19] updates their success model by using system usage or alternative intention to use as an important measure of IS success. DeLone and McLean further adds service quality measure as a new factor for the IS success and lastly groups all the impact measures into a single impact category called 'net benefit'. In conclusion, the updated DeLone and McLean model [19] success variables are enlisted as: 'system quality', 'information quality', 'service quality', 'use', 'user satisfaction', 'individual impact' and 'Net benefits'.

DeLone and McLean [19] highlight four conclusions from their research: The IS researcher has a broad list of individual dependent variables to choose from, significant reductions in the number of independent variable measures are needed so that research results can be

compared, there are too few Management Information Systems (MIS) field study research attempts to measure the influence of agriculture mobile information systems in an effort to enhance the successful use of the system by the farmers. Mobile information system success is a multidimensional construct and it should be measured as such. However, there is limited published literature emphasizing the measures of successful agriculture mobile information systems. The literature review has identified that the updated DeLone and McLean information system success model is a useful basis for this research. Therefore this study serves as a basis to close this knowledge gap.

1.3 Problem Statement

The failure of Information systems is a major concern for organizations. In targeting this failure, evaluation of IS success emerges as a prerequisite to increase the rate of success in future Information systems initiatives. Agriculture mobile information systems currently lack appropriate success evaluation tools that will explain and report the success of these modern interactive mobile information systems which are used voluntarily to assure the effective functioning of the system. Furthermore, there is a research gap related to determining the mobile app attributes that could affect the success of Botswana agriculture mobile information systems. So far the researcher has not identified any similar research being done in this field. Moreover there are no empirical studies that have unearthed agriculture mobile information system attributes or factors that are critical in improving continued usage, increased satisfaction and benefits of the mobile app systems to Botswana farmers. DeLone and Mclean[13], [18], [19] stated that Information system success is a multi-dimensional construct and as such the factors identified should be measured or examined and further validated in different contexts. The research fills this knowledge gap by determining the mobile app success factors.

1.4 Objectives

The main objective of this study is as follows:

To assess the factors which influence the success of agricultural mobile information systems

1.4.1 Specific Objectives

Consequently, the specific objectives are identified as follows:

1. To identify the factors that influences the success of agricultural mobile information system.

2. To test the validity and reliability of the IS success factors in the context of agriculture mobile information system.
3. To measure the relationships between the factors of the DeLone and McLean model.

1.5 Research Questions

1. What are the factors influencing agriculture mobile information system success?
2. How valid and reliable are the IS success factors in assessing agriculture mobile information system success?
3. What are the relationships between the success factors?

1.6 Hypotheses

The hypotheses are useful in identifying the relationships between the factors contributing to the success of the information system. Understanding the relationships between the factors in the context of agriculture mobile information system is important as it gives an insight to information system developers to design efficient, robust and informative systems for the farmers. The Hypotheses of this study are adopted from the updated DeLone and McLean model [19] illustrating the relationships between the six success variables: 'system quality', 'information quality', 'service quality', 'use', 'user satisfaction', 'individual impact' and 'Net benefits'. The updated DeLone and McLean model has dependent variables (use, user satisfaction and net benefits) and independent variables (system quality, service quality and information quality) which are further discussed in chapter 4. Objective No.3 was further divided into 9 sub questions and the sub questions were used to generate the 9 hypothesis for the study.

- 1. Does system quality positively affect the use of agriculture mobile information systems?**

H1: System quality will positively affect use of the agriculture mobile information system.

- 2. Does information quality affect the use of agriculture mobile information systems?**

H2: Information quality will positively affect use of the agriculture mobile information system.

- 3. Does service quality positively affect the use of agriculture mobile information systems?**

H3: Service quality will positively affect use of the agriculture mobile information system.

4. Does system quality positively affect the user satisfaction of agriculture mobile information systems?

H4: System quality will positively affect user satisfaction of the agriculture mobile information system.

5. Does information quality positively affect the user satisfaction of agriculture mobile information systems?

H5: Information quality will positively affect user satisfaction of the agriculture mobile information system.

6. Does service quality positively affect the user satisfaction of agriculture mobile information systems?

H6: Service quality will positively affect user satisfaction of the agriculture mobile information system.

7. Does use positively affect the user satisfaction of agriculture mobile information systems?

H7: Use will positively affect user satisfaction of the agriculture mobile information system.

8. Does use positively affect the perceived net benefits of agriculture mobile information systems?

H8: Use will positively affect perceived net benefit of the agriculture mobile information system.

9. Does user satisfaction positively affect the net benefits of agriculture mobile information systems?

H9: User satisfaction will positively affect perceived net benefit of the agriculture mobile information system.

1.7 Contribution to the Body of Knowledge

This study makes several contributions to the body of knowledge of Information systems. Firstly it contributes to the existing body of knowledge by comprehensively investigating the relationships between the success factors of agricultural mobile Apps in Botswana. Secondly, this study empirically tested the DeLone and McLean updated information system success model in a mobile environment and will be the first to apply this model to assess the success of agriculture mobile Information systems. The study contributes by meeting the call

of Petter *et al.* [11] for comprehensive measurement instruments and rigorous success measurement methods to create comprehensive, replicable, and informative measures of IS success” (p. 258) which can be used by future researchers and practitioners. Mollar & Licker [12], informed that success is a multidimensional concept that can be evaluated at different levels and has several assessment criteria and this study serves an important role in evaluating information system success at the individual level (the farmer in this case) in the context of agriculture in Botswana. Careful evaluation of information systems is crucial as it determines the sustainability of systems under investigation and enhances effective functioning of these information systems.

In addition this study contributes by evaluating agriculture mobile systems to help determine success attributes or factors that can influence the effective functioning of these systems leading to the successful use of the mAgri mobile app by the farmers in Botswana. In practice, a well-defined or validated measure is essential for a sound evaluation of agriculture mobile information system success. The study contributes to the body of knowledge by guiding future research efforts through a comprehensive review of agriculture mobile information systems. The study also conducts a thorough review of literature and concludes by pointing out areas where work has been done so that new studies can work on the unidentified areas thus pointing out wide research areas that still need to be done.

1.7.1 Practical Implications

This study provides a validated evaluation tool for agriculture mobile App companies to use for evaluating the success of their mobile information systems. The success of agriculture mobile apps was investigated using six constructs: system quality, information quality, service quality, use/perceived use, user satisfaction and net benefits. These companies can adopt these factors to evaluate the success of other mobile apps. App companies should, however, note that these dimensions are interrelated and no single dimension is superior to another. Therefore, they should be examined jointly. This study also helps developers of farming apps to identify user requirements for the successful efficient and effective information system for the farmers being the targeted users of the system.

1.8 Research Justification

Based on the review of literature, the following are justifications for conducting this research:

- Previous researchers have not unearthed any major empirical findings on the agriculture mobile information system characteristics that are important to increase mobile application use, increase mobile application user satisfaction and benefit to Botswana mobile application enterprises. The researcher also did not identify any research being done on the factors affecting the success of mobile systems in the context of agriculture and hence the findings of this research will close this knowledge gap
- On account of the growing prevalence of mobile applications for the dissemination of agricultural information, the findings of this research could be used as a guide to the growing developmental needs for both existing and new agriculture mobile apps in Botswana.
- The research responds to DeLone & McLean [3] call for further validation of the model in different contexts. The findings of this research will contribute to the information systems body of knowledge by providing a validated instrument for measuring IS success in the context of agriculture mobile information system.
- The assessment of agricultural practices and technologies enhances productivity in a sustainable manner, food security and resilience.

1.9 Research Structure

This thesis consists of five chapters. Chapter one presents an overview of the key components of the study, problem definition, objectives, research questions, contribution to the body of knowledge. Chapter two provides a review of relevant literature on the DeLone & McLean model in information systems is performed. Several studies on measuring information system success were reviewed to identify information system success measures. Gaps as well as potential contributions of this study were identified from prior studies. Then, based on findings from the exploratory study of the literature related hypotheses were proposed. Chapter three presents the research methodology selected for the study. It outlines the methods used to achieve each specific objective and the methods for collecting and performing data analysis. The measures of information system success are also operationalized in this section. Chapter four discusses the results of each and every objective for this study. Finally, chapter five interprets the findings of the study, presents concluding remarks and then discusses practical implications, limitations of the study and opportunities for future studies.

Chapter 2

2.0 Literature Review

This section reviews current literature on the status of agriculture in Botswana and existing agriculture mobile Apps in and outside Botswana. In this section, we also discuss information system success, the evolution of the IS success model and how the model has been used by other researches in an attempt to evaluate IS success.

2.0.1 The Status of Agriculture in Botswana

The agriculture sector in Botswana has experienced a significant decline in its contribution to the Gross Domestic Product (GDP) over the past 42 years since independence in 1966 from 42.7% to 1.9% [20]. The Agriculture sector in Botswana covers both crop production and animal husbandry however the beef industry has remained a significant contributor to the nations GDP. According to NDP 10, only 45% of the farmers have access to roads, 17% electricity, 22% telecommunication, 66% water for domestic use, 43% water for irrigation, 64% water for livestock, 52% to markets (Ministry of Finance and development planning 2010). Other major challenges facing the agriculture sector include lack of infrastructure, climate change and lack of support services leading to low production volumes and inefficiency.

Majority of the farmers are small scale farmers who need continued assistance in capacity building to commercialize agriculture. According to Seleka [8], farmer associations have failed to foster collective action among farmers addressing that their associations have inadequate capacity to mobilize them into effective, coherent and cohesive groups. Seleka [8] also stated that farmers lack entrepreneurial skills which are necessary to foster commercialization of the agriculture sector while promoting the success of any business and diversification of the economy. The challenges incurred within the agriculture sector have led to a decline in the growth of the agro industrial and supply chain development that is needed to drive the associated sub sectors such as food processing, transport and manufacturing. The poor performance by this sector poses a challenge against the mission of eradicating poverty in Botswana. These challenges implies for the need of timely and appropriate response to the ever changing economic conditions with solutions such as technology development and transfer, capacity building and infrastructure development.

2.0.2 Digital Technologies & Agriculture Information

Agriculture technologies are developed by research institutes, private companies, universities for the delivery of agriculture knowledge dissemination. Information system development is an essential part of the diffusion and implementation of Information Technology facilitated by means of analysis, design, implementation and sustained support [21]. The information conveyed by the system is critical for agricultural education, research and extension services. Information systems play a vital role in providing a competitive edge to businesses in an effort to enhance their success while reducing costs and maximizing revenues. Organizations must however recognize factors that contribute to the success of the information system. In this digital age, it is essential to strengthen the use information systems for stimulating information dissemination through e-learning, m-learning and agricultural extension services as well as marketing to enhance agricultural sustainability.

The implementation of Information Communication Technologies and Information Systems has led to the development and adoption on the use of mobile based applications as a platform for disseminating real time information. According to Maningas *et al.* [2], information within the hands of the farmers means empowerment through control over their resources and the making of better and informed decisions. The National ICT Policy commonly known as Maitlamo [22] lays out a clear ICT goal that addresses the need for provision of universal service and access to information and communication facilities in Botswana.

2.1 Overview of Agriculture Mobile Information Systems

Mobile enabled information services provides an effective way to improve information dissemination to the knowledge intensive agriculture sector and helps to bridge the gaps between availability and delivery of agricultural inputs and infrastructure [23]. The information conveyed by the system is critical for agricultural education, research and extension services. According to Maningas *et al.* [2], information within the hands of the farmers means empowerment through control over their resources and the making of better and informed decisions. However these mobile information systems have to be evaluated to explain and report the effective implementation and use of these agriculture mobile information systems.

2.1.1 Agriculture Mobile Information Systems (International)

The mobile information systems are grouped into three categories; mobile advisory information systems also referred to as consultation, mobile market information systems and alert systems. The mobile advisory information systems such as the iCOW, vKVK, and Mkisan send advisory alerts from experts to farmers on farming methods and care. Mobile marketing information systems were identified as Esoko, Farmerline and Mfarm whose main deliverable is to provide market platform for farmers to receive market prices, sell of their produce and negotiate prices with agricultural and financial stakeholders. Alert systems such as Nokia Life tools, Mkrishi and Mshamba; are responsible for sending information such as weather updates, news and new technologies [2] [20] [21]. Several agriculture mobile applications have been developed in an effort to enhance information dissemination from agriculture service providers to farmers however little research has unearthed success criteria or evaluation tools for the effective functioning of these apps.

2.1.2 Agriculture Mobile Information Systems in Botswana

The first mobile App developed is the Modisar mobile App which was developed in Botswana to provide a platform for livestock farmers to manage their farms for profitable farming. The application was designed to stimulate development of the livestock industry in Botswana and cultivate interest in livestock farming among younger generations by associating modern technologies with the nation's passion for farming. The mobile app is android and web based and provides a livestock management platform which provides livestock farming knowledge base and market insights. Modisar services include farm/ranch management, animal management, health management, collaboration with farm employees and farm financials management.

2.1.3 Research Locale: mAgri Mobile App

The mAgri mobile farming App was designed to specifically disseminate agriculture information to farmers such as marketing information, weather updates and Alerts among farmers living in Botswana. The mobile farming App uses USSD and SMS technologies as tools for disseminating agricultural information to address agricultural information needs of farmers such as effortless access to timely information. The USSD technology which allows farmers using feature phones to have equal access to information as those with smart phones. The benefits of the mAgri mobile App is that it addresses the concerns of farmers such as inadequate access to extension services and their information literacy needs by

taking the services to the farmers by equipping them with the necessary information for fundamental farming practices.

The mAgri mobile app enables farmers to chat, have access to the mobile market place where farmers can buy and sell on the app. Other services include agri tips, Wikipedia search and email as tools for disseminating and accessing agricultural information to address the information needs of farmers. This mobile app transforms the entire agriculture community as it extends to the underserved communities by using technological innovations and giving the users effortless access to timely information.

Though information systems are widely developed and adopted, it is critical to draw to attention the required assessments so they can be used successfully and to successfully meet the needs of their target groups. Since the inception and the adoption of the mAgri farming App, it has never been evaluated through rigorous and empirically sound methods. Thus this study's main aim is to investigate the factors that influence the success of the mobile farming Apps in Botswana. The mAgri mobile App was adapted as the research locale as it is widely used by various farmers in Botswana for crop production and animal husbandry disciplines and targets the entire agriculture community in Botswana. The mAgri app is unbiased and provides a more generalizable agriculture population that serves as a basis for investigating agriculture mobile information system success in Botswana. The mAgri mobile App allows farmers to set up their on mobile stores and allows farmers to search for products and services and compare prices using their mobile phones. The mAgri mobile application connects farmers with the latest news and announcement from the Ministry of Agriculture, other farmers, buyers and resellers both local and internationally. A screen shot of the mAgri home menu user

interface is shown

in figure 1 below.

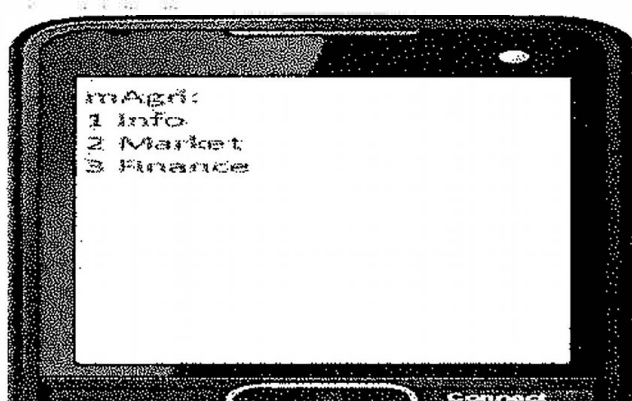


Figure 1: mAgri Main Menu [11]

2.2 Agriculture Mobile Information System Success

Information systems play a decisive role in the success or failure of an organization. Organisations spend thousands of dollars in the design and implementation of the information system with the aim of improving individual and organisational performance. Therefore the success of such information systems should be evaluated. Information system success is a critical issue among practitioners and researchers. The effective measurement of IS success provides the value of Information system management actions and IS investments [13][19]. The process of analysing agriculture mobile information system success involves several aspects such as; assessing the quality of the information conveyed by the information system, the quality of services delivered by the system, the system quality, the direct use of the system by the farmer, if the user is satisfied by the overall impact of the system and the net benefits of the system to the individual and organisation as a whole.

2.3 Information System Success Models

Several researchers have proposed alternative frameworks for measuring IS effectiveness. Grover *et al.* [24] used theory of organizational effectiveness comprising of five measures; economic measures (organisational impacts), market measures, usage measures (system use), perceptual measures (user satisfaction) and productivity measures (individual impact) [19]. Their framework considers system quality and information quality to be antecedent effectiveness constructs whereas D&M considers them as important factors of IS success themselves. In conclusion, Grover *et al.* [24]. IS effectiveness framework validates the DeLone and McLean IS success model and suggests extension on market impacts which are further extended and updated by DeLone and McLean in their updated model.

Smithson and Hirschheim [25] proposed a conceptual IS evaluation framework based on theoretical grounding composing of three evaluation zones namely: efficiency, effectiveness and understanding. This framework comprises of evaluation criteria which overlap the D&M model with attributes such as system quality, system usage, user satisfaction, cost benefit analysis. Other factors include software metrics, organizational behaviour, sociology, cognitive psychology. The framework is a source for identifying and developing IS evaluation measures rather than a single frame work of success dimensions and relationships i.e. DeLone and McLean model. The framework does not specify actual success constructs and related measures which make it difficult to apply in practice. However, it offers the researcher an alternate framework for developing IS evaluation schemes.

2.4 Theoretical Model

In this section we describe the DeLone and McLean IS success model in detail.

2.4.1 The Development of the IS Success Model

Researchers have developed numerous models in an attempt to explain what makes some Information systems more successful. Davis [16] developed the Technology Acceptance Model (TAM) using the Theory of Reasoned Action and Theory of Planned Behaviour by Fishbein and Azjein [26] in an attempt to explain why some information systems are readily accepted by users than others. Acceptance however is a necessary pre-condition for evaluating IS success and can never be equated to information system success. Acceptance is a necessary precondition to success and nonetheless not equivalent to success [11]. Several attempts to measure IS success were ill defined, as a result DeLone and McLean created a taxonomy for measuring IS success.

Information system success is a complex construct to measure due to its multi-dimensional and independent nature. This factor made several attempts to measure IS success by prior researchers to be ill-defined. DeLone and McLean [3] created a taxonomy of IS success based upon a review of published literature based on published literature from 1981- 1987.

This taxonomy was based on Mason's modification of the Shannon and Weaver [27] model of communication which had three levels of information: the technical level (accuracy and efficiency of the system), the semantic level (its ability to transfer the intended message), and the effective level (its impact on the receiver). D&M identified six variables by mapping them to each of Manson's effective levels. The six variables of IS success were identified as; system quality', 'information quality', 'use', 'user satisfaction', 'individual impact' and 'organisational impact' as components of IS success. Shortly after the publication on the DeLone and McLean Information system success model, IS researchers began proposing modifications to the D&M model. Accepting the call for further development and validation of the model Seddon & Kiew [15] studied a portion of the model and in their evaluation they modified the construct 'use'. The Results from their study show that "use" from the DeLone and McLean model was replaced with "usefulness". The other difference between Seddon and Kiew's model and the DeLone and McLean model is that a new variable "system importance" was added explain variations in user's perceptions of usefulness and user satisfaction. Seddon and Kiew argued that usefulness causes user satisfaction and not vice versa [15].

2.4.2 Overview of the DeLone & McLean Model

The original DeLone and McLean model's primary purpose was to synthesize previous research involving IS success into a more coherent body of knowledge and to provide guidance to future researchers. Though Empirical studies have adopted multiple measures of IS success, the true meaning of IS success has always been ambiguous and remains a controversial issue among IS researchers. The ambiguity is a result of success being a multidimensional concept that can be evaluated at different levels and has several assessment criteria [12]. The widely adopted success model in investigating and evaluating IS success is the DeLone and McLean model.

DeLone & McLean [3] comprehensively reviewed six variables of IS success and proposed a model illustrating the interrelationships between them namely: 'system quality', 'information quality', 'use', 'user satisfaction', 'individual impact' and 'organisational impact'. In the D&M IS success model, system quality measures technical success, information quality measures semantic success; and use, user satisfaction, individual impacts and organizational impacts measure effectiveness success [3]. The system quality construct is associated with the desired characteristics of the information system whereas the information quality construct measures the quality of the information produced by the information system (input). And lastly the output of the information system focuses on the outcomes of the user's interaction with the information system. User satisfaction is the outcome of the successful interaction of information system by the user which eventually influences the individual performance and organisational performance or benefits.

The DeLone and McLean model is a causal or variance model that studies the covariance of the success dimensions to determine if there is a causal relationship among the factors. System quality and information quality both affect use and user satisfaction. In addition the amount of use affects the extent of user satisfaction either positively or negatively. Use and user satisfaction are direct antecedents of individual impact which eventually impacts the entire organisation. A system with high system quality and or information quality, is expected to lead to the increased use of the information system thus yielding a high user satisfaction and eventually yield positive impacts on individual productivity and ultimately lead to organisational productivity and improvements [3]. The DeLone and McLean IS success model (1992) is illustrated in Figure 2 below.

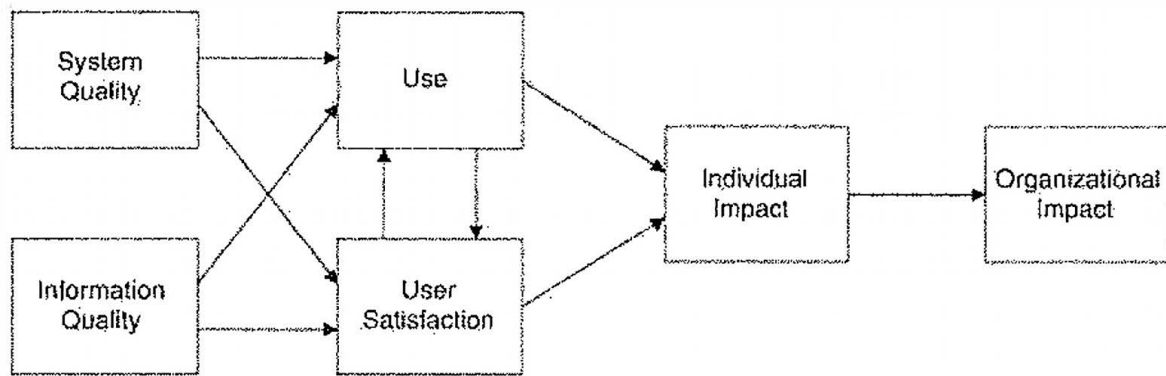


Figure 2: The Original IS success model[13]

2.4.3 The Updated DeLone & McLean Model

Later after the publication of the success taxonomy, information system researchers proposed modifications and extension to the proposed model. Accepting the call for further development and validation of the model Pitt *et al.* [14] added service quality as a quality factor to the DeLone and McLean model. Seddon & Kiew [15] studied a portion of the model and in their evaluation they modified the construct 'use' stating that the underlying success construct that researchers have been trying to study is usefulness instead of use. Seddon's concept of usefulness was derived from the Technology Acceptance Model (TAM) by Davis [16]. Seddon and Kiew [28] argued that use is an appropriate measure for voluntary systems whereas usefulness is a right measure for an instance where use is mandatory. DeLone and McLean responded that, even in mandatory systems there can still be variability in the use therefore the construct use deserves to be retained. Seddon [28] further claimed that use is not a success measure rather a behavior and re-specified it with 'perceived usefulness' which serves as a general perceptual measure of the net benefits of information system use. DeLone & McLean argued that Seddon's reformulation of the model into two partial variance models (IS success model and partial behavioral model of IS use complicates the success model and contraries the intent of the original model.

Pitt *et al.* [14] stated that DeLone and McLean ignored the value of the IS department and its personnel in assisting its users with several tasks such as problem resolution, installation and software education. DeLone and McLean responded to this critique by incorporating service quality into their updated model which is measured through the SERVQUAL instrument. In addition, another critique that was identified by prior validated research stated that the IS impacts extend beyond the individual and organizations. These impacts extend to customers, suppliers, markets, industries and even cities [18]. DeLone and McLean[18] in their

updated model merged individual benefits and organizational benefits into a single entity or construct and named it 'net benefits'. The last update was to include intention to use as an alternative to use due to its multi dimensionality. DeLone and McLean affirmed that intention to use could be more appropriate in some contexts where the use of the system is mandatory. DeLone and McLean further stated that the updated model is suitable for assessing the success of e-commerce. The updated version of the DeLone and McLean model are illustrated in Figure 2.

Later [13], [18] revised their model and responded to the critiques by making minor adjustments and redefined their updated model variables to: 'system quality', 'information quality', 'service quality' 'use or intention to use', 'user satisfaction' and 'Net benefits'. Figure 3 below shows the updated or adjusted DeLone and Mclean [18] IS success model with the updated model variables. Several empirical studies have been made and the findings of these studies provided important implications for using the D&M model in research and practice. DeLone and McLean highlighted a conclusion from their research by stating that: The IS researcher has a broad list of individual dependent variables to choose from, significant reductions in the number of independent variable measures are needed so that research results can be compared, there are too few MIS field study research attempts to measure the influence of the MIS effort on organisational performance and lastly MIS success is a multidimensional construct and it should be measured as such.

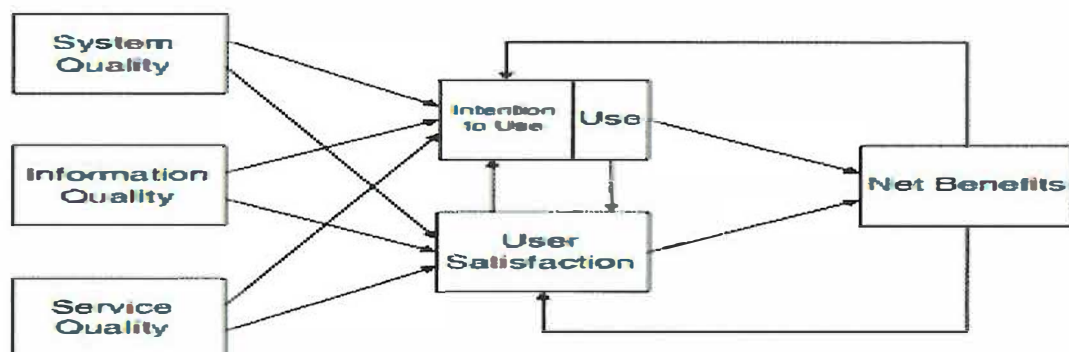


Figure 3: The Updated IS success model[19]

2.4.4 The Updated DeLone and McLean Model Success Measures

DeLone and McLean IS success measures for the updated model are system quality, information quality, service quality, intention to use/use, user satisfaction and net benefits. These measures are described in subsections below.

2.4.4.1 System Quality

System quality plays an important role in the success of an overall agriculture mobile information system. It is considered as a very important aspect for developers, users, and project managers. The desirable characteristics of an information system includes: ease of use, system flexibility, system reliability, ease of learning, as well as system features of intuitiveness sophistication, flexibility and fast response time [11]. According to Davis [16], Information systems that are perceived as effortless by users tend to be more likely accepted by users. Doll and Torkzadeh [29] stated that ease of use enhances efficiency of users using the Information system.

2.4.4.2 Information Quality

Information quality refers to the desirable characteristics of the information produced by the information system. According to [18] Information quality is measured in terms of accuracy, timeliness, completeness, relevance, accessibility, adaptability and consistency. IS content should be personalized, complete, relevant, easy to understand and secure if users of the system are expected to be returning [18]. According to Petter *et al.* [11], information quality is a key variable for measuring user satisfaction. The quality of information produced by the agriculture mobile IS determines the farmer's satisfaction from using the information system. If the system produces information which is difficult to understand among the farmers, it will lead to frustration among the farmers.

2.4.4.3 Service Quality

The construct service quality has been defined as the degree of discrepancy between customers' normative expectations for service and their perceptions of service performance. Several researchers [11], [18] define service quality as the overall internal or external support that the IT department or service provider offers to the system users. The main components of service quality are usability, availability, reliability, adaptability and response time [18]. Responsiveness is concerned with the support unit's willingness to provide timely support to address the needs of farmers. Poor support by the service providers will lead to a decline in the number of farmers using the mAgri mobile App hence leading to the farmers not benefiting from the App that is intended to improve their farming livelihoods, to create a market for them to sell off their produce and to have access to information that is relevant to them.

2.4.4.4 System Use/Intention to Use

Use is measured as reported by the users (i.e. System Use) or the actual use as reported by the system in terms of queries by time, connect time, or number of computer functions utilized. According to Seddon [15], use is the effort that will be consumed to use the IS and present frequency of use, number of use, use versus non-use as the best way to assess IS use. DeLone and Mclean [13] stated that use is only relevant in IS success if the use of the information system is voluntary. In addition, Rai *et al.* [30] proposed that the best way to evaluate the use of the information system is to measure the degree at which users are dependent on the IS to execute their work. The dimension of Use was subcategorized with Intention to Use to differentiate actual system use and the attitude toward the system before use [18]. DeLone and McLean [18] mentioned that intention to use is an attitude whereas use is behaviour. However, attitudes are difficult to measure and many researchers may choose to stay with actual use.

2.4.4.5 User Satisfaction

According to DeLone and McLean[3], user satisfaction is one of the most important dependent variables used in measuring the success of the system due to the non-volitional status of the majority of the systems. User satisfaction refers to measures of how the information delivered by the agriculture mobile system affects the farmers. It measures the user's opinions of the information system and covers the entire customer experience cycle from information retrieval through purchase, receipt and service [18].

2.4.4.6 Net Benefits

Net Benefits capture the balance of positive or negative impacts of the information system on the customers, suppliers, employees, organizations, markets, industries, economies and even societies. According to [18] the choice of where the impacts depends on the system being evaluated and their purposes. The benefits or the impacts of the information systems are grouped rather than enlisting them to a single individual or entity to resist from parsimony. The net benefits measures are determined by context and objectives for each e-commerce investment however many measures have been developed and tested in the context of IS investments in general [18]. System quality and information quality contributes to the net benefits of the IS investment for example the impact of a mobile application design cannot be fully understood without the evaluation on the usability of the mobile application. According to [18], It is impossible to determine net benefits without first defining context or frame of reference.

2.5 Rationale of the Model

There are several reasons why the DeLone and McLean model is chosen as a grounding theory to guide this research. The DeLone and McLean model is the most popular model in IS literature which measures information system success Petter and McLean [31]. In addition DeLone and McLean mentioned that success is a multi-dimensional construct and that with specific modifications their model can be applied to various information systems. Several researchers have answered the call for validation and modification of the DeLone and McLean IS success model in different contexts; Knowledge management systems by Wu and Wang [32], e-commerce by Mollar and Licker [12], e-learning systems by Lin [33], e-HRM by Alshibly [34], mobile banking systems by Chung [35], e-government systems by Wang & Liao [36].

The DeLone and McLean model is considered applicable to be used as a base model for the agriculture mobile information systems success because of its comprehensive set of constructs and linked relationships. All of the proposed measures are substantial in assessing agriculture mobile information systems success and can be divided into the updated DeLone and Mclean IS success model's six dimensions. The prevalent use of agriculture mobile information systems is also considered to have had an important influence on the mobile systems success. In 2003, DeLone and McLean [18] revised their original IS success model and gave an open call to validate this model in different contexts. For these reasons, the updated DeLone and Mclean IS success model [18] is considered to be an applicable model to be used in conducting research in assessing the success of e-commerce systems which makes agriculture mobile information system success context applicable in this study.

2.6 Previous Studies on Information System Success

Several studies have attempted to validate the entire model and some attempted to re-specify or extend the DeLone and McLean IS success model. The DeLone & McLean model has been adapted to suit different contexts for the measurement of IS success; Knowledge management systems by Wu and Wang [32], e-commerce by Molla and Licker [12], e-learning systems by Lin [33], e-HRM by Alshibly [34], mobile banking systems by Chung [35], e-government systems by Wang & Liao [36].

Wu and Wang [37] proposed and empirically assessed a Knowledge Management System (KMS) success model. In their study, five constructs (system quality, information quality, perceived KMS benefits, user satisfaction and system use) were used as dependent variables

in evaluating KMS success and their interrelationships were empirically measured through a two phased approach using structural equation modelling for hypothesis testing between the constructs. Firstly the measurement model was estimated using CFA to test the overall fit of the model and to justify factor structure and assess the reliability of and validity of factors and items. Secondly the hypotheses were tested between the constructs using structural modelling. The results of the study at individual level of analysis on empirical IS success evaluation reflected that system quality and user satisfaction have a positive correlation. Information quality and user satisfaction also proved to have a strong positive correlation. Net Benefits and user satisfaction also reflected a positive correlation whereas the measure between use and Net benefits reflected no significant relationship.

Wang and Liao [36] assessed e-government system success and validated the D&M IS success model. In their study, structural equation modelling technique was applied to data collected from 119 users of e-government systems in Taiwan. In their results, five hypotheses were supported except for the link between system quality and use. Alshibly 2014 evaluated E-HRM success and validated their study with the DeLone and McLean IS success model. In their survey, data was collected from 104 human resources managers and HR employees from the Jordanian governmental ministry. The data was analysed using structural equation modelling technique to the data that was collected. In their findings, all the 6 hypotheses were significantly supported by the data.

2.7 The Relationships between the IS Success Factors

The updated DeLone and McLean IS success model includes arrows to demonstrate the propose relationships or associations among the IS success factors but does not show positive or negative signs for the associations in causal sense [18]. Therefore the nature of these associations should be investigated within various contexts. A system of high quality is associated with more use of the system which eventually will lead to more user satisfaction leading to positive net benefits, As a result all the proposed associations would all be positive. On the Contrary, a system of low or poor quality would be associated with less use leading to a lot of dissatisfaction to the users of the system leading to negative benefits. The proposed associations would all be negative.

2.8 DeLone and McLean Model Validation and Adoption

The main purpose of this research study is to apply and test the updated D&M model of IS success in the context of agriculture mobile information system success. Thus, the researcher

has adopted the updated DeLone and McLean model and validates the model in the mobile agriculture context through evaluation of the mAgri mobile application. The collective findings from previous research [13], [18], [38] suggested that systems success or its measurements may vary considerably with key system or organization characteristics. Henceforth, the model should be modified according to the targeted context. Addition to this, DeLone and McLean [18] also stated that the model includes arrows to demonstrate proposed associations among success dimensions in a process sense, but does not show positive or negative signs for those associations in a causal sense. The nature of these causal associations should therefore be hypothesized within the context of a particular study.

DeLone and McLean [18] suggested that research must be done to further examine how the updated IS success factors can be applied in different contexts and advised researchers to further test and validate the updated model. Farmers use of the mobile application features makes the mobile farming Application an IS phenomenon that lends itself to the updated DeLone and McLean IS success model. DeLone and McLean [18] revealed that internet applications process fit well into their updated IS success model and the six dimensions of IS success and encouraged other researchers to continue testing and validating their multidimensional model. Information quality focuses on the quality of the mobile farming App output and its usefulness for the farmer. Information quality has been proven to be a critical IS success factor in the context of web based systems.

2.9 Hypothesis Development

DeLone and McLean stated that IS success is a multi-dimensional and interdependent construct. Therefore it is necessary to study the interrelationships between the constructs and to be validated before it could serve as a basis for the selection of appropriate IS success measure. DeLone and McLean further suggested that studying the interactions among the components or attributes of the model provides a clearer picture on what constitutes information system success. The study therefore attempts to test and validate the applicability of the D&M IS success model in the context of agriculture mobile information systems in Botswana. The hypothesized relationships between mobile farming IS success variables are based on the theoretical and empirical IS success model [18].

Information quality focuses on the quality of the output produced by the mAgri mobile App and its usefulness to the farmer [11], [16], [18], [28]. System quality considers performance, functionality and usability characteristics of the mAgri mobile App. Service quality

measures the overall support delivered by the service provider with regard to the farmers' use of the mAgri mobile App [11], [14], [18]. User satisfaction is the affective attitude of the farmer towards the mAgri mobile App [29]. Use as a behavior refers to the actual use of the mAgri mobile App by the farmers whereas intention to use is an attitude states whether farmers intend to use the mAgri mobile App [29]. Net Benefits focuses on the benefits of the mAgri mobile App to the farmer and the overall farm management processes [18]. The following hypotheses are constructed:

H1: Information quality will positively affect the use of the agriculture mobile information system.

H2: Information quality will positively affect the user satisfaction of the agriculture mobile information system.

H3: System quality will positively affect the use of the agriculture mobile information system.

H4: System quality will positively affect user satisfaction of the agriculture mobile information system.

H5: Service quality will positively affect the use of the agriculture mobile information system.

H6: Service quality will positively affect the user satisfaction of the agriculture mobile information system.

H7: Use will positively affect the user satisfaction of the agriculture mobile information system.

H8: User satisfaction will positively affect the perceived net benefit of the agriculture mobile information system.

H9: Use will positively affect the perceived net benefit of the agriculture mobile information system.

Figure 4 below shows the theoretical model illustrating the hypothesized interrelationships among the attributes of the updated DeLone and McLean IS success model.

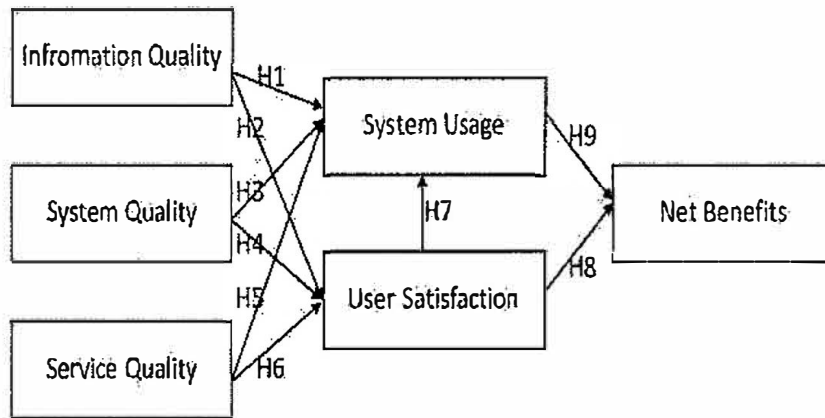


Figure 4 : Theoretical Research model [39]

Chapter 3

3.0 Methodology

3.1 Research Paradigm

The paradigm for this research is positivism which deals with testing theory in an attempt to increase the predictive understanding of a phenomenon. Positivist research involves formulating propositions that portray the subject matter in terms of quantifiable measures of dependent and independent variables and the relationships among them. Theory and observations have a dependence on each other however authentic theories should be validated through observation. In this light, the study serves an important role by taking the positivist route to validate the hypothesized relationships among the factors contributing to the success of the agriculture mobile information system. The D&M success model was used as an instrument to test the success of the agriculture mobile application. According to Hussey and Hussey[40], if a research follows the positivism paradigm, the quantitative research methodology is the appropriate research methodology for that particular research.

3.2 Research Strategy

Research strategy defines key phases of the study. This study incorporates the quantitative research approach in a top down framework focusing on construct definitions, possible relationships between constructs in the IS success context leading to the validation of the research model used. The study uses the deductive research approach that typically begins with a logical framework/model to categorize the responses employing the top-down approach.

The deductive approach uses an existing model as the foundation for the data mapping exercise. In general, frameworks/models are developed through extensive research where the dimensions and measures are based on either theory or empirical research. Therefore, it is believed that in most frameworks and models, the dimensions and measures are mutually exclusive. The mutually exclusivity of the dimensions and measures would ease the data mapping synthesis and analysis efforts of the identification-survey. Furthermore, the use of existing frameworks and models make the findings and interpretation more generalizable and repeatable in a longitudinal study.

3.3 Research Methods

The purpose of this section is to describe the research methods that were applied to address the four research objectives and consequently the research hypotheses that were tested. The study adopts the explanatory research method in an attempt to generate knowledge with the help of quantitative research methods to enhance precision of describing parameters and the relationships among them. The aim of this research is to identify the success factors for the successful use and implementation of agriculture mobile information systems and to perform hypotheses tests to explain the relationship between the six success constructs adopted from the DeLone and McLean model [19].

The first objective was to identify the factors that influence the success of agricultural mobile information system. This objective was achieved by doing a thorough review of literature in an effort to identify the factors contributing to the success of agriculture mobile information systems to enable organisations to evaluate success of their information systems using a validated instrument within their context. These factors are information quality, service and system quality, use/intention to use, user satisfaction and net benefits.

The second, third and fourth objective were achieved by carrying out a quantitative survey study. This was achieved by distributing a self-administered survey study on the web using questionnaire adapted from validated peer reviewed prior studies. Objective number three was further divided into nine sub questions and the sub questions were used to generate the nine hypotheses for the study. The validated IS success instrument [39] was used to estimate the validity and reliability of the factors and the relationships between the factors influencing the success of agriculture mobile information system through a web based survey. Online surveys provide an efficient, inexpensive way to collect data about a particular system or program. The survey was edited and drafted through Google forms to suit the agriculture mobile information system context. The survey was then sent out to subsistence and commercial farmers in Botswana who have experience with the mAgri App through a web link attached to the invitation e-mail that redirected the participants to the survey.

3.4 Research Design

The study adopts positivist research design that is meant for theory testing. Positivist designs seek generalized patterns based on an objective or phenomena [41]. The positivist research technique employed in this survey is field survey. Field surveys capture snapshots of practices, beliefs or situations from a random sample. In field survey, variables and their

effects were tested using statistical methods. The type of field study used in this study is cross sectional field survey which measures the independent and dependent variables at the same time using a single questionnaire. The reason for selecting cross sectional field survey method is that it has several benefits such as its ability to capture and control a large number of variables in a single survey instrument. The other benefit is its ability to study a problem from several perspectives or using several theories.

3.5 Conceptualization and Operationalization of Measures

3.5.1 Conceptualization of Measures

Conceptualisation of measures is the process of defining constructs or concepts in concrete and precise terms. This process is important to avoid imprecision and vagueness or ambiguity in research. Information systems success factors were adopted from validated instruments in prior studies to ensure content validity. The six IS success factors were adopted from the updated DeLone and McLean model and have been identified as; information quality, system and service quality, use or intention to use, user satisfaction and net benefits. The concept of mobile farming IS success has been adapted to test the causal relationships between the multidimensional IS success measures. The IS success measures are multi-dimensional because each of them consists of over two underlying dimensions. The definition of the measures are summarised in Table 1 below.

Table 1 : Conceptualisation of IS success measures

Construct	Theoretical Definition	Multi/ Uni - dimensional	Perspectives/ Approaches
Information Quality	Information quality refers to the desirable characteristics of the information produced by the information system[18]	Multi-dimensional	
System Quality	System quality refers to the desirable characteristics of an information system.[11]	Multi-dimensional	
Service Quality	Service Quality refers to the overall internal or external support that the IT department or service provider offers to the system users [19] [11]	Multi-dimensional	

Use/Intention to Use	use is the effort that will be consumed to use the IS and present frequency of use, number of use, use versus non-use as the best way to assess IS use [15]	Multi-dimensional	Use is a behaviour Intention to use is an attitude [18]
User Satisfaction	User satisfaction measures the user's opinions of the information system and covers the entire customer experience cycle from information retrieval through purchase, receipt and service [18]	Multi-dimensional	
Net Benefits	Net Benefits capture the balance of positive or negative impacts of the information system on the customers, suppliers, employees, organizations, markets, industries, economies and even societies	Multi-dimensional	Benefits to an individual on the suppliers, employees, organizations, markets, industries, economies and societies [13], [18]

3.5.2 Operationalization of Constructs

Operationalization is the process of developing indicators or items for measuring constructs. The six constructs are operationalized in Table 2. The items to measure user satisfaction were adapted from previous measures in prior studies. Information Quality construct was measured using a seven-item scale adopted from [39]. The scale has been widely adopted, tested for reliability and validated by prior researchers and has become a standard instrument in the IS field. Modifications were made to fit the agriculture mobile IS context.

Table 2: Operationalization of Constructs

Construct/Factor	Indicator	Question	Reference
Information Quality	IQ1	The mobile App provides the exact information I need	Alshibly 2014
	IQ2	The mobile App provides information I need at the right time	
	IQ3	The mobile App provides information that is relevant to my farm	
	IQ4	The mobile App provides sufficient information	
	IQ5	The mobile App provides information that is easy to understand	
	IQ6	The mobile App provides up to date information	
Net Benefits	NBI	The mobile App helps me to improve my performance at the farm	Alshibly 2014

	NB2	The mobile App helps me to save on farm costs	
	NB3	The mobile App helps me to achieve my farm goals	
	NB4	Using the mobile App improves the assessment of my farm	
	NB5	Using the mobile App increases my farm productivity	
	NB6	Overall, using the mobile App enhances performance management at my farm	
System Quality	SQ1	The mobile App is easy to use	Alshibly 2014
	SQ2	The mobile App is user-friendly	
	SQ3	The mobile App provides high speed information access	
	SQ4	The mobile App provides interactive features	
Service Quality	SVQ1	I receive support for the mobile App when needed	Alshibly 2014
	SVQ2	The mobile App provides error free records	
	SVQ3	The mobile App tells me when exactly the services will be performed	
	SVQ4	My information is safe while interacting with the mobile App	
	SVQ5	The mobile App gives me individual attention	
Use	U1	The frequency of use for the mobile App is high	Alshibly 2014
	U2	I depend upon the mobile App	
	U3	I am able to complete a task using the mobile App even if there was no one around to tell me what to do	
	U4	I have the necessary knowledge to use the mobile App	
User Satisfaction	US1	I have a positive attitude towards the mobile App functions	Alshibly 2014
	US2	The perceived utility of the mobile App is high	
	US3	The mobile App has met my expectations	
	US4	My experience on using the mobile App is satisfying	

System quality construct was measured by adopting the four-item scale used by [39]. Service quality construct was measured according to [39] refined five item scale. Use was measured using a four item scale adopted from validated prior studies [39]. User satisfaction was measured indirectly through information quality, system quality, service quality. The construct was measured using a four item scale from [39]. Mobile farming perceived benefits

covers the impacts of the end user related achievements from using the mobile App. This was operationalized by a six item scale adopted from [39]. All these items were measured using a 5 point likert scale with anchors ranging from strongly (1) agree to strongly disagree (5) were used for all questions.

3.6 Population & Area of the Study

This study was conducted In Botswana. The questionnaire was distributed purposively to both subsistence and commercial farmers across Botswana who had experience in using the mAgri mobile App. The farmers were randomly picked from the mAgri app users were randomly chosen from the mAgri Facebook page to respond the online survey. A total number of 150 farmers were invited to be participants of the survey. The sample size subsection ahead explains how the total number of 150 participants was reached. The area of study for this research was in the Botswana International University of Science and Technology where the data analysis was carried out. A summary of the demographics of the farmers is provided in chapter 4 and the complete responses for each farmer is attached in Appendix X.

3.7 Data Collection

The data for the study was collected using 5 point likert scale questionnaire ranging from strongly (1) agree to strongly disagree (5) which was adopted from a prior validated study on measuring IS success using the DeLone and McLean updated model [39]. The unit of analysis of this study was at the individual level which is the farmer in this case, the user of the information system. The mAgri mobile app was chosen by the researcher's ability to obtain contacts of individuals using the agricultural mobile App. These individuals could be described as "key informants" in the selected mobile app. The mAgri mobile App was chosen as the research locale because it is widely used by all farmers in Botswana, those who are into commercial and subsistence farming and those who are practicing horticulture and animal husbandry. The results are therefore easy to generalize, unbiased and represents the population of the Agriculture sector in Botswana. The responses used in this research were obtained from the mAgri Facebook page. A summary of the farmers biography can be seen in chapter 4 and a summary of the farmers individual responses is attached in Appendix Z.

3.7.1 Pilot Testing

Before distributing the questionnaire to the farmers, the instrument was pilot tested by three IS experts to ensure that the wording was understandable and that its length was appropriate.

The IS experts reviewed the measurement variables and provided feedback on the clarity of the survey instrument. Questions which were found to be unclear and could potentially form confusion to respondents were replaced with new, more clear and understandable items. The reason for pilot testing was to ensure that the respondents would find it easy to understand and answer the questions after pre-testing the items were modified to adequately fit the mobile farming context.

3.7.2 Sample Size

According to mAgri survey results [42] by March 2016; the total size of Botswana agriculture population using the mAgri mobile application was 30,000. Data was collected from a simple random sample of 150 farmers using the mAgri mobile application in Botswana. The sample size number was reached by making use of the online sample size calculator [34]. The online sample size calculator requires the population size to be known; which is 30,000 farmers in the case of Botswana. The confidence level should also be determined which is a measure of how certain you are that your sample accurately reflects the population within its margin error. In this study the confidence level proposed is 95% which is a measure of how the sample accurately represents the true population. The 8% margin of error is a percentage that describes how closely the sample provides a true value of the population. The sample size was calculated using the survey monkey online sample size calculator [34]; the results are presented in figure 5 below.

The image shows a web-based sample size calculator interface. It has three input fields on the left: 'Population Size' with the value '30000', 'Confidence Level (%)' with the value '95', and 'Margin of Error (%)' with the value '8'. To the right of these inputs is a large green box displaying the 'Sample Size' as '150'. Below the input fields is a green 'Calculate' button. To the right of the button is a small disclaimer: '*This sample size calculator uses a normal distribution (50%) to calculate your optimum sample size'.

Figure 5 : Sample size calculator [34]

3.7.3 The Survey Instrument

The questionnaire was adapted from prior validated IS studies that measured IS success using the DeLone and McLean IS success model. According to Saunders *et al.* [43], adopting prior validated survey instruments makes it possible to compare the results but most importantly assures content reliability. The aim of distributing the questionnaire was to capture the respondent's (farmer's) perceptions on the six IS success factors. The

questionnaire was sent to the participants using email which is fast and convenient in terms of data collection and makes it easier to code and analyse the data. The questionnaire was pretested by three IS experts before it could be distributed to the participants to assure that the respondents would find it easy to understand and answer the questions. The online questionnaire consisted of seven main parts.

The first part included demographic questions such as age, gender and industry. The second part consisted of 5 five-point likert-scale questions aiming to assess the six factors of the proposed research model divided into sub categories of six constructs adopted from the DeLone and McLean model as measures of IS success. The five-point likert scales ranged from strongly agree to strongly disagree. The final instrument was administered over a four-week period to the users of the mobile Application. The Questionnaire is attached in Appendix A and the results of the data analysis used to test the hypotheses will be presented in the next section.

3.8 Data Analysis Technique

Quantitative analysis and Descriptive statistics were used as methods for analyzing data. The data collected was coded onto the spreadsheet and subsequently analyzed using partial least squares structural equation modeling techniques using the Smart MPLS version 2.0.m3 software. Smart MPLS software is commonly used when assessing the covariance of the hypothesized paths in a causal model. PLS path modeling is a statistical approach that was applied to assess multivariate relationships among observed and latent variables. The first objective was to identify the agriculture mobile information system success factors. This was achieved by carrying out a thorough review of literature. The identified factors and their indicators were framed into a questionnaire and the survey questions were distributed to farmers. Consequently the responses from the farmers were analysed and the results from the data analysis are presented in chapter 4.

The second objective was to test the validity and reliability of the IS success factors. The purpose for validating an instrument after the development process is to reduce errors in the measurement process. The data collected was coded onto the spreadsheet and the smart PLS program was used to test the validity and reliability of the variables by estimating the measurement model comprising of Confirmatory Factor Analysis (CFA) and Fornell Lacker latent variable correlation matrix.

The measurement model is composed of the conceptual factors of interest and measures underlying each construct. The measurement model included the estimation of internal consistency and reliability of individual items. Secondly the measurement model included the convergent and discriminant validity of the measures associated with the individual constructs. Smart MPLS software was used to compute and analyze the results. As suggested by [44], factor loadings, composite reliability and the average variance are constructed to assess convergent validity.

Smart PLS software was used to compute discriminant validity which represents the extent to which a construct differs from their neighboring constructs. It was assessed using latent constructs correlation matrix representing the square roots of the average variance extracted along the diagonal. Discriminant validity involves examining cross loadings between constructs in a matrix fashion. Discriminant validity is established when an indicator's loading on a construct is higher than all of its cross loadings with other constructs. The measurement model demonstrated inadequate discriminant validity on the matrix between use and use construct as well as use and net benefits construct

The third objective was to measure the relationships between the factors of the DeLone and McLean model. The structural model was used to test hypothesis. According to Geffen *et al.* [45] describes a structural model as a set of one or more dependence relationships linking model constructs. A structural model provides information on how well the theoretical model predicts the hypothesized paths. Smart MPLS software was used to estimate the structural model in an attempt to predict the hypothesized paths. The metrics used to estimate the structural model include: the coefficients of each path (β), R^2 , T-statistics, variance inflation factor (VIF), f^2 and Q^2 . The tables of the results are presented in chapter 4 and the implications of these results are consequently discussed in chapter 5.

3.9 Ethical Consideration

Ethical clearance was obtained before conducting this study. The participants of the survey were assured that the data collected from them will solely be used for the benefit of this research. Participants were made aware that their participation in the survey is voluntary and that they have the freedom to withdraw from the survey at any time. The participants were also made aware that they will remain harmless whether they take part in the survey or decide to withdraw from participating in the survey. This information was communicated in the introductory part of the survey instrument.

The data collection exercise proceeded after the participants had agreed to participate in the survey and were assured that their input will remain confidential and this was achieved by including the aspect of anonymity throughout the survey exercise. For example, participants were never asked for names neither were they requested to provide their personal information during the course of the survey. The research process followed the approved research protocol where in this case the university had to permit the researcher to carry out the research and to request the participants, in this case, the farmers and the mAgri mobile App organisation to support and take part in the survey. The purpose of this process was to protect the rights of the participants of the survey.

Chapter 4

4.0 Data Analysis and Results

The results from the analysis that was applied to the data collected from the farmers are presented in this section and discussed in chapter 5. The type of data collected is quantitative (numerical) data in ordinal form. Therefore the data analysis is based on quantitative methods and the results (output) from the analysis process are generated using the Smart MPLS software. The average scores of items is applied to the numerical data set for each variable or factor predicted as discussed earlier. According to Piguët and Peraya [46], averaging of the items enhances the flexibility of the scale without affecting the statistical properties of the scores. The results for the demographic attributes are first presented in Table 3, followed by the results of measurement model and lastly the results of the structural model which was used to test the hypotheses between the underlying constructs and the effect size.

4.1 Background Information of the Sample

This section provides background information for the questionnaire survey.

4.1.1 Response Rate

In order to validate the research model, data were collected by means of an online questionnaire. In total 150 questionnaire were sent out and only 140 useful responses were collected. The response rate was at 93.3 %. Response rate is the percentage of people who respond to a survey instrument. The 93.3% response rate means that most people completed the survey and it was meaningful and found to be useful by the respondents. According to Saunders *et al.* [37], 30% is a reasonable response rate when a questionnaire is distributed through the organizations intranet. The response rate of the online survey was increased by making a push survey whereby the respondents were provided with a survey URL attached in an email sent directly to them. The response rate for the survey was calculated using the following formula;

Equation 1: Response rate calculation

$$\begin{aligned}\text{Response Rate} &= \frac{\text{responses to the survey}}{\text{\# of people you sent the survey total}} * 100 \\ &= \frac{140 * 100}{150} \\ &= 93.3\%\end{aligned}$$

4.1.2 Demographics

Table 2 presents descriptive data about the participants' demographic profiles from the data collection process explained in chapter 3. The Demographics section of the survey was categorized using the following attributes; age, gender, computer skills, educational level, type of farmer and ownership of mobile phone. The data shows that 28.9% of the farmers from the sample size aged between 26-30 frequently use the mAgri mobile app. In the gender section, the males who use the mAgri mobile App makes 54.8% whereas followed by females with 45.2% from the sample population. The results presented in Table 2 shows that most farmers using the mAgri mobile App are at an advanced level of computer literacy attributing to 51.5% of the sample population. The results show that 79.1% of the farmers from the sample population have completed tertiary education. The results presented in Table 3 shows that 55.2% of the farmers from the sample population are commercial farmers and 45.5% are subsistence or traditional farmers. The results show that 100% or all of the farmers have mobile phones which they use to access the mAgri mobile app. The online questionnaire form is attached in appendix A and the summary of each farmers response is attached in Appendix X. The summary of the demographic results is presented in Table 3 below.

Table 3 : Summary of Demographics

Demographic	Frequency	Percentage
Age		
25 and below	22	16.3%
26-30	39	28.9%
31-35	30	22.2%
36-45	25	18.5%
45 and Above	19	14.1%
Gender		
Male	74	54.8%
Female	61	45.2%
Computer Skills		
Beginner	16	11.9%
Intermediate	49	36.6%
Advanced	69	51.5%
Educational Level		
Primary	8	6%
Secondary	20	14.9%
Tertiary	106	79.1%
Type of Farmer		
Commercial	74	55.2%
Subsistence	61	45.5%
Ownership of mobile Phone		
Yes	135	100%

4.2 Evaluation of the mAgri Mobile App

The mAgri mobile app was evaluated by the farmers to assess if it suits the criteria for a successful information system. The mAgri mobile App was assessed based on the responses of the farmers using the theoretical grounding of the updated DeLone and Mclean model constructs. The mobile app was assessed using system quality, information quality, service quality, use, user satisfaction and net benefits. The DeLone and McLean six IS success factors were identified (1) through literature as factors influencing the success of an information system and tested in the mAgri mobile App context. Statistical analysis was used for validating (2) the IS success factors by testing each underlying IS success construct for its reliability and validity using the measurement model and for testing the hypotheses (3) using the structural model.

4.3 Evaluation of the Model

The DeLone and McLean model was evaluated and validated using Partial Least Squares Structural Equation Modeling (PLS-SEM) using Smart MPLS version 2.0.m3 software. SEM is a multivariate technique which estimates the strength of the relationship between the dependent and independent variables. The term Structural Equation Modeling conveys that the causal processes under enquiry are presented by a series of structural (i.e. regression) equations. The structural model predicts the Partial Least Squares (PLS) graph which shows the causal relationships (hypothesized directional paths) between the latent variables by estimating the path coefficients and the amount of variance explained by the independent variables. The entire hypothesized model with all the latent variables is tested statistically to determine the extent to which it is consistent with the data.

4.3.1 The Inner Model (Conceptual Framework)

The Inner model presents the path coefficients connecting the latent variables. The inner model involves the cycle between path coefficients, total and direct effect coefficient [47]. The inner model is presented in figure 6 below.

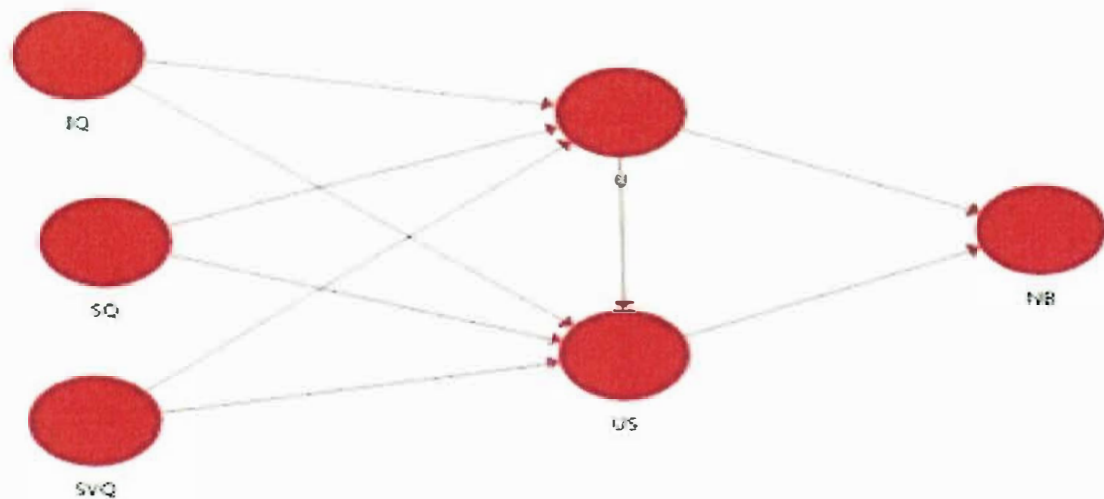


Figure 6 : The Inner model

4.3.2 Latent Variables

The measurement instrument consists of latent variables which are operationally defined in terms of the behavior they represent. These variables cannot be measured directly. The latent variables for this study are Information Quality (IQ), System Quality (SQ), Service Quality (SVQ), Use (U), User Satisfaction (US) and Net Benefits (NB). The two categories of latent variables are explained below.

4.3.3 Exogenous (Independent) Latent Variables

Exogenous latent variables are synonymous with independent variables. These variables cause fluctuations in the values of other latent variables in the model. The exogenous variables in this study are; system quality, information quality and service quality.

4.3.4 Endogenous (Dependent) Latent Variables

Endogenous latent variables are synonymous with dependent variables and are influenced by exogenous variables in the model. The endogenous variables in this study are use, user satisfaction and net benefits.

4.3.5 Observed Variables

In addition to latent variables, the measurement instrument comprises of observed variables or manifest variables which serve as indicators for the underlying construct which they presume to represent. In this study information quality (latent variable) had six indicators (observed variables) to represent it. A summary of latent variables and their observed variables is presented in Table 4 below.

Table 4 : Latent and Observed Variables

LATENT VARIABLES	OBSERVED VARIABLES	DEPENDENT/INDEPENDENT
Information Quality	IQ1 IQ2 IQ3 IQ4 IQ5 IQ6	Independent
Net Benefits	NB1 NB2 NB3 NB4 NB5 NB6	Dependent
System Quality	SQ1 SQ2 SQ3 SQ4	Independent
Service Quality	SVQ1 SVQ2 SVQ3 SVQ4 SVQ5	Independent
Use	U1 U2 U3 U4	Dependent
User Satisfaction	US1 US2 US3 US4	Dependent

4.3.6 The Outer Model

The outer model displays the weights assigned to the paths from the latent variables to the indicators [47]. In this model for example outer model is defined by the relationship between information quality and its observed variables or indicators (IQ1, IQ2, IQ3, IQ4, IQ5 and IQ6).

4.4 The Factor Analytic Model

The Factor analytic model deals with Confirmatory Factor Analysis which is a method used to estimate the measurement model which is used to test for its validity and reliability.

4.4.1 Confirmatory Factor Analysis

Confirmatory Factor Analysis (CFA) is used for postulating relations between the observed measures and their underlying factors (latent variables) based on knowledge of theory or empirical research and then the hypothesized structure is tested statistically. CFA model focuses on the link between factors and their measured variables within SEM and represents the measurement model. It only validates the model but does not explain the relationships between the underlying factors. CFA explains the extent to which the observed measures represent the latent variables to which they represent by performing validity and reliability tests. Consequently, CFA confirms the hypothesized factor structure and is used as a procedure for validating the measurement model and to test for its validity and reliability.

4.4.2 The Measurement Model

The measurement model was used to test the validity and reliability of the model. The measurement model comprises of relationships among the conceptual factors of interest and measures underlying each construct. The measurement model included the estimation of internal consistency and reliability of individual items using confirmatory factor analysis. Secondly the measurement model included the convergent and discriminant validity of the measures associated with the individual constructs. Smart MPLS software was used to compute and analyze the results. As suggested by Hair *et al.* [44], factor loadings, composite reliability and the average variance were constructed to assess convergent validity. According to Cronbach's [48], any research based on measurement must be concerned with accuracy or reliability to measure the strengths of the collective items towards a phenomena under investigation.

4.4.3 Validation of the Measurement Model

A Confirmatory factor analysis was conducted using Smart MPLS. The validity and reliability checks were carried out using convergent validity (factor loadings, indicator reliability, average variance), composite reliability and discriminant validity and cronbach's alpha [44].

4.4.4 Convergent Validity

Convergent validity is presented when each measurement item correlates strongly with its assumed theoretical construct. According to Hair *et al.* [44], factor loadings, indicator reliability, average variance are statistical measures used to estimate convergent validity.

4.4.5 Factor Loadings

The ideal level for standardized loadings for reflective indicators is 0.70 but a loading value of 0.60 is considered acceptable [49]. All factor loadings of the 35 items in Appendix E for measuring the six factors in the model were greater than 0.5, demonstrating high convergent validity for each of the items. The implication of the results means that this measurement instrument is a valid instrument for measuring information system success in the context of agriculture mobile information systems. The loadings of some item constructs were below the recommended value of 0.70 by [44] and the results of the construct items showing adequate item reliability greater than 0.70 are illustrated in Table 5 below.

Table 5 : Outer Model Loadings and Significance

	IQ	NB	SQ	SVQ	U	US
IQ1	0.884					
IQ2	0.737					
IQ3	0.843					
IQ4	0.733					
IQ5	0.753					
IQ6	0.751					
NB1		0.913				
NB2		0.781				
NB3		0.819				
NB4		0.797				
NB5		0.860				
NB6		0.816				
SQ1			0.916			
SQ2			0.895			
SQ3			0.872			
SQ4			0.872			
SVQ1				0.875		
SVQ2				0.673		
SVQ3				0.813		
SVQ4				0.709		
SVQ5				0.840		
U1					0.885	
U2					0.810	
U3					0.830	
U4					0.732	
US1						0.853
US2						0.819
US3						0.808
US4						0.820

4.4.6 Indicator Reliability

Indicator reliability is examined by looking at all the construct loadings to check whether each indicator measures what they are supposed to measure in the corresponding construct. According to Hair *et al.* [44], loadings greater than 0.70 are considered significant and those with values greater than 0.40 are still considered acceptable for exploratory research as recommended by Hulland [50]. Acceptable loadings imply that there is more shared variance or correlations between the construct and its measure. The indicator reliability (IR) value is attained by squaring each of the outer loadings value. The formula is attached below;

Equation 2 : Calculating Indicator Reliability

$$IR = (\text{factor loading})^2$$

The results for indicator reliability in Table 6 below shows that all observed variables; information quality, net benefits, system quality, service quality, use, user satisfaction and

net benefits have indicator loadings that vary between 0.40 and 0.70 which are all considered acceptable and significant.

Table 6 : Indicator Reliability (loadings squared)

Factors	Indicators	Loadings	Indicator Reliability
Information Quality	IQ1	0.884	0.781
	IQ2	0.737	0.543
	IQ3	0.843	0.710
	IQ4	0.733	0.538
	IQ5	0.753	0.567
	IQ6	0.751	0.564
Net Benefits	NB1	0.913	0.834
	NB2	0.781	0.610
	NB3	0.819	0.671
	NB4	0.797	0.635
	NB5	0.860	0.740
	NB6	0.816	0.666
System Quality	SQ1	0.916	0.839
	SQ2	0.895	0.802
	SQ3	0.872	0.760
	SQ4	0.872	0.760
Service Quality	SVQ1	0.875	0.766
	SVQ2	0.673	0.453
	SVQ3	0.813	0.660
	SVQ4	0.709	0.503
	SVQ5	0.840	0.706
Use	U1	0.885	0.783
	U2	0.810	0.657
	U3	0.830	0.689
	U4	0.732	0.536
User Satisfaction	US1	0.883	0.780
	US2	0.819	0.671
	US3	0.808	0.652
	US4	0.820	0.673

4.4.7 Average Variance (AVE)

According to Hair *et al.* [51], an AVE value of 0.50 and higher indicates a sufficient degree of convergent validity, meaning that the latent variable explains more than half of its indicators' variance. Table 7 presents the results of the average variance extracted from the constructs. The average variance for the six constructs (information quality, system quality, service quality, use, user satisfaction and net benefits) exceeded the minimum threshold of 0.50, hence indicating a high convergent validity for the constructs which proves that all the identified constructs are applicable in assessing agriculture mobile information system success.

Table 7 : Average Variance

Factors	Indicators	Average Variance
Information Quality	IQ1	0.617
	IQ2	
	IQ3	
	IQ4	
	IQ5	
	IQ6	
Net Benefits	NB1	0.693
	NB2	
	NB3	
	NB4	
	NB5	
	NB6	
System Quality	SQ1	0.79
	SQ2	
	SQ3	
	SQ4	
Service Quality	SVQ1	0.618
	SVQ2	
	SVQ3	
	SVQ4	
	SVQ5	
Use	U1	0.666
	U2	
	U3	
	U4	
User Satisfaction	US1	0.694
	US2	
	US3	
	US4	

4.4.8 Internal Consistency

Composite reliability and Cronbach's alpha were used to assess the internal consistency of the agriculture mobile information system success factors.

4.4.9 Composite Reliability

Composite reliability was used to test the internal consistency of measures. They suggested that for a construct to be considered considerable it should have a composite reliability of 0.70 or greater. Composite reliabilities of item constructs were measured and some were considered insignificant and dropped off. The composite reliabilities of the different measures indicating adequate internal consistency with a recommended threshold value of 0.70 and above are represented in Table 8. Composite reliabilities of item constructs were measured and illustrated in Table 8. The composite reliabilities of the different measures indicating adequate internal consistency with a recommended threshold value of 0.70 and above are represented in Table 8 and some items were considered insignificant as their values were less than 0.70 and hence dropped off as recommended by [5]. The implication of the composite reliability results means that not all the items entirely depend on a common construct.

Table 8 : Composite Reliability

	Composite Reliability
IQ	0.906
NB	0.931
SQ	0.938
SVQ	0.889
U	0.888
US	0.901

4.5 Cronbach's Alpha

Similar to composite reliability, cronbach's alpha is used to test the internal consistency of measures. Bagozzi and Yi [52] suggested a threshold of 0.70 for a construct indicating an adequate internal consistency. The results in Figure 7 below show that all the six constructs; information quality, system quality, service quality, use, user satisfaction and net benefits indicate an adequate internal consistency.

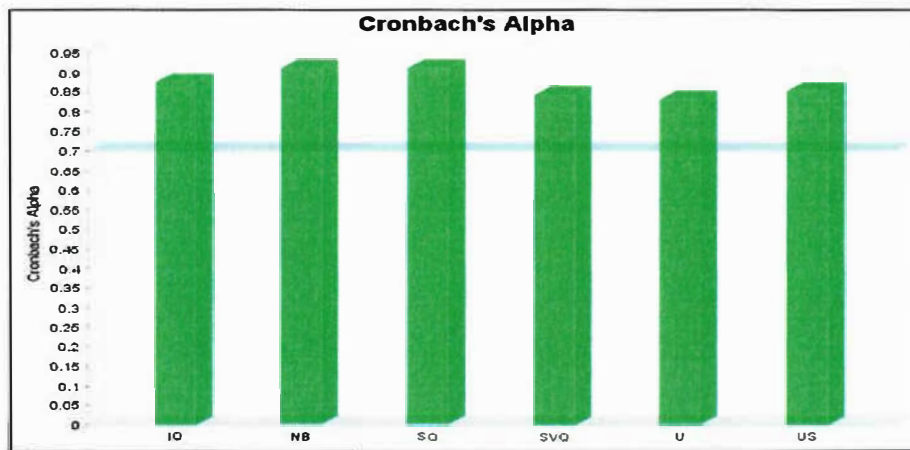


Figure 7: Cronbach's Alpha

4.5.1 Discriminant Validity

Discriminant validity represents the extent to which a construct differs from their neighboring constructs. It was assessed using latent constructs correlation matrix representing the square roots of the average variance extracted along the diagonal. Discriminant validity involves examining cross loadings between constructs in a matrix fashion. Discriminant validity is established when an indicator's loading on a construct is higher than all of its cross loadings with other constructs.

4.5.2 Fornell – Larker Criterion

Fornell and Larker [53] suggested that the square root of the Average variance for each latent variable can be used to determine discriminant validity. The square root of the AVE for each latent variable should be greater than the correlations among the latent variables. The AVE is written in bold along the diagonal of the table. The latent variable IQ's AVE is found to be 0.617 hence its square root becomes 0.786. This value is larger all the values in the IQ column and row. The latent variable NB's AVE is 0.693 hence its square root becomes 0.832. This value is insignificant as it is greater than the values in the NB column and row. SQ's square root is significant at the level 0.889 which is greater than all values in the SQ row and column. Nevertheless, SVQ's square root is not significant at the level 0.786 which is greater than all the values in the column but less than square root explained by IQ. U's square root is not significant as it has the equal to the square root explained by US in the column and less than the square root explained by NB on U. The square root explained by US is insignificant at the level 0.833 which is less than the square root explained by NB on US. Table 9 presents these results.

Table 9: Fornell Larker Criterion

	IQ	NB	SQ	SVQ	U	US
IQ	0.786					
NB	0.706	0.832				
SQ	0.854	0.709	0.889			
SVQ	0.816	0.754	0.711	0.786		
U	0.684	0.836	0.654	0.750	0.816	
US	0.734	0.895	0.724	0.781	0.816	0.833

4.6Hypothesis Testing

This section describes how the relationships between the IS success factors were tested and presents the results for the hypothesis tests.

4.6.1 Structural Model (Inner Model Validity)

The structural model is used to test hypothesis. Geffen *et al.* [45] describes a structural model as a set of one or more dependence relationships linking model constructs. A structural model provides information on how well the theoretical model predicts the hypothesized paths. The structural model was assessed by examining: (1) the coefficients of each path (β), (2) R^2 and T statistics.

4.6.2Coefficients of Each Path (B))

Table 4 shows the results of the path coefficients calculations which were computed using t-statistics through the bootstrap technique. The entire hypothesis was supported because the coefficient values for each path were significant. Figure 7 shows the results of the path coefficients calculations which were computed using t-statistics through the bootstrap technique.

The inner model suggests that US has the strongest effect on NB with a coefficient value of 0.637. The effect of U on NB was 0.316 which is also statistically significant. The impact of U on US is statistically significant at 0.464. SVQ has the strongest impact on U with a coefficient path value of 0.562. The hypothesized relationship between SQ and U is also significant at 0.225. However the hypothesized relationship between IQ and U is insignificant at the coefficient path value of 0.033 which is less than the recommended threshold of 0.1. The hypothesized path between SQ and US is also significant at a coefficient path value of 0.226. The hypothesized path between SVQ and US is statistically significant with a

coefficient path value of 0.271. However the hypothesized path between IQ and US is insignificant with a coefficient path value of 0.002. A summary of the path coefficients results is presented in Figure 8 below.

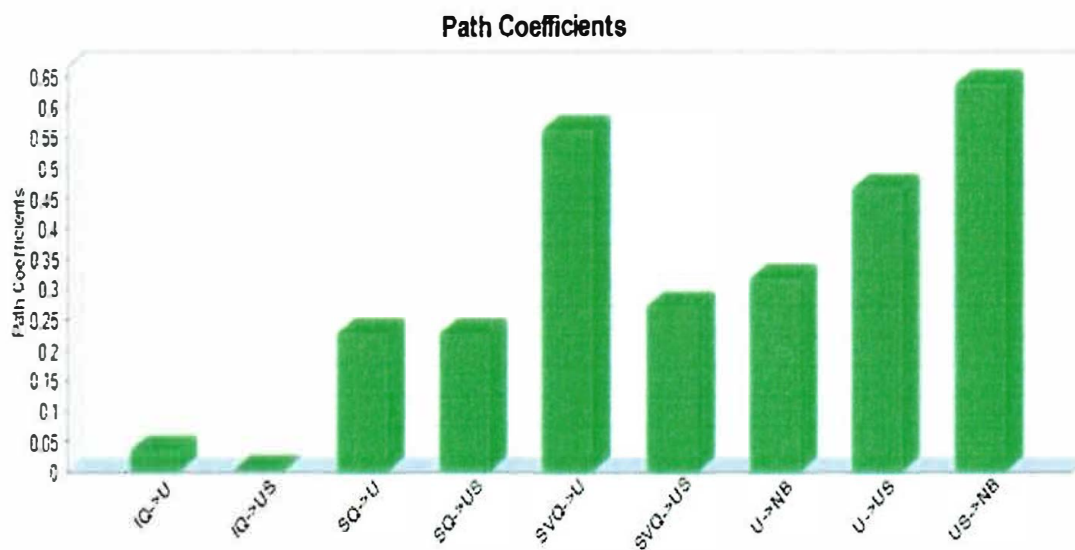


Figure 8: Coefficient of each path

4.6.3 Target Endogenous Variable Variance (R-Square)

R^2 is an indicator of the overall predictive strength of the model. Hair *et al.* [44] explains R^2 results as a representation of the amount of variance in the construct in question. That is R^2 attempts to measure the variance of the dependent variable relative to its total variance. Table 3 presents results of the coefficient of determination (R^2) values which reflect variations on the dependent variables. The coefficient of determination is 0.883 for the Net benefits endogenous latent variable. This means that the two latent variables (Use and User Satisfaction) explain 88.3% of the variance in Net benefits. System Quality, Information Quality and service Quality explains R^2 value of 0.591 which moderately explain 59.1% of the variance on Use. Use explains R^2 value of 0.756 which reflects 75.6% of the variance on User Satisfaction. Table 10 below presents results of the R^2 values which reflect variations on the dependent variables.

Table 10 : R-Square

	R Square
NB	0.833
U	0.591
US	0.756

4.6.4 T- Statistics

The results for the T-statistics are presented in the following sub sections.

4.6.5 Inner Model T-Statistics of Path Coefficients

The T-statistics of the inner model is investigated by carrying out the two tailed t-test with a significance level of 5%. The T-statistic test is significant if the T-Statistics is greater than 1.96. The results in table 11 below show that the hypothesized relationship between IQ and U is insignificant at t-statistic value of 0.177 which is less than the recommended threshold of 1.96. In addition, the hypothesized relationship between IQ and US is insignificant with a t-statistics value of 0.017 which is less than the recommended threshold. All other paths in the model are statistically significant.

Table 11 : T-statistics of path coefficients (Inner Model)

	T- Statistics
IQ → U	0.177
IQ → US	0.017
SQ → U	1.340
SQ → US	1.966
SVQ → U	4.540
SVQ → US	2.543
U → NB	3.338
U → US	3.888
US → NB	7.132

4.6.6 Outer Model T-Statistics of Path Coefficients

The path coefficient of the outer model is investigated by carrying out the T-statistic test on the outer loadings. The recommended significant threshold for a t-statistics is T-statistic >1.96. As presented in Figure 9, all of the T-statistics are greater than 1.96. It can therefore be deduced that all the outer model loadings are highly significant.

	IQ	NB	SQ	SVQ	U	US
IQ1 <- IQ	49.249					
IQ2 <- IQ	13.940					
IQ3 <- IQ	32.136					
IQ4 <- IQ	14.118					
IQ5 <- IQ	11.151					
IQ6 <- IQ	13.098					
NB1 <- NB		52.111				
NB2 <- NB		15.864				
NB3 <- NB		21.908				
NB4 <- NB		17.110				
NB5 <- NB		31.355				
NB6 <- NB		16.115				
SQ1 <- SQ			59.925			
SQ2 <- SQ			38.597			
SQ3 <- SQ			34.376			
SQ4 <- SQ			36.207			
SVQ1 <- SVQ				39.045		
SVQ2 <- SVQ				8.666		
SVQ3 <- SVQ				21.772		
SVQ4 <- SVQ				10.991		
SVQ5 <- SVQ				26.335		
U1 <- U					32.611	
U2 <- U					22.742	
U3 <- U					19.503	
U4 <- U					9.402	
US1 <- US						34.837
US2 <- US						19.281
US3 <- US						24.627
US4 <- US						21.171

Figure 9: The Outer Model T-Statistics

4.6.7 The Structural Model Summary of Results

The structural model results for the path coefficients and the target endogenous variable variance (R-square) values discussed above are illustrated on figure 10 below. The R-square values are contained in endogenous latent variables U, US and NB. The path coefficients are the weights between the paths connecting the latent variables.

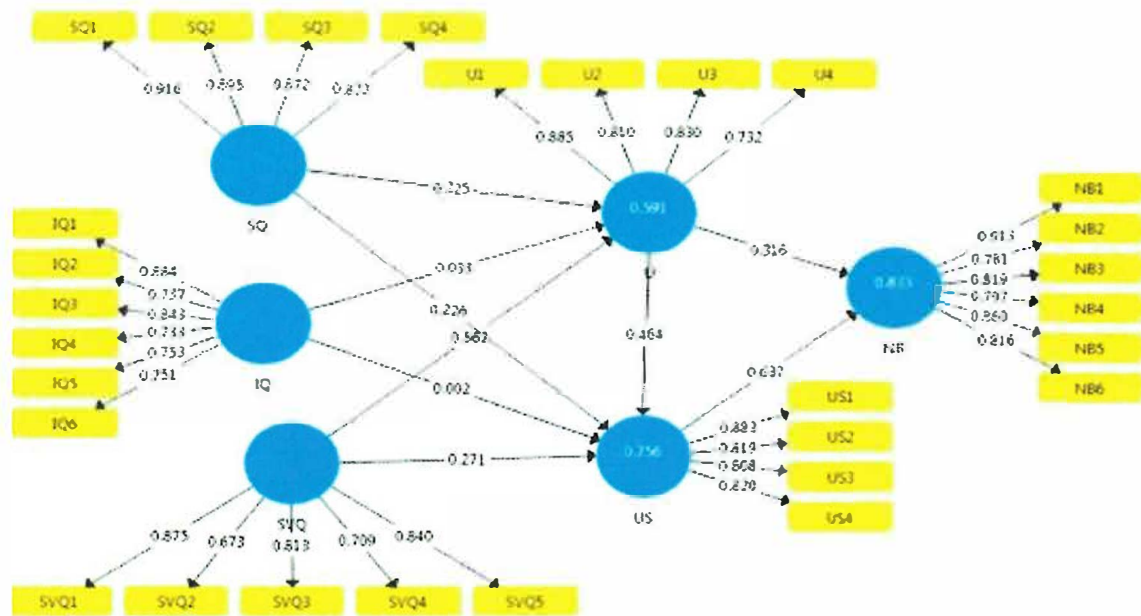


Figure 10 : The Structural Model

4.7Hypothesis Test Results

Table 12 below shows the summation of the results for the hypothesized paths in the structural model.

Table 12 : Hypotheses Results

Hypothesis	Statement	Result
H1:	Information quality will positively affect user satisfaction of the Agriculture mobile information system.	Not Supported 0.002
H2:	System quality will positively affect user satisfaction of the Agriculture mobile information system.	Supported 0.226
H3:	Service quality will positively affect user satisfaction of the Agriculture mobile information system.	Supported 0.271
H4:	Information quality will positively affect the use of the Agriculture mobile information system.	Not Supported 0.033
H5:	System quality will positively affect use of the Agriculture mobile	Supported

	information system.	0.225
H6:	Service quality will positively affect the use of the Agriculture mobile information system.	Supported 0.562
H7:	Use will positively affect the user satisfaction of the Agriculture mobile information system.	Supported 0.464
H8:	Use will positively affect the perceived net benefit of the Agriculture mobile information system	Supported 0.316
H9:	User satisfaction will positively affect perceived net benefit of the agriculture mobile information system	Supported 0.637

4.8 Indirect and Total Effects

Cause effect relationships invoke the concept of mediation which is a process whereby some variables exert influences on other variables through mediator variables. In the DeLone and Mclean success model Information Quality and Use both predict Net Benefits. This instance is a simple mediation process whereby the effect of a causal variable X on the proposed outcome Y is mediated by a single variable M. The mediation process employed in this study is simple mediation due to the model positing a single mediation variable.

4.8.1 Indirect Effects

Indirect effects and their inference statistics are necessary for mediation analysis. The indirect effect significance was tested using T-statistics through the bootstrapping procedure. Standardized path coefficients with absolute values less than 0.10 indicate a small effect; values around 0.30 indicate a medium effect and values greater than 0.50 show a large effect. Table 13 shows the results of the indirect effects on the standardized path coefficients. Indirect effect of IQ on NB (0.02) and of IQ on US (0.016) indicates a small effect. The indirect effect of SQ on NB (0.282) and SQ on US (0.105) indicate a medium impact. The indirect effect of SVQ on NB indicates a large effect whereas the effect of SVQ on US shows a medium impact. The indirect effect of U on NB depicts a medium effect.

Table 13 : Indirect effects

	IQ	NB	SQ	SVQ	U	US
IQ		0.022				0.016
NB						
SQ		0.282				0.105
SVQ		0.516				0.261
U		0.295				
US						

4.8.2 Total Effects

A mediating latent variable exists in the model (Use and User Satisfaction) it is therefore imperative to discuss the total effect of the exogenous latent variables on the endogenous latent variables. The total effect test is useful for success factor analysis (Albers 2010). The total effect significance was tested using T-statistics through the bootstrapping procedure. Standardized path coefficients with absolute values less than 0.10 indicate a small effect; values around 0.30 indicate a medium effect and values greater than 0.50 show a large effect.

The total effect of IQ on NB (0.022), IQ on U (0.033) and IQ on US (0.018) indicates a small effect because the total effect values are all less than 0.10. The total effect of SQ on NB is 0.282, SQ on U is 0.225 and SQ on US is 0.330 showing a medium effect. The impacts of SVQ on NB are greater than 0.50 showing a large effect. The total effect of U and US is 0.464 showing a medium effect. The effect of U on NB is 0.611 which shows that there is a large effect whereas the total effect of U on US is of medium effect. The summation of the total effects results of the exogenous latent variables on the endogenous latent variables is presented in Table 14 below.

Table 14 : Total Effects

	IQ	NB	SQ	SVQ	U	US
IQ		0.022			0.033	0.018
NB						
SQ		0.282			0.225	0.330
SVQ		0.516			0.562	0.532
U		0.611				0.464
US		0.637				

4.9 Collinearity

Collinearity explains the linear association between two variables. Multi-collinearity is a phenomenon in which two or more variables are highly correlated. An indicator can be considered irrelevant in the formative index if it does not significantly impact the formative index or if it has high multi-collinearity which would possibly mean that the indicator is redundant. In PLS SEM each set of exogenous latent variables in the inner model is checked for potential collinearity issues to determine if the variables should be eliminated, merged into one or to have a high order latent variable developed [54].

4.9.1 Variance Inflation Factor (VIF)

VIF explains the variance inflation factors. It is used to describe how much multi-collinearity or correlation between predictor variables exist in regression analysis. VIF is calculated as $1/\text{tolerance}$. A VIF of 5 or lower is required to avoid the collinearity problem [44]. A VIF greater than 10 indicates the presence of harmful multi-collinearity [55].

4.9.2 Inner VIF

Inner VIF's are used to assess reflective measures. The results in Table 15 below show that all reflective measures have a VIF less than 5. The reflective measures Use and User satisfaction had a slightly higher than 5 showing slight chances of multi-collinearity.

Table 15: Inner VIF

	IQ	NB	SQ	SVQ	U	US
IQ					5.471	5.474
NB						
SQ					3.707	3.832
SVQ					2.994	3.767
U		2.997				2.448
US		2.997				

4.9.3 Outer VIF

Outer VIF's are used to assess the formative measures. The results in Table 16 below show that all formative measures have a VIF less than 5 thus showing fewer chances of collinearity problems.

Table 16 : Outer VIF

	VIF
IQ1	3.287
IQ2	2.077
IQ3	2.908
IQ4	1.859
IQ5	1.976
IQ6	1.867
NB1	4.172
NB2	2.123
NB3	3.290
NB4	2.397
NB5	3.746
NB6	2.394
SQ1	3.492
SQ2	3.400
SQ3	2.741
SQ4	2.948
SVQ1	2.717
SVQ2	1.513
SVQ3	2.158
SVQ4	1.547

SVQ5	2.197
U1	2.999
U2	1.949
U3	2.341
U4	1.495
US1	2.540
US2	2.017
US3	1.946
US4	1.967

4.9.4 Effect Size (f^2)

Effect size is the impact a particular exogenous latent variable has on an endogenous latent variable. According to Henseler [56], effect size (f^2) is calculated as the increase in R-square relative to the proportion of variance of the endogenous latent variable that remains unexplained. f^2 values of 0.02, 0.15 and 0.35 depicts small, medium and large effects respectively [57][58]. Sawilowsky [59], expanded magnitudes of effect size by adding 0.01, 1.20 and 2.0 which signify very small, very large and huge effect sizes. Table 17 below shows the results of the effect sizes explained by the exogenous latent variables on the endogenous latent variables.

Table 17: Effect Size Results

Exogenous variable	Endogenous variable	f^2	Effect Size
Information Quality	Use	0.001	none
Information Quality	User Satisfaction	0	none
System Quality	Use	0.034	small
System Quality	User Satisfaction	0.054	small
Service Quality	Use	0.258	medium
Service Quality	User Satisfaction	0.08	small
Use	Net Benefits	0.2	medium
Use	User Satisfaction	0.36	large
User Satisfaction	Net Benefits	0.812	large

Information Quality has no effect on use ($f^2 = 0.001$) and on user satisfaction ($f^2 = 0$). The effect size of system quality is small for both use ($f^2 = 0.034$) and user satisfaction ($f^2 = 0.054$). The effect size for service quality of use is medium ($f^2 = 0.258$) whereas the effect

size for service quality on user satisfaction is small ($f^2=0.08$). The effect size explained by use on net benefits is medium ($f^2=0.2$) whereas the effect of use on user satisfaction is large ($f^2=0.36$). Lastly, the effect size of user satisfaction on net benefits is large ($f^2=0.812$).

4.9.5 Predictive Relevance (Q^2)

The final assessment of the structural model is the predictive relevance (Q^2) by Stone Geisser [60]. A model that exhibits predictive relevance can accurately predict the data points of indicators of endogenous construct in a reflective model [56]. Q^2 uses the blindfolding procedure to evaluate the predictive validity of a large model using PLS. The effect values for Q^2 of 0.02, 0.15 and 0.35 indicate that the exogenous latent variable has a small, medium and large predictive relevance for a particular endogenous construct [57].

Q^2 values greater than zero explain that the observed values are well reconstructed and that the model has predictive relevance. Q^2 values less zero indicate a lack of predictive relevance. Information quality, system quality and service quality indicated lack of predictive relevance. Net benefits portray a Q^2 value of 0.549 which is large; therefore NB is of predictive relevance. Use has a value of 0.371 which is of a large predictive relevance. Lastly, user satisfaction has a value of 0.496 which is also of a large predictive relevance. All Q^2 values for each endogenous constructs in Table 18 were greater than 0, hence indicating predictive validity of the structural model.

Table 18 : Construct Cross-validated Redundancy of endogenous constructs

	Q^2
IQ	
NB	0.549
SQ	
SVQ	
U	0.371
US	0.496

Chapter 5

5.0 Discussion

This section provides a summary and discusses the results presented in the previous section.

5.0.1 What are the factors influencing the success of Agriculture mobile information systems?

The first objective was to identify factors influencing the success of agriculture mobile information systems. After doing a thorough review of literature, it has been revealed that the area for investigating IS success in the context of agriculture mobile information systems has remained un-explored. However literature explained that careful evaluation of existing mobile information system is critical in explaining and reporting the effective implementation and use of these agriculture mobile information systems. This objective was achieved by investigating the IS success factors by doing a thorough review of literature. After careful evaluation of IS success models, the updated 2003 DeLone and McLean IS success model was adopted and validated to investigate its suitability and applicability in the context of agriculture mobile information systems. The six IS factors were adapted as IS success criteria for evaluating the mAgri mobile App in particular are; information quality, system quality, service quality, use, user satisfaction and net benefits. Several empirical studies have evaluated IS success in different contexts and validated the DeLone and McLean IS success model in their relevant areas of study. The results of this study are consistent with the results of; Alshibly [34] who investigated E-HRM success and Wang & Liao [61] who assessed e-government systems. These researchers identified the IS success factors as Information quality, service quality, system quality, use, user satisfaction and net benefits in their different research domains.

5.0.2 How valid and reliable are the IS success factors in the context of Agriculture mobile information system?

The second objective was to test the validity and reliability of the IS success factors in the context of agriculture mobile information systems. The purpose for validating the IS success factors is to reduce errors in the measurement process. Both the IS success factors and their indicators are tested for validity and reliability in the measurement model using CFA and Fornell Lacker discriminant validity using Smart MPLS statistical software. CFA explains the extent to which the observed measures represent the latent variables and confirms the hypothesized factor structure. Discriminant validity explains that a construct is different

from its neighboring construct to avoid issues of redundancy. The discussion of the results is explained for each underlying construct below.

5.0.2.1 Information Quality

The factor loadings for the latent variable information quality and its observed variables IQ1 to IQ6 were assessed for convergent validity in the outer model. All the loadings for the observed variables of the latent variable information quality were greater than 0.70 which is a recommended threshold by Hair [44]. This implies that the observed variables IQ1 to IQ6 are valid and reliable indicators to be included in the evaluation criteria for the exogenous latent variable “information quality” in assessing agriculture mobile information systems. It can be concluded that there is a relationship between the latent variable and its indicators and that these indicators accurately and consistently measure the concept of information quality in the context of the agriculture mobile information systems.

The PLS analysis results for the assessment of the indicator reliability for the observed variable's item loadings ranged between 0.543 and 0.781. The results imply that there is more shared variance or a high correlation between the observed variables (IQ1 to IQ6) and their exogenous latent variable “information quality”. This also implies that the indicators (IQ1 to IQ6) measure what they are supposed to measure in the corresponding construct information quality. The AVE PLS result for the information quality variable is 0.617 which indicates a higher and sufficient degree of convergent validity. This implies that the latent variable information quality explains more than half of its indicators' variance. The average variance extracted is significant meaning that the information quality construct is a valid measure for assessing agriculture mobile information system success.

The internal consistency of the construct information quality was assessed using composite reliability and cronbach's alpha. Internal consistency simply measures how reliable a variable is. The composite reliability result for the latent variable information quality is 0.906, showing an adequate internal consistency. The cronbach's value extracted for information quality is 0.875 also showing an adequate internal consistency. The results of composite reliability test are consistent with the cronbach's alpha score. These results imply that the observed variables are highly consistent and reliable since they produce similar scores using different tests. Fornell and Larker criterion was used to determine discriminant validity which explains the extent to which a construct differs from its neighboring constructs. The latent variable information quality was found to have established

discriminant validity with a square root value of 0.786. The square root value in the IQ column and row is the largest hence implying that the construct is different from other constructs hence there is no redundancy in the measurement factors for evaluating agriculture mobile information system success.

The results provide support that the information quality is a valid and reliable IS factor in assessing and evaluating the success of agriculture mobile information systems. The results explain that the quality of the information delivered by the agriculture mobile information system can be measured or assessed using IQ1 to IQ2.

5.0.2.2 System Quality

The factor loadings for the latent variable system quality and its observed variables SQ1 to SQ4 were assessed for convergent validity in the outer model. All the loadings for the observed variables of the latent variable system quality were greater than 0.70 which is a recommended threshold Hair *et al.* [44]. This implies that the observed variables SQ1 to SQ4 are valid and reliable indicators to be included in the evaluation criteria for the exogenous latent variable “system quality” in assessing agriculture mobile information systems. It can be concluded that there is a relationship between the latent variable and its indicators and that these indicators accurately and consistently measure the concept of system quality in the context of agriculture mobile information systems.

The PLS analysis results for the assessment of the indicator reliability for the observed variable's item loadings ranged between 0.760 and 0.839. The results imply that there is more shared variance or a high correlation between the the observed variables (SQ1 to SQ4) and their exogenous latent variable “system quality”. This also implies that the indicators (SQ1 to SQ4) measure what they are supposed to measure in the corresponding construct system quality. The AVE PLS result for the system quality variable is 0.79 which indicates a higher and sufficient degree of convergent validity. This implies that the latent variable system quality explains more than half of its indicators' variance. The average variance extracted is significant meaning that the system quality construct is a valid measure for assessing agriculture mobile information system success.

The internal consistency of the construct system quality was assessed using composite reliability and cronbach's alpha. Internal consistence simply measures how reliable a variable is. The composite reliability result for the latent variable system quality is 0.938, showing an adequate internal consistency. The cronbach's value extracted for system quality

is 0.912 also showing an adequate internal consistency. The results of composite reliability test are consistent with the cronbach's alpha score. These results imply that the observed variables for system quality are highly consistent and reliable since they produce similar scores using different tests. Fornell and Larker criterion was used to determine discriminant validity which explains the extent to which a construct differs from its neighboring constructs. The latent variable system quality was found to have established discriminant validity with a square root value of 0.889. The square root value in the SQ column and row is the largest hence implying that the construct is different from other constructs hence there is no redundancy in the measurement factors for evaluating agriculture mobile information system success.

The results reveal that the quality of the agriculture mobile information system is significantly associated with the indicators; SQ1 to SQ4. These results imply that the quality of the system is directly influenced by these factors as a result, system quality and its underlying indicators are valid and reliable agriculture mobile IS evaluation factors. The quality of the system is very crucial during the implantation phase as a result agriculture mobile App developers should take into consideration that the indicators are at least met as a milestone towards developing a high quality agriculture mobile information system.

5.0.2.3 Service Quality

The factor loadings for the latent variable service quality and its observed variables SVQ1 to SVQ5 were assessed for convergent validity in the outer model. The loadings for the observed variables SVQ1, SVQ3, SVQ4 and SVQ5 of the latent variable service quality were greater than 0.70 which is a recommended threshold by Hair *et al.* [44]. The loadings for the observed variable SVQ2 had a loading of 0.673 which 0.60 is considered acceptable [49]. This implies that the observed variables SVQ1, SVQ2, SVQ3, SVQ4 and SVQ5 are valid and reliable indicators to be included in the evaluation criteria for the exogenous latent variable "service quality" in assessing agriculture mobile information systems. It can be concluded that there is a relationship between the latent variable and its indicators and that these indicators accurately and consistently measure the concept of service quality.

The PLS analysis results for the assessment of the indicator reliability for the observed variable's item loadings ranged between 0.453 and 0.766. The results imply that there is more shared variance or a high correlation between the observed variables (SVQ1 to SVQ5) and their exogenous latent variable "service quality". This also implies that the

indicators (SVQ1 to SVQ5) measure what they are supposed to measure in the corresponding construct service quality. The AVE PLS result for the service quality variable is 0.618 which indicates a higher and sufficient degree of convergent validity. This implies that the latent variable service quality explains more than half of its indicators' variance. The average variance extracted is significant meaning that the service quality construct is a valid measure for assessing agriculture mobile information system success.

The internal consistency of the construct service quality was assessed using composite reliability and cronbach's alpha. Internal consistence simply measures how reliable a variable is. The composite reliability result for the latent variable service quality is 0.889, showing an adequate internal consistency. The cronbach's value extracted for service quality is 0.843 also showing an adequate internal consistency. The results of composite reliability test are consistent with the cronbach's alpha score. These results imply that the observed variables for system quality are highly consistent and reliable since they produce similar scores using different tests. Fornell and Larker criterion was used to determine discriminant validity which explains the extent to which a construct differs from its neighboring constructs. Discriminant validity has not been established for the latent variable system quality with a square root value of 0.786. The square root value in the SVQ column is the largest however in the row it is less than information quality which possesses a square root of 0.816. The results imply that the construct is different from other constructs hence there is no redundancy in the measurement factors for evaluating agriculture mobile information system success.

The results provide support that the service quality construct is a valid and reliable IS factor in assessing and evaluating the success of agriculture mobile information systems. The results suggest that the quality of the service delivered by the agriculture mobile information system can be measured or assessed using SVQ1 to SVQ4 as valid and reliable factors.

5.0.2.4 Use

The factor loadings for the latent variable Use and its observed variables U1 to U4 were assessed for convergent validity in the outer model. All the loadings for the observed variables of the latent variable Use were greater than 0.70 which is a recommended threshold by Hair *et al.* [44]. This implies that the observed variables U1 to U4 are valid and reliable indicators to be included in the evaluation criteria for the endogenous latent variable "use" in

assessing agriculture mobile information systems. It can be concluded that there is a relationship between the latent variable and its indicators and that these indicators accurately and consistently measure the concept of use.

The PLS analysis results for the assessment of the indicator reliability for the observed variable's item loadings ranged between 0.536 and 0.780. The results imply that there is more shared variance or a high correlation between the observed variables (U1 to U4) and their endogenous latent variable "use". This also implies that the indicators (U1 to U4) measure what they are supposed to measure in the corresponding construct use. The AVE PLS result for the use variable is 0.666 which indicates a higher and sufficient degree of convergent validity. This implies that the latent variable use explains more than half of its indicators' variance. The average variance extracted is significant meaning that the use construct is a valid measure for assessing agriculture mobile information system success.

The internal consistency of the construct use was assessed using composite reliability and cronbach's alpha. Internal consistence simply measures how reliable a variable is. The composite reliability result for the latent variable use is 0.888, showing an adequate internal consistency. The cronbach's value extracted for information quality is 0.831 also showing an adequate internal consistency. The results of composite reliability test are consistent with the cronbach's alpha score. These results imply that the observed variables for the use latent variable are highly consistent and reliable since they produce similar scores using different tests. Fornell and Larker criterion was used to determine discriminant validity which explains the extent to which a construct differs from its neighboring constructs. The latent variable use was found to have established discriminant validity with a square root value of 0.816. The square root value in the SQ column and row is the largest hence implying that the construct is different from other constructs hence there is no redundancy in the measurement factors for evaluating agriculture mobile information system success.

The results reveal that the farmer's use the agriculture mobile information system is significantly influenced by U1 to U4. These results imply that the construct use and its underlying indicators are valid and reliable agriculture mobile IS evaluation factors. The farmers use of the system is vital to farmers as it can bring long term benefits to their farming and eventually transform the entire agriculture community. As a result mobile App developers should ensure that these attributes (U1 to U4) are integrated into the agriculture mobile information system so it can lead to continued use of the system

5.0.2.5 User Satisfaction

The factor loadings for the latent variable user satisfaction and its observed variables US1 to US4 were assessed for convergent validity in the outer model. All the loadings for the observed variables of the latent variable user satisfaction were greater than 0.70 which is a recommended threshold by Hair *et al.* [44]. This implies that the observed variables US1 to US4 are valid and reliable indicators to be included in the evaluation criteria for the endogenous latent variable “user satisfaction” in assessing agriculture mobile information systems. It can be concluded that there is a relationship between the latent variable and its indicators and that these indicators accurately and consistently measure the concept of user satisfaction.

The PLS analysis results for the assessment of the indicator reliability for the observed variable's item loadings ranged between 0.652 and 0.780. The results imply that there is more shared variance or a high correlation between the the observed variables (US1 to US4) and their endogenous latent variable “user satisfaction”. This also implies that the indicators (US1 to US4) measure what they are supposed to measure in the corresponding construct user satisfaction. The AVE PLS result for the user satisfaction variable is 0.694 which indicates a higher and sufficient degree of convergent validity. This implies that the latent variable user satisfaction explains more than half of its indicators' variance. The average variance extracted is significant meaning that the user satisfaction construct is a valid measure for assessing agriculture mobile information system success

The internal consistency of the construct user satisfaction was assessed using composite reliability and cronbach's alpha. Internal consistence simply measures how reliable a variable is. The composite reliability result for the latent variable user satisfaction is 0.901, showing an adequate internal consistency. The cronbach's value extracted for user satisfaction is 0.853 also showing an adequate internal consistency. The results of composite reliability test are consistent with the cronbach's alpha score. These results imply that the observed variables are highly consistent and reliable since they produce similar scores using different tests. Fornell and Larker criterion was used to determine discriminant validity which explains the extent to which a construct differs from its neighboring constructs The latent variable system quality was found to have established discriminant validity with a square root value of 0.833. The square root value in the US column and row is the largest hence implying that the construct is different from other constructs hence there is no

redundancy in the measurement factors for evaluating agriculture mobile information system success.

The results provide support that user satisfaction is a valid and reliable factor in assessing the success of agriculture mobile information systems. It is evident from the results that the indicators; US1 to US4 are valid and reliable indicators for assessing the farmer's satisfaction from the use of the agriculture mobile information system. If the farmers are satisfied with the agriculture mobile information system they have a reason to continue using the agriculture mobile information system.

5.0.2.6 Net Benefits

The factor loadings for the latent variable net benefits and its observed variables NB1 to NB6 were assessed for convergent validity in the outer model. All the loadings for the observed variables of the latent variable information quality were greater than 0.70 which is a recommended threshold by Hair *et al.* [44]. This implies that the observed variables NB1 to NB6 are valid and reliable indicators to be included in the evaluation criteria for the endogenous latent variable "net benefits" in assessing agriculture mobile information systems. It can be concluded that there is a relationship between the latent variable and its indicators and that these indicators accurately and consistently measure the concept of net benefits.

The PLS analysis results for the assessment of the indicator reliability for the observed variable's item loadings ranged between 0.610 and 0.834. The results imply that there is more shared variance or a high correlation between the observed variables (NB1 to NB6) and their endogenous latent variable "net benefits". This also implies that the indicators (NB1 to NB6) measure what they are supposed to measure in the corresponding construct net benefits. The AVE PLS result for the net benefits variable is 0.693 which indicates a higher and sufficient degree of convergent validity. This implies that the latent variable net benefits explain more than half of its indicators' variance. The average variance extracted is significant meaning that the net benefits construct is a valid measure for assessing agriculture mobile information system success.

The internal consistency of the construct net benefits was assessed using composite reliability and cronbach's alpha. Internal consistence simply measures how reliable a variable is. The composite reliability result for the latent variable net benefits is 0.931, showing an adequate internal consistency. The cronbach's value extracted for net benefits is

0.911 also showing an adequate internal consistency. The results of composite reliability test are consistent with the cronbach's alpha score. These results imply that the observed variables are highly consistent and reliable since they produce similar scores using different tests. Fornell and Larker criterion was used to determine discriminant validity which explains the extent to which a construct differs from its neighboring constructs. Discriminant validity has not been established for the latent variable net benefit with a square root value of 0.832. The square root value in the NB row is the largest however the NB value in the column is less than use which possesses a square root value of 0.836 and net benefits with the value 0.895. This implies that the construct is different from other constructs hence there is no redundancy in the measurement factors for evaluating agriculture mobile information system success.

The results for assessing the validity and reliability of the constructs are consistent with the results found by Alshibly [39], who validated the measurement model for investigated E-HRM success. Alshibly assessed the observed latent variables and their corresponding latent variables for convergent validity (factor loadings, AVE, Composite reliability and cronbach's alpha) and all the factors were valid and reliable to be included in the measurement model. Discriminant Validity was then assessed using Fornell Lacker criterion and the results of their analysis demonstrated that discriminant validity was established. The results of this study are also consistent with Alshibly's results [39] for the measurement model illustrating adequate convergent validity, adequate internal consistence and discriminant validity of the latent and observed variables.

The results reveal that the net benefits of the agriculture mobile information system is significantly associated with the indicators; NB1 to NB6. These results imply that tsystem quality and its underlying indicators are valid and reliable IS success evaluation criterion in the context of agriculture mobile information systems. As a result mobile App developers should take into consideration that the indicators are atleast met as a milestone towards farmers enjoying the intended benefits from the use of the agriculture mobile information system.

5.0.3 What are the relationships between the success factors

This study presented and validated the IS success model for evaluating agriculture mobile information system success based on the updated DeLone and McLean IS success model. The factors adopted from the updated D&M IS success model (information quality, system

quality, service quality, use, user satisfaction and net benefits) were first assessed for validity and reliability using the measurement model then the relationships among the constructs were investigated using the structural model. The study empirically tested nine hypothesis or relationships between the six IS success factors. The structural model results for the nine hypotheses are discussed below.

5.0.3.1 Information quality and User satisfaction

The first hypothesis statement was “Information quality will positively affect user satisfaction of the Agriculture mobile information system”. The relationship between information quality and user satisfaction was tested in the context of agriculture mobile information systems as suggested by DeLone and McLean [13][19]. The coefficient of the path IQ->US was estimated using the bootstrap technique using the smart MPLS software. The hypothesized path between information quality and user satisfaction is insignificant with a coefficient value of 0.002. The hypothesized relationship between IQ and US is insignificant with a t-statistics value of 0.017 which is less than the recommended threshold. The indirect impact of IQ on US (0.016) indicates a small effect and the total effect value of IQ on US (0.018) indicates a small effect. The variance inflation factor of use and user satisfaction (5.474) was slightly higher than 5 showing slight chances of multicollinearity. The effect size of information quality on user satisfaction was 0 meaning that IQ has no effect on US. From these results it can be concluded that there is no relationship between information quality and user satisfaction hence the hypothesis is not supported. The hypothesis is not supported because the latent variables do not significantly impact each other due hence there are slight chances of multi collinearity. The results for investigating the relationship between information quality and user satisfaction are consistent with the survey results of Koo [35] who assessed mobile banking success who found the relationship between information quality and user satisfaction to be insignificant.

In summary, the empirical results from this study have shown that that the relationship between information quality and user satisfaction was insignificant. These results imply that the quality of the information produced by the agriculture mobile information system in this case the mAri mobile App, does not directly influence the farmer's satisfaction.

5.0.3.2 System quality and User satisfaction

The second hypothesis statement was “System quality will positively affect user satisfaction of the agriculture mobile information system”. The relationship between system quality and

user satisfaction was tested in the context of agriculture mobile information systems as suggested by DeLone and McLean [13][19]. The coefficient of the path SQ->US was estimated using the bootstrap technique using the smart MPLS software. The hypothesized path between information quality and User satisfaction is significant with a coefficient value of 0.226. The hypothesized relationship between SQ and US is significant in the context of agriculture mobile information systems with a t-statistics value of 1.966 which is within the range of the recommended threshold. The indirect impact of SQ on US is (0.105) indicating a medium impact and the total effect value of SQ on US is 0.330 which shows a medium effect. The variance inflation factor of system quality and User satisfaction (3.832) was less than 5 showing no chances of multicollinearity. The effect size of system quality on User satisfaction was small at 0.054 levels. These results show that there is a relationship between system quality and user satisfaction hence the hypothesis is supported. . The hypothesized relationship between system quality and user satisfaction results are consistent with the results of Wang and Liao [61], Koo[35] and Alshibly [39].The results imply that in the context of agriculture mobile information systems; farmers belief on system quality has a more dominant impact on the farmers satisfaction from the use of the mAgri mobile App. As a result mobile App developers should pay more attention on improving the quality of the agriculture mobile information system as it will lead to the farmers satisfaction which will eventually lead to continued use of the mAgri mobile App.

5.0.3.3 Service quality and User satisfaction

The third hypothesis statement was “Service quality will positively affect user satisfaction of the Agriculture mobile information system”. The relationship between system quality and user satisfaction was tested in the context of agriculture mobile information systems as suggested by DeLone and McLean [13][19]. The coefficient of the path SVQ->US was estimated using the bootstrap technique using the smart MPLS software. The hypothesized path between service quality and User satisfaction is significant with a coefficient value of 0.271. The hypothesized relationship between SVQ and US is significant with a t-statistics value of 2.543 which is less than the recommended threshold. The indirect impact of SVQ on US (0.261) indicates a medium effect and the total effect value of SVQ on US (0.532) indicates a large effect. The variance inflation factor of service quality and User satisfaction (3.767) was lower than 5 showing no chances of multicollinearity. The effect size of Information quality on User satisfaction was $f^2=0.08$ showing a small effect. These results show that there is a relationship between information quality and user satisfaction hence the

hypothesis is supported. The results for investigating the relationship between service quality and user satisfaction are consistent with the survey results of Wang and Liao [61] and Alshibly [39] who found a strong support for the relationship between service quality and user satisfaction. The results from the data analysis imply that the relationship between service quality and user satisfaction is supported in the context of agriculture mobile information systems. These results explain that if the mAgri mobile app offers high quality service to the farmers in terms of supporting the farmers where technical assistance may be needed, it will ultimately lead to farmers satisfaction from the use of the mAgri mobile app which will lead to continued use of the agriculture mobile information system. As a result, mobile App developers should pay more attention to assuring that there are efficient and effective support systems in place to assist farmers during their interaction with the mobile information system.

5.0.3.4 Information quality and Use

The fourth hypothesis statement was “Information quality will positively affect the use of the Agriculture mobile information system”. The relationship between system quality and user satisfaction was tested in the context of agriculture mobile information systems as suggested by DeLone and McLean [13][19]. The coefficient of the path IQ->U was estimated using the bootstrap technique using the smart MPLS software. The hypothesized path between information quality and Use is insignificant with a coefficient value of 0.033. The hypothesized relationship between IQ and U is insignificant with a t-statistics value of 0.177 which is less than the recommended threshold. The total impact of IQ on U (0.033) indicates a small effect. The variance inflation factor of IQ and Use (5.471) is slightly higher than 5 showing slight chances of multicollinearity. The effect size of Information quality on User satisfaction was $f^2=0.001$ showing that there is no effect. These results show that there is no relationship between information quality and use hence the hypothesis is not supported. The weak support of the hypothesis is influenced by high chances of multicollinearity between information quality and use. The relationship between information quality and use was investigated by Koo [35] in assessing mobile banking success however the results of their study showed that there is no significant relationship between information quality and use. The results of this study are consistent with Koo’s results [35]. In summary, the empirical results from this study have shown that the relationship between information quality and use of the agriculture mobile information system was insignificant. These results imply that

the quality of the information produced by the agriculture mobile information system in the case the mAri mobile App, does not directly influence the farmer's use of the mobile App.

5.0.3.5 System quality and Use

The fifth hypothesis statement was "System quality will positively affect use of the Agriculture mobile information system". The relationship between system quality and use was tested in the context of agriculture mobile information systems as suggested by DeLone and McLean [13][19]. The coefficient of the path SQ->U was estimated using the bootstrap technique using the smart MPLS software. The hypothesized path between system quality and Use is significant with a coefficient value of 0.225. The hypothesized relationship between SQ and U is significant with a t-statistics value of 1.340 which is less than the recommended threshold. The total impact of SQ on U (0.225) indicates a medium effect. The variance inflation factor of SQ and U (3.707) was less than 5 showing no chances of multicollinearity. The effect size of Information quality on User satisfaction was small ($f^2=0.034$). These results show that there is a relationship between system quality and use hence the hypothesis is supported. However this hypothesis is not very significant. The results from assessing the relationship between system quality and use in this study are consistent with the results by Wang and Liao [61] and Koo [35] and contrary to the results found by Alshibly [39]. The results from the data analysis imply that the relationship between system quality and use is supported in the context of agriculture mobile information systems. These results explain that if the mAgri mobile app is of high quality to the farmers in terms of in terms of the overall system, it will lead to farmers continued use of the mAgri mobile app which will lead to continued use of the agriculture mobile information system. As a result, mobile App developers should pay more attention to assuring that the agriculture mobile App is of high quality which will lead to farmers continued use on the system.

5.0.3.6 Service quality and Use

The sixth hypothesis statement was "Service quality will positively affect the use of the Agriculture mobile information system". The relationship between service quality and use was tested in the context of agriculture mobile information systems as suggested by DeLone and McLean [13][19]. The coefficient of the path SVQ->U was estimated using the bootstrap technique using the smart MPLS software. The hypothesized path between service quality and Use is significant with a coefficient value of 0.562 showing strong support of the hypothesis. The hypothesized relationship between SVQ and U is significant with a t-

statistics value of 4.540 which is less than the recommended threshold. The total effect value of SVQ on U (0.562) indicates large effect. The variance inflation factor of service quality and Use (2.994) was less than 5 showing no chances of multicollinearity. The effect size of service quality on Use was $f^2=0.258$ showing medium effect. These results show that there is a relationship between service quality and use hence the hypothesis is supported. Similarly, Wang and Liao [61] and Alshibly [39] found strong support for the hypothesized relationship between service quality and use. These results imply that the quality of the service produced by the agriculture mobile information system directly influence the farmer's use of the mobile App. The results from the data analysis imply that if the agriculture mobile App offers good quality service to the farmers in terms of the technical support, training on how to use the mAgri mobile and other services to meet the needs of the farmers, farmers will enjoy using the agriculture mobile App. As a result, mobile App developers should ensure that they offer high and quality services to the farmers as a strategy to attract more farmers to use the mobile App.

5.0.3.7 Use and User satisfaction

The seventh hypothesis statement was "Use will positively affect the user satisfaction of the Agriculture mobile information system". The relationship between use and user satisfaction was tested in the context of agriculture mobile information systems as suggested by DeLone and McLean [13][19]. The coefficient of the path U->US was estimated using the bootstrap technique using the smart MPLS software. The hypothesized path between use and User satisfaction is significant with a coefficient value of 0.464. The hypothesized relationship between U and US is significant with a t-statistics value of 3.888 which is less than the recommended threshold. The the total effect value of U on US (0.464) indicates medium effect. The variance inflation factor of Use and User satisfaction (2.448) was less than 5 showing no chances of multicollinearity. The effect size of use on user satisfaction was $f^2=0.36$ showing large effect. These results show that there is a relationship between use and user satisfaction hence the hypothesis is supported. The results are consistent with the estimation of the hypothesized relationship between use and user satisfaction done by Wang and Liao [61], Koo [35] and Alshibly [39]. The results from the data analysis imply that the relationship between use and user satisfaction is supported in the context of agriculture mobile information systems. These results explain that if the farmers continue to use the mAgri mobile App; farmers themselves will get the satisfaction from the use of mobile app which will lead to continued use of the agriculture mobile information system.

5.0.3.8 Use and Net Benefits

The eighth hypothesis statement was "Use will positively affect the perceived net benefit of the Agriculture mobile information system". The relationship between use and net benefits was tested in the context of agriculture mobile information systems as suggested by DeLone and McLean [13][19]. The coefficient of the path U->NB was estimated using the bootstrap technique using the smart MPLS software. The hypothesized path between Use and Net benefits is significant with a coefficient value of 0.316. The hypothesized relationship between U and NB is significant with a t-statistics value of 3.338 which is less than the recommended threshold. The indirect impact of U on NB (0.295) indicates a medium effect and the total effect value of U on NB (0.611) indicates a large effect. The variance inflation factor of Use and net benefits (2.997) was less than 5 showing no chances of multicollinearity. The effect size of Information quality on User satisfaction was $f^2 = 0.2$ indicating a medium effect. These results show that there is a relationship between use and net benefits hence the hypothesis is supported. Similarly, Wang and Liao [61] as well as Alshibly [39] found strong support for the hypothesized relationship between service quality and use. In summary, the use of the agriculture mobile information system positively affects net benefits of the system to the farmer. As a result farmers should be encouraged to use the mAgri mobile App so that they can enjoy the benefits offered by the agriculture mobile information system. In addition agriculture mobile App developers should assure that their mobile Apps have aspects of Information quality, service quality and system quality which directly influence the use of the agriculture mobile information system.

5.0.3.9 User satisfaction and Net Benefits

The ninth hypothesis statement was "User satisfaction will positively affect perceived net benefit of the agriculture mobile information system". The relationship between user satisfaction and net benefits was tested in the context of agriculture mobile information systems as suggested by DeLone and McLean [13][19]. The coefficient of the path US->NB was estimated using the bootstrap technique using the smart MPLS software. The hypothesized path between User satisfaction and Net Benefits is significant with a coefficient value of 0.637 showing the strongest impact among all the 9 hypothesized relationships. The hypothesized relationship between US and NB is significant with a t-statistics value of 7.132 which is less than the recommended threshold. The total effect value of US on NB (0.637) indicates a strong and large effect. The variance inflation factor of US

and NB (2.997) was less than 5 showing no chances of multicollinearity. The effect size of US on NB was $f^2=0.812$ showing a large impact.

These results show that there is a relationship between user satisfaction and net benefits hence the hypothesis is supported. Wang and Liao [61] as well as Alshibly [39] found strong support for the hypothesized relationship between user satisfaction and net benefits. The results from the data analysis imply that the relationship between user satisfaction and net benefits is supported in the context of agriculture mobile information systems. These results explain that if the farmers continue to use the mAgri mobile App; farmers themselves will get the satisfaction from the use of mobile app which will lead to farmers enjoying the benefits from the services offered by the agriculture mobile information system. These benefits include farmers being equipped with the necessary skills and knowledge to improve their farming practices. As a further recommendation, mobile Application developers and practitioners should pay attention to several aspects of the mobile App such as; Information quality, service quality and system quality to attract farmers to use the system which eventually will lead to farmers enjoying the benefits from the use of the agriculture mobile information system.

Chapter 6

6.0 Conclusion and Future Research

This study has provided a constructive analysis of factors affecting the success of agriculture mobile information systems in Botswana. The current study investigated the factors influencing the success of agriculture mobile information systems in Botswana and consequently adapted the updated DeLone and McLean IS success model with the following factors; information quality, system quality, service quality, use, user satisfaction and net benefits as IS success factors. The applicability of the DeLone and McLean IS success model in the context of agriculture mobile information systems was assessed using partial least squares structural equation modeling. Data was collected from a sample of 150 farmers who have an experience in the use of the mAgri App. The results from the analysis on the data collected have proven that the six IS success factors (information quality, system quality, service quality, use, user satisfaction and net benefits) are valid and reliable measures for evaluating the success of agriculture mobile information systems. These results have demonstrated the applicability of the updated DeLone and McLean IS success model in the context of mobile farming in Botswana.

Furthermore the nine hypotheses or the relationships between the six IS success factors were examined using the structural model. These relationships are part of the DeLone and McLean IS success model [13], [18]. The results of the hypothesis have shown that out of the nine hypotheses, seven were supported; system quality has a positive influence on user satisfaction, service quality has a positive influence on user satisfaction, system quality has a positive influence on use, service quality has a positive influence on use, use has a positive influence on user satisfaction and use has a positive influence on net benefits. However, the relationship between information quality and user satisfaction was not supported. In addition, the relationship between information quality and use was not established. The implication of these results means that the users of the mAgri mobile App may have different expectations of what the requirements of information quality are. Future studies could re-test these relationships and validate the relationships using the original IS success model [13] or the updated IS success model [18].

The main contribution of this study is a valid and reliable evaluation tool for assessing agriculture mobile information system success. The evaluation tool will help determine success attributes or factors that can influence the effective functioning of these systems

leading to the successful use of the mAgri mobile App by the farmers in Botswana. The successful evaluation of agriculture mobile information systems can lead to long term benefits such as improved farming practices and production among Botswana farmers.

6.0.1 Research Implications

This study provides an evaluation tool for agriculture mobile information system companies to assess the success of their mobile Apps. The success of agriculture mobile information systems was investigated using six dimensions: system quality, information quality, and service quality, use/perceived use, user satisfaction and net benefits. These companies can adopt the validated IS success evaluation tool to assess the success of their mobile apps. This study also helps developers of farming apps to identify user requirements or attributes of the system for the successful implementation and use of the agriculture mobile information system by the targeted users being the farmers.

6.0.2 Limitations

The major limitation of this research is that it focuses on the evaluation of one particular agriculture mobile information system namely 'mAgri' however the results from this study cannot be generalized to other existing agriculture mobile apps. The findings from the data collected reported self-reported usage instead of actual usage therefore further validation needs to be done on actual use of the mAgri mobile application. In addition, the findings of this study were gathered from the context of Botswana agriculture commercial and subsistence farmers and mAgri mobile App in Botswana, as a result, the results from this study cannot be generalized to the entire agriculture sector across the world.

6.0.3 Future Research

The validity of the mobile farming success model cannot be truly established from a single study. Therefore caution should be exercised when generalizing the findings. The validation of the measurement model requires assessment using different methods in similar or different contexts. Researchers should note that the IS success factors are interrelated and no single dimension is superior to another. Therefore, they should be examined jointly. In addition managerial factors, facilitating conditions and resource availability should be considered as they may have an influence on the success of agriculture mobile information systems. The results of this study showed that information quality has no positive influence on the use and user satisfaction of the mobile App. It is important to understand the

relationship between the factors which influence the quality of information delivered by the information system and the service providers first in order to generalize these findings.

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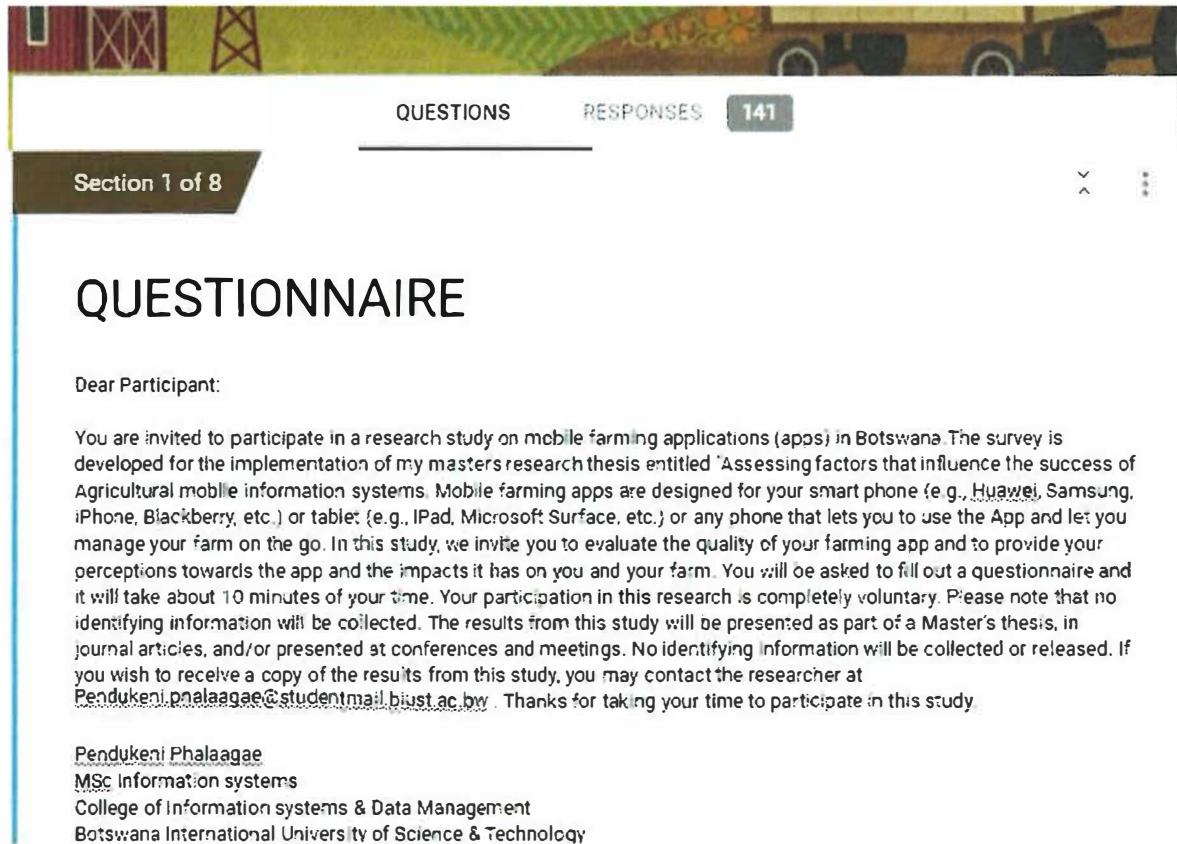
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Appendices

Appendix A: Questionnaire



QUESTIONS RESPONSES 141

Section 1 of 8

QUESTIONNAIRE

Dear Participant:

You are invited to participate in a research study on mobile farming applications (apps) in Botswana. The survey is developed for the implementation of my masters research thesis entitled 'Assessing factors that influence the success of Agricultural mobile information systems. Mobile farming apps are designed for your smart phone (e.g., Huawei, Samsung, iPhone, Blackberry, etc.) or tablet (e.g., iPad, Microsoft Surface, etc.) or any phone that lets you to use the App and let you manage your farm on the go. In this study, we invite you to evaluate the quality of your farming app and to provide your perceptions towards the app and the impacts it has on you and your farm. You will be asked to fill out a questionnaire and it will take about 10 minutes of your time. Your participation in this research is completely voluntary. Please note that no identifying information will be collected. The results from this study will be presented as part of a Master's thesis, in journal articles, and/or presented at conferences and meetings. No identifying information will be collected or released. If you wish to receive a copy of the results from this study, you may contact the researcher at Pendukeni.phalaagae@studentmail.biust.ac.bw. Thanks for taking your time to participate in this study.

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Age

- ☐ 25 and below
- ☐ 26-30
- ☐ 31-35
- ☐ 36-45
- ☐ 45 and Above

BIOGRAPHY

information about an individual's demographic, experiential or attitudinal backgrounds

Gender

☐ Male

☐ Female

Computer Skills

☐ Beginner

☐ Intermediate

☐ Advanced

User Satisfaction

Customers' opinions of the mobile App covering the entire customer experience cycle from information retrieval through system use

I have a positive attitude towards the mobile App functions



The perceived utility of the mobile App is high



The mobile App has met my expectations



My experience of using the mobile App is satisfying



Net Benefits

As the "impacts" of IS beyond the immediate user such as work group impacts, inter-organizational and industry impacts, consumer impacts and societal impacts

The mobile App helps me improve my performance at the farm.



The mobile App helps me save on farm costs.



The mobile App helps me achieve my farm goals.



Using the mobile App improves the assessment of my farm



Using the mobile App in job increases my farm productivity.

Overall, using the mobile App enhances performance management at my farm.



Appendix B: The Outer Model

