MAPÚA MALAYAN COLLEGES MINDANAO

Assessing Attitudes Towards Adopting an Innovative Crop Monitoring System at Bartulaba-Domolok Banana Farm

Kagie Angelo L. Maruyama

Jhon Louise S. Tan

Bachelor of Science in Information Systems

Capstone Adviser

Cherry B. Lisondra, MIT

College of Computer and Information Science

Assessing Attitudes Towards Adopting an Innovative Crop Monitoring System at Bartulaba-Domolok Banana Farm

by

Kagie Angelo L. Maruyama
Jhon Louise S. Tan

A Capstone Report Submitted to the College of Computer and Information Science in Partial Fulfillment of the Requirements for the Degree

Bachelor of Science in Information Systems

Mapúa Malayan Colleges Mindanao
Davao City

March 2024

APPROVAL SHEET

The capstone, entitled **“Assessing Attitudes Towards Adopting an Innovative Crop Monitoring System at Bartulaba-Domolok Banana Farm”** prepared and submitted by Group 23-IS-002 consisted of **Kagie Angelo L. Maruyama** and **Jhon Louise S. Tan** in partial fulfillment of the requirements for the degree of **Bachelor of Science in Information Systems** is hereby accepted.

Cherry B. Lisondra, MIT
(Signature over printed name/date)
CAPSTONE ADVISER

Accepted as partial fulfillment of the requirements for the degree of **BACHELOR OF SCIENCE IN INFORMATION SYSTEMS**

Rhodessa J. Cascaro, DIT
(Signature over printed name/date)
DEAN

ACKNOWLEDGEMENT

This research would not have been made possible without the help of the farm manager and our professors, friends, and family.

We would like to thank the farm manager of the cardava banana farm, Kent Bartulaba, for allowing us to use his farm as the focus of our research study.

We would like to thank our Capstone Project professor, Neil P. Magloyuan, panel chair, Genevieve A. Pilongo, and panel members, Christopher Josh L. Dellosa, and Christopher Rey A. Lungay for their guidance and suggestions during our research journey.

We would also like to express our gratitude to our capstone adviser, Cherry B. Lisondra, MIT, for guiding us with our research since its inception. Without her guidance this research would not have been made possible.

Lastly, we would also like to give thanks to our friends and family who have supported us in our endeavors, and especially in our research. Without their encouragement and financial and emotional support, we would not have the willpower to continue doing this research.

TABLE OF CONTENTS

LIST OF TABLES

ARTICLE 1

LIST OF FIGURES

ARTICLE 1

LIST OF ABBREVIATIONS

CMS	Crop Monitoring System
DOI	Diffusion of Innovation
IS	Information Systems
POM	Problem-Opportunity Matrix

Article 1

Assessing Attitudes Towards Adopting an Innovative Crop Monitoring System at Bartulaba-Domolok Banana Farm

Kagie Angelo L. Maruyama*, Jhon Louise S. Tan*

College of Computer and Information Science, Mapúa Malayan Colleges Mindanao, Davao City, Philippines 8000

Emails: kaMaruyama@mcm.edu.ph, jlTan@mcm.edu.ph

*Corresponding author

College of Computer and Information Science

Mapúa Malayan Colleges Mindanao

Gen. Douglas MacArthur Hwy, Talomo

Davao City, Philippines

Email: kaMaruyama@mcm.edu.ph

Abstract

Implementing a crop monitoring system is an advancement in improving the data monitoring of the farm's de-budding and harvesting processes. However, it is not certain that they will be able to adopt this innovation. Using the five main perceived innovation attributes from Diffusion of Innovation Theory, this study aims to address this concern by assessing the relative advantage, compatibility, complexity, trialability, and observability of the crop monitoring system to further understand how these perceived innovation attributes affect the intent of adopting the innovation. Specifically, this study aims to implement an information system with crop monitoring functionalities for de-budding and harvesting processes of the farm, to evaluate the relative advantage, compatibility, complexity, trialability, and observability attributes of the crop monitoring system, and to determine how each perceived attribute affects the intent of adopting the developed system. This study follows an applied research design with a quantitative approach. A 19-item survey was given to 20 respondents to evaluate the attributes of the crop monitoring system. Multiple logistics regression analysis was performed to test the hypotheses of this study.

Keywords: banana farm, crop monitoring system, diffusion of innovation theory, innovation adoption

SDGs: Goal 9 (Industry, Innovation, and Infrastructure)

1. INTRODUCTION

This section of the paper contains the background of the study, research problem statement, the objectives to be met by this study, and the significance of the study.

1.1 Background of the Study

The advancement of technology in the agriculture sector has been growing (Parker & Sinclair, 2001). However, not all farmers adopt these technologies into their processes (Manalo et al., 2021). The diffusion of innovation (DOI) theory is an information systems theory that has been first developed by Everett Rogers (Rogers, Simon, & Schuster, 2003), and is often used in the context of understanding how advancements and innovations in technology is being accepted and/or denied by certain social structures. The theory is utilized to explain how, why, and at what rate innovations spread among individuals in a set social structure. Rogers (1995) has also identified the five main attributes that influence the adoption of innovation: relative advantage, compatibility, complexity of innovation, trialability, and observability.

With this considered, the agricultural sector, specifically the agricultural sector in the SOCCSKSARGEN region, has potential for further developments, including IoT systems and digital crop monitoring systems. The organization that the researchers have chosen to work with is the Bartulaba-Domolok Banana Farm, a small-scale one-hectare farm located in Barangay Domolok, Alabel, Sarangani, Philippines. The organization is concerned with the cultivation and harvesting of cardava bananas and the shipment of said bananas to SAGREX FOOD INC., which will process them.

Figure 1.1 Bartulaba-Domolok Banana Farm

During the observation of the farm's processes and interview with the farm manager and the caretaker, the researchers learned about the organization, how they conduct their business, the caretaker's daily and occasional maintenance routines, the farm's harvesting process, and how the farm manager monitors the harvesting and financial data of the farm.

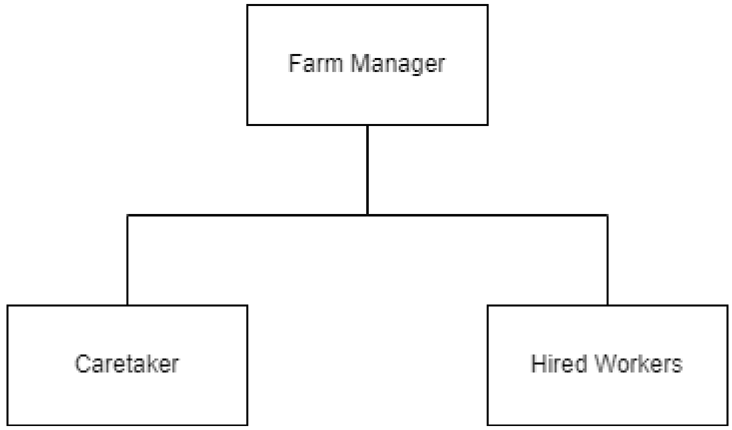


Figure 1.2 Organizational Structure

The organization consists of the farm manager/owner and the caretaker. The farm manager collects the data on de-budding from the caretaker and encodes the harvesting data and the farm's financial data. The caretaker does the daily and occasional maintenance such as de-budding, de-leafing, de-suckering, fertilizing, and spraying herbicide. During harvesting, the farm manager hires four to five people to help with the harvesting. This usually consists of the driver and the rest helps in hauling and classifying the yields.

The farm is subdivided into five areas: A, B, C, D, and E. According to the farm manager, this was to make the harvesting process and data monitoring easier. Before the area was subdivided, the caretaker roamed around the whole farm looking for trees ready to be harvested, which took an entire day. Ever since the farm was subdivided, the caretaker only roams around a specific area, making it less tiring and intensive than it was.

Table 1.1 Color of String based on Month

Months De-budded	**Color of String**
January/May/September	Red
February/June/October	Blue
March/July/November	Yellow
April/August/December	White

The farm's maintenance includes de-leafing, de-budding, de-suckering, applying fertilizer, and spraying herbicides. Daily maintenance includes de-leafing, which is the process of removing dead leaves from the tree; de-budding, which is the process of removing the bud or flower from the tree; and de-suckering, the process of removing the suckers around the mother tree. According to the farm manager, de-suckering and de-leafing are done to avoid overpopulation and it is considered good practice to leave one sucker so that after the mother tree is harvested, the sucker will follow. The caretaker usually applies urea and potash, chicken dung, duofus, or complete (mix of all three fertilizers every three months. Spraying herbicides is only done when needed. After de-budding the fruit, the caretaker marks the date on the tree's trunk and inserts a colored string (see table 1.1), indicating the month it was de-budded.

Figure 1.3 Example of De-budding Practice

Currently, the farm is a supplier for SAGREX FOODS INC., a manufacturing and exporting company of Philippine cardava banana products, located in Davao City. Harvesting happens 17-19 weeks (about four and a half months) after the de-budding process. In the farm’s harvesting process, firstly, the farm manager tells the caretaker how many trees are to be harvested in each area. After which, the caretaker looks around the area for a stick with a colored string attached to it to determine which de-budded month it belongs to (see table 1.1). When the hired labor arrives, they gather all the yields in one place and start classifying the size of each finger/piece of the harvested bunch. They then put the fingers in a separate crate, depending on the size (see table 1.2). The classification process is a requirement for SAGREX, according to the farm manager.

Table 1.2 Banana Size Classification

Class	Size
A	Large
B	Small
C	Extra Small

Based on the needs analysis done on Bartulaba-Domolok Banana Farm, the researchers created a problem-opportunity matrix (POM) to summarize the organization's problems, opportunities for those problems, causes and effects of the problems, and the impact and feasibility of the opportunities on each domain, namely, performance, information, economics, control, efficiency, and service.

Table 1.3 Problem-Opportunity Matrix

Domain	Problem	Opportunity	Cause	Effect	Impact	Feasibility
Performance	n/a	n/a	n/a	n/a	**Low**	**Low**
Information	(1) Lack of proper data monitoring during de-budding and harvesting (2) Inefficient relay of de-budding data from caretaker to farm manager	(1) Introduce a system or technology where farm manager can easily and properly monitor data of crops (2) Use Messenger or SMS text to relay data from caretaker to farm manager	(1) Errors causing inaccuracies such as inputting incorrect data, forgetting to input data, etc. (1) Lack of dedicated worker for data monitoring/ helper for caretaker during de-budding	(1) Not all crops are harvested (1) Not all de-budded and harvested crops are listed down (1) Farm manager cannot accurately monitor de-budding and harvest data	**High (Both Opportunities)** -farm manager can accurately monitor the de-budding and harvest data, thus can get a better idea of how much trees are being unaccounted for -farm manager gets daily or more	**High (Opportunity 2)** -Doable when taking research timeline into account -Save a lot of money on gas fuel and implementation -Farm manager will get more frequent updates on de-budding data from

			and harvesting (2) no/weak cellular signal. Need to go to street (outside farm) to get okay signal	(2) Lack of real-time, accurate data monitoring for the farm manager	frequent de-budding data from caretaker	caretaker without going to farm **Low (Opportunity 1)** -timeline would not allow for development, testing, implementation, and post-implementation observations. -Costly compared to other opportunities -During harvesting, droplets from cutting the stalk might damage the device of caretaker
Economics	Big loss for every tree not harvested, stolen, fallen due to weather/nature	A crop monitoring system could help in locating the general area where a crop is ready to be harvested Improve data monitoring methods Improve farm security Install protective measures against windy weather such as tying down	Caretaker is not able to properly take note of trees that are accidentally taken down by natural causes (windy, weakened body), thus when crossmatched with number of trees de-budded, inconsistencies are seen	Negatively affects the farm's profits and operations such as crop maintenance. Affects how many resources such as how much fertilizer and herbicides can be purchased or how much equipment/tools would be used before earnings become a net loss.	**High (All Opportunities)** -Improving data monitoring methods -Lessen the number of trees unaccounted for thus more yields	**High (Opportunity 2)** -little to no implementation expenses - time feasibility is high -Builds upon already existing system and improves on it, which makes it easier for the farm workers to understand and utilize

		weak trees to a post		Added food waste because fruit will just rot Farm manager cannot accurately encode de-budding and harvesting data		**Low (Opportunity 1, 3, 4)** -(Opportunity 1) capstone project timeline would not allow for development, testing, implementation, and post-implementation observations. -(Opportunity 3) improving security will be costly since it will need materials and resources -(Opportunity 4) also costly since there is a need to purchase materials such as wood and rope
Control	Data inconsistencies in their data storage by manager.	Improve data consistency by using reminders and better data collection and monitoring methods	Errors causing inaccuracies and inconsistencies such as inputting incorrect data, forgetting to input data, etc. Caretaker may forget to list it	Lack of proper, consistent, usable data Reduced data integrity Cannot accurately compute loss and gains for specific periods	**High** -farm manager can better compute their financial data and harvest data	**High** -no cost/cheaper than a CMS -time feasibility is high -Builds upon already existing system and improves on it, which makes it easier for the farm workers

			down during de-budding and harvesting which also affects the encoding of the farm manager			to understand and utilize
Efficiency	Farm manager must go to farm to gather the data written by caretaker	Send de-budding and harvesting data online via Messenger (pictures of paper) or SMS text (manually type the data written)	No/weak cellular signal. Need to go to street (outside farm) to get okay signal	Lack of real-time, accurate data monitoring for the farm manager	**High** -farm manager can get daily or more frequent de-budding data without going to farm -save a lot of money on gas fuel	**High** -cheap and easy implementati on -only expense is cellphone load for mobile data or SMS text
Service	n/a	n/a	n/a	n/a	**Low**	**Low**

1.2 Statement of the Problem

Based on the problem-opportunity matrix (see table 1.3), implementing a crop monitoring system (CMS) is an advancement in improving the data monitoring of the farm's de-budding, fertilizing, and harvesting processes. However, it is not certain that they will be able to adopt this innovation. Using the five main perceived innovation attributes from Diffusion of Innovation (DOI) theory, the study aimed to address this concern by assessing the perceived relative advantage, perceived compatibility, perceived complexity, perceived trialability, and perceived observability of the CMS to further understand how these perceived innovation attributes affect the intent of adopting the CMS.

1.3 Research Objectives

This study was conducted to examine the perceived innovation attributes of a crop monitoring system based on the Diffusion of Innovation Theory. Specifically, this study aimed:

1. To implement an information system with crop monitoring functionalities for de-budding, fertilizing, and harvesting processes of the farm.
2. To evaluate the perceived relative advantage, perceived compatibility, perceived complexity, perceived trialability, and perceived observability attributes of the CMS.
3. To determine how each perceived attribute affects the intent of adopting the developed CMS.

1.4 Significance of the Study

Firstly, this study will benefit the organization since this would improve their de-budding, fertilizing, and harvest data monitoring. The farm manager may obtain accurate data on how many trees have been de-budded, harvested and how many they have missed harvest. In addition, they will be able to compute how much they are losing, which can potentially lead to implementing a better and more accurate system.

This study could also be beneficial to other farms, particularly banana farms, who are interested in implementing and adopting a crop monitoring system to improve their processes. If they have similar de-budding, fertilizing, and harvesting processes, they can use the crop monitoring system.

Lastly, this study will aid future researchers as it will add knowledge on information systems in the sector of agriculture, specifically, evaluating the perceived innovation attributes of a crop monitoring system for a cardava banana farm located in Sarangani, Philippines.

2. REVIEW OF RELATED LITERATURE

This section of the paper discusses the related literature to this study. It contains the subtopics of this study and the synthesis to summarize overall review of related literature.

2.1 Information Systems in Agriculture

Information systems in agriculture have been widely pursued since the start of widespread technology use. There are several kinds of technological improvements that have been implemented in agriculture, including but not limited to automation, as shown by studies done by Látečková et al. (2018) and by Jha et al. (2019), Internet of Things, as shown by research done in “Internet of Things (IoT) in Agriculture Industries” by Adesta et al., 2017, and information systems, as shown by Birt et al. (2012).

The importance of information and knowledge systems in agriculture and food-processing industries was the focus of research by Kučera and Látečková (2006). The researchers claim that the Slovak Republic is investing more money in the IT industry. Even while Slovakia's government is cognizant of the need to establish an information society, its efforts are insufficient when compared to those of other EU nations. They concluded that agricultural firms' information systems do not offer enough data for operative or tactical management. However, the use of information systems is crucial for making decisions. Particularly for farmers as it aids in learning about plants and the ideal circumstances for growing them.

The research of Jha, Doshi, Patel, and Shah (2019) talks about using an automation system with artificial intelligence and IoT in the agriculture sector. The researchers proposed an idea to use IoT devices such as sensors to help in monitoring the farm and automating processes like irrigation for optimal water usage. They added different techniques for automation like artificial intelligence, deep learning, and neural network to reduce human intervention and increase production. In conclusion, they used artificial intelligence for crop selection and to help the farmer in fertilizer selection. They also used IoT for their advanced watering system to eliminate water crises by effectively using fresh water.

Information systems, pertaining to the context of this research, are shown to be more relevant in agriculture since they are usually relatively lightweight and less expensive than IoT solutions or artificial intelligence and automation solutions.

In the context of the development of a crop management system, it is shown that systems and analyses such as that and other related systems provide benefits. Ortiz (1995) analyzed plot techniques for proper crop management. This research shows that actions such as plot techniques are of help to crop management as a whole and could be considered. Cavendish banana farmers in Davao City have also been the research focus of Mata et al. (2020) in their research involving a model simulation approach.

Ramírez-Orellana et al. (2021) studied the perception of SME farm managers in Ecuador on using innovation as a driver for environmental sustainability practices. The discussion of results in the paper shows that the adoption of information systems has six measures, some of which are the use of the Internet and the development of a web page that informs customers and suppliers. The results show that the adoption of information systems impacts agricultural innovation and improves environmental sustainability.

Shuen et al. (2017) developed a fertilizer information system for banana plantations to calculate the quantity of fertilizer to be sown on banana plant, and fertilizing task management. The system consists of five main modules: a login module, manage banana plantation information module, fertilizer formulation management module, fertilizer information management module, and reporting module. The system also has two main user roles, which are the administrator or the farmer role, and the worker role. The administrator user role is the most important as it can access all modules and can manage data and information in the database. They can also do data management like add, edit, delete, manage plant information, manage formulation of fertilizer, calculate fertilizer mixture, and amount, and manage workers. The worker role can only view the banana plantation information, view their schedule, and view their personal profile. They are also required to update the job status after applying fertilizers.

Parker and Sinclair's (2001) research, titled "User Centred Design Does Make a Difference. The Case of Decision Support Systems in Crop Production" provides a look at how decision support systems could be used in the advancement of agriculture. In the research, it is shown that decision support systems implementation has been growing in farms in the UK and the researchers have also noted the main reasons of not implementing decision support systems, including but not limited to limited computer ownership, conflict with other systems, and inappropriate use of models, to name a few.

In the national scope, there have been studies done regarding the implementation of information technology systems in agriculture, particularly crop monitoring and/or management systems to aid farmers or to optimize crops. One such study is done by Nelson et al. (2014), in which the researchers assigned to mapping and studying the rice areas of the Philippines, most notably Leyte East, Leyte West, Agusan del Norte, and Nueva Ecija, found out that said provinces are classified as irrigated lowland, and they mainly rely on the release of irrigation water from the Upper Pampanga River Integrated Irrigation System. With this taken into consideration, the researchers studying the area have also started to apply information technology to the research methodology, capturing several rice area maps for the region for analysis and monitoring based on multi-temporal SAR data.

In the local context, it has been addressed by few studies, one such being the study of Tiausas et al. (2017), wherein the researchers utilized a wireless sensor network that would continuously and automatically monitor environmental conditions in the banana plantation in General Santos City. The findings from the research show that their nodes have been resilient to tropical temperatures and weather conditions, which shows that the implementation of IoT and IT systems for agriculture in General Santos City and the areas surrounding it is feasible.

2.2 Diffusion of Innovation Theory

Diffusion of innovation theory has been first discussed in 1903 by the French sociologist Gabriel Tarde, who also plotted the S-shaped diffusion curve (Toews, 2003), which is then followed by Ryan and Gross (1943) who implemented the five adopter categories. The modern definition revolves around both the concept of diffusion, which is the concept of which an innovation is communicated through social channels over time in a social system, and the concept of innovation, which is the concept of an idea, practice, tool, or technology that is perceived as novel to a social structure (Communication Theory, n.d.). The theory categorizes individuals into five distinct categories, namely, innovators, early adopters, early majority, late majority, and laggards. This theory is mostly utilized in the discovery and analysis of innovations, information systems innovations in the context of this research, and their social impact in the form of diffusion through the social structures.

As stated in an article written by Robinson (2009), the main qualities that make innovations spread more are the relative advantages of the innovations prior to older innovations, the compatibility with existing values and practices in the social structure, the simplicity and ease of use of the innovations, the trialability of the innovations, and the provision of observable results from the innovations.

The article written by Dearing and Cox (2018) goes further into diffusion, which allows the researchers in this study and in other studies to better understand diffusion in the context of the diffusion of innovations theory. In the article, it was stated that the typical dependent variable in diffusion research is the time of adoption and can be assessed among individuals. It was also stated that diffusion is often well explained by three main variables; the innovation’s pros and cons, perceptions of opinion leaders, particularly in the early adopters, and the larger social and political context in which the diffusion takes place in.

In Wainwright and Waring’s study (2007), the diffusion of innovation theory was used in an information systems context, specifically, information systems in healthcare. The study's main goal was to analyze the diffusion of innovation frameworks available and to develop and propose an adapted diffusion of innovation model that would be more suitable for information systems research in healthcare.

2.3 Innovation Adoption

In innovation adoption studies, researchers commonly use the five main perceived innovation attributes: relative advantage, compatibility, complexity, trialability, and observation (Rogers, 1995). Most based the questionnaires from Moore and Benbasat's (1991) developed instrument on measuring the perceptions of adopting an IT innovation, in which are contextualized to fit the study.

Duan et al. (2010) studied the intent of college students in China to take up e-learning. The five main attributes were used; however, the relative advantage was separated into two: process relative advantage and outcome relative advantage. For the hypothesis testing, multiple-linear regression analysis was performed to identify how these attributes affected the intention of the students to take up e-learning. It was concluded that only perceived compatibility has a positive significant effect on the intent to take up e-learning, the other attributes having negative and no significant effects.

In He et al.'s (2006) innovation adoption study of online e-payment in Chinese companies, an 18-item questionnaire were handed out to senior managers of each company. The questionnaire consists of five main attributes as constructs, each with different dimensions to generalize each question. For their data analysis, multiple logistic regression analysis was utilized as well, the same reason from the aforementioned study. Multicollinearity test was also used to see if independent variables, the perceived attributes, have relationships with each other. They concluded, like the study above, that only perceived compatibility is positively related to the companies' adoption decisions.

Although both studies mentioned performed reliability and validity analysis on the respective questionnaires, due to the time and labor feasibility, this study will only be performing hypotheses testing, specifically multiple logistic regression analysis to achieve this study’s objectives.

2.4 Synthesis

With all the considerations and understanding of previous research considered, a synthesis of the cited research could be formed to give better context and understanding to this research and to provide guidance to the researchers.

The common themes of the research articles collected are information systems in the agriculture sector, diffusion of innovation theory, and innovation adoption. These common themes share elements of this research, namely the elements of improving agriculture through different means, including implementing information systems.

The studies that have been analyzed and critiqued have given the researchers more knowledge and understanding of the fields which they would operate in. In several studies, it is shown that there is a benefit to implementing information systems in agriculture, particularly, systems that aid in managing time for agricultural tasks. These studies have also shown that there is a need for such systems to improve their activities and processes.

Diffusion of innovation theory has been determined to be the most appropriate theory to apply in the analysis of the farm and its ability and willingness to adapt to the proposed information system. The theory can be utilized. through a survey using the Likert scale, to gauge the perceived innovation of the system.

3. MATERIALS AND METHODS

This section of the paper discusses the research design used in this study, the theoretical framework used, the hypotheses of this study, respondents of the study, research instruments used, the system development life cycle.

3.1 Research Design

The study followed an applied research design with a quantitative approach since the study aimed to develop a crop monitoring system and it was evaluated by farm managers using a survey.

This study presented a problem and objectives answered and met in the later parts. These objectives include implementing an information system with crop monitoring functionalities for de-budding, fertilizing, and harvesting, evaluating the perceived innovation attributes of the crop monitoring system, and determining how these perceived attributes affect the intent to adopt the crop monitoring system.

The main source of data was the farm manager of Bartulaba-Domolok Banana Farm and farm managers from other farms. They answered a survey provided by the researchers. The results from the survey gave the necessary data that were later analyzed. The data analysis was conducted by performing multiple logistic regression analysis. In doing so, the researchers further understood and interpreted the results.

3.2 Theoretical Framework

Rogers (1995) identified five attributes that are key influences in innovation adoption: perceived relative advantage, perceived compatibility, perceived complexity, perceived trialability, and perceived observability.

In the context of this study, the researchers used the five perceived innovation attributes to determine how these attributes affect the intent of farm managers/owners in adopting a crop monitoring system for their banana farm.

Perceived relative advantage is positively related to the intention of adopting the crop monitoring system (Rogers, 1995). This measures how much a certain user group views an innovation as superior to the notion it replaces as determined by factors important to that user group, such as economic benefit, social standing, practicality, or satisfaction. The faster an innovation's pace of adoption is anticipated to be, the larger the perceived relative advantage it has (Robinson, 2009).

Perceived compatibility is positively related to the intention of adopting the crop monitoring system (Rogers, 1995). This refers to the degree to which an innovation is viewed in this way in line with the needs, values, and history of potential adopters. An innovation that conflicts with their values, customs, or habits will not be embraced as quickly as one that does (Robinson, 2009).

Perceived complexity is negatively related to the intention of adopting the crop monitoring system (Rogers, 1995). This refers to how challenging users find it to grasp and apply an invention. Innovations that are easier to grasp are adopted faster than those that demand the adopter to acquire new knowledge and abilities (Robinson, 2009).

Perceived trialability is positively related to the intention of adopting the crop monitoring system (Rogers, 1995). This is the extent to which a new idea can be tested on a small scale. An innovation that can be tested reduces uncertainty for the person who is thinking about it (Robinson, 2009).

Perceived observability is positively related to the intention of adopting the crop monitoring system (Rogers, 1995). This refers to individuals who are more inclined to adopt an innovation if they can quickly see its benefits. Visible outcomes reduce ambiguity and encourage peer discussion of a novel concept because friends and neighbors of an adopter frequently inquire about them (Robinson, 2009).

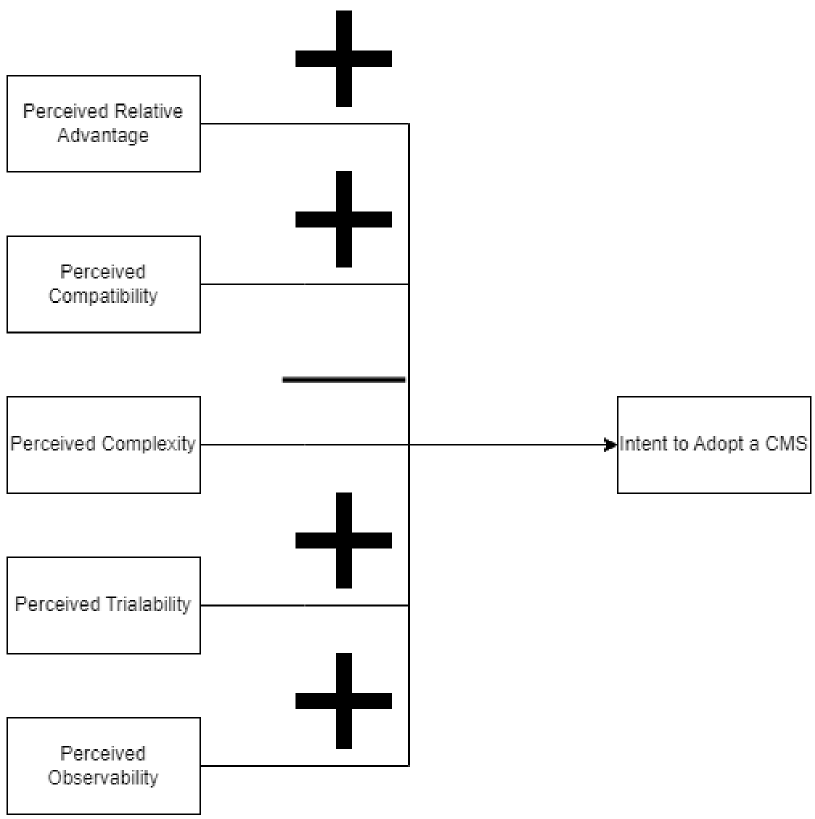


Figure 3.1 Theoretical Framework (Rogers, 1995)

3.3 Hypotheses

Modifications to Rogers' (1995) original theoretical framework were made since this study's object of analysis is a crop monitoring system. As seen in Figure 3.1, the independent variables are the five main perceived innovation attributes, namely, perceived relative advantage, perceived compatibility, perceived complexity, perceived trialability, and perceived observability; the dependent variable is the intention to adopt the crop monitoring system. According to the theoretical framework, the following hypotheses was tested:

$H_1$1 The relative advantage of the CMS positively affects the intent to adopt the CMS.

$H_1$2: The compatibility of the CMS positively affects the intent to adopt the CMS.

$H_1$3 The complexity of the CMS negatively affects the intent to adopt the CMS.

$H_1$4: The trialability of the CMS positively affects the intent to adopt the CMS.

$H_1$5: The observability of the CMS positively affects the intent to adopt the CMS.

3.4 Respondents and Research Instrument

The respondents of this study were 20 farm managers from Bartulaba-Domolok Banana Farm and other farms. Convenience sampling was the method used in selecting the participants due to their availability, geographical proximity, and willingness to participate in the study.

The research instrument this study utilized was a modified survey derived from He et al. (2006) to fit in with the study's innovation and locale. The consisted of 19 items, and five constructs: perceived relative advantage, perceived compatibility, perceived complexity, perceived trialability, and perceived observability. One question would be for the dependent variable, the intent to adopt a CMS.

Table 3.1 Survey Constructs and Items

Construct	Dimensions	Items
Perceived relative advantage	ADV 1: Operational Cost ADV 2: Profitability ADV 3: Competitiveness ADV 4: Efficiency ADV 5: Prestige	A CMS is relatively cheaper to use compared to the traditional crop monitoring methods. A CMS will strengthen your farm's profitability. A CMS will strengthen your farm’s competitive power. A CMS will increase the efficiency of your farm. Utilization of a CMS will enhance your farm’s prestige.
Perceived Compatibility	COMP 1: Fit Needs COMP 2: Complement COMP 3: Conflict COMP 4: Fit Style COMP 5: Overall Compatibility	A CMS fits your farm’s needs. A CMS is a good complement to the traditional crop monitoring methods. A CMS does not conflict with the traditional crop monitoring methods. A CMS fits well with the operation style of your farm. A CMS is compatible with the overall operation of your farm.
Perceived Complexity	CLEX 1: Setup Difficulty CLEX 2: Overall Effort	A CMS is difficult to set up compared to traditional crop monitoring methods. It takes your farm a lot of effort to get a CMS to work.

Perceived Trialability	TRIL 1: Technology Access TRIL 2: Service Access TRIL 3: Try Out Opportunities	Your farm has proper access to the technology related to a CMS before application. Your farm has proper access to the services related to a CMS before application. Your farm has opportunities to try out a CMS before application.
Perceived Observability	OBSR 1: Benefit Information OBSR 2: Result Apparentness OBSR 3: Benefit Understanding	Your farm has proper information on the benefits of a CMS. The result of applying a CMS would be apparent to you. Benefits of a CMS application is easy to understand.
Intent to Adopt a CMS		Do you intend to use a CMS?

The survey used a five-point Likert scale, by doing so, the researchers were able to evaluate the perceived innovation attributes and determine how these attributes affect the intent to adopt the CMS. And for the last question, the respondents would only need to answer yes or no.

Table 3.2 5-point Likert Scale

Score	**Interpretation**
1	Strongly Disagree
2	Disagree
3	Neutral
4	Agree
5	Strongly Agree

In the study of He et al. (2006), there were 22 items in the questionnaire originally. However, after performing confirmatory factor analysis (CFA), four items were removed due to having a factor loading below 0.7, which indicates that these items are not a proper indicator of their respective constructs (He et al., 2006), hence the 18-item questionnaire.

3.5 System Development

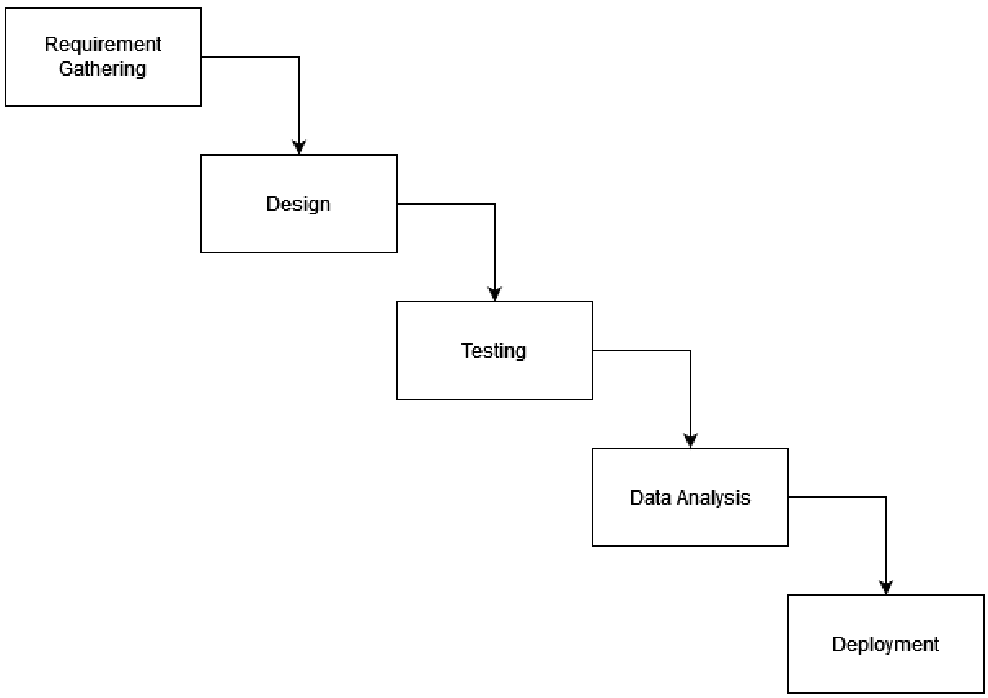


Figure 3.2 Waterfall SDLC

Requirement Gathering

The requirement gathering phase was done by performing a needs analysis on the farm to understand their process and gather necessary requirements and information for the system.

Design

The crop monitoring system was developed for desktop computers using python and SQLite for the database. The system consists of eight modules: for login, admin main menu, for user management, user main menu, for crop de-budding and harvesting monitoring, harvested and lost crops, fertilizer application, and a summary report of the harvesting dates. The functionalities and features of the crop monitoring system were developed specifically to fit the de-budding, fertilizing, and harvesting processes of Bartulaba-Domolok Banana Farm.

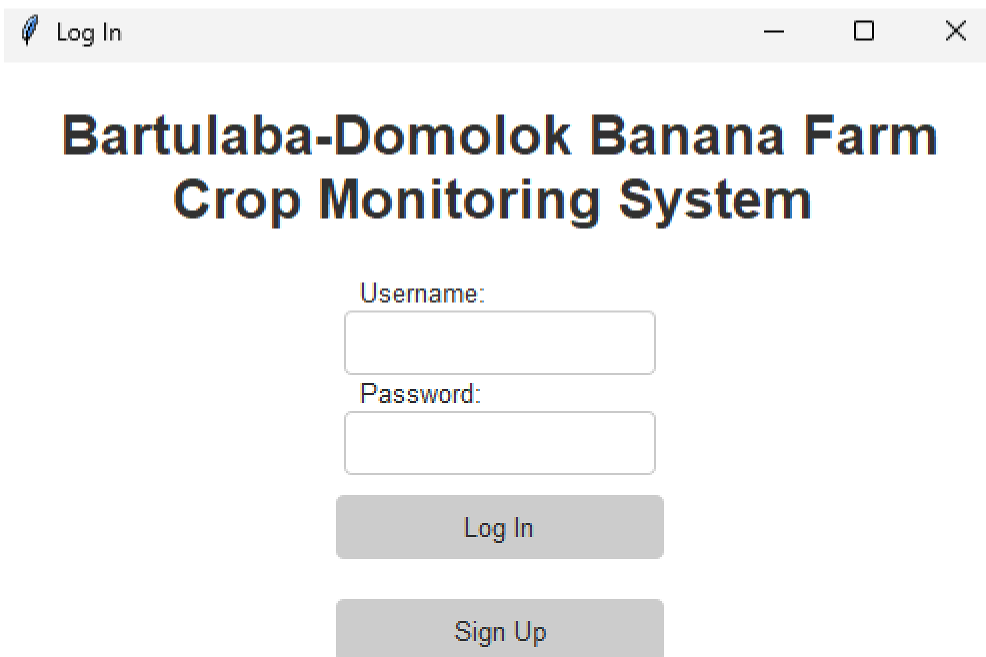


Figure 3.3 Login Module

Figure 3.3 shows the login module of the crop monitoring system. The module consists of a Log In button and Sign Up button. To create a user for the system, the user can type their username and password and simply click the “Sign Up” button. They can then login and access the rest of the modules in the system.

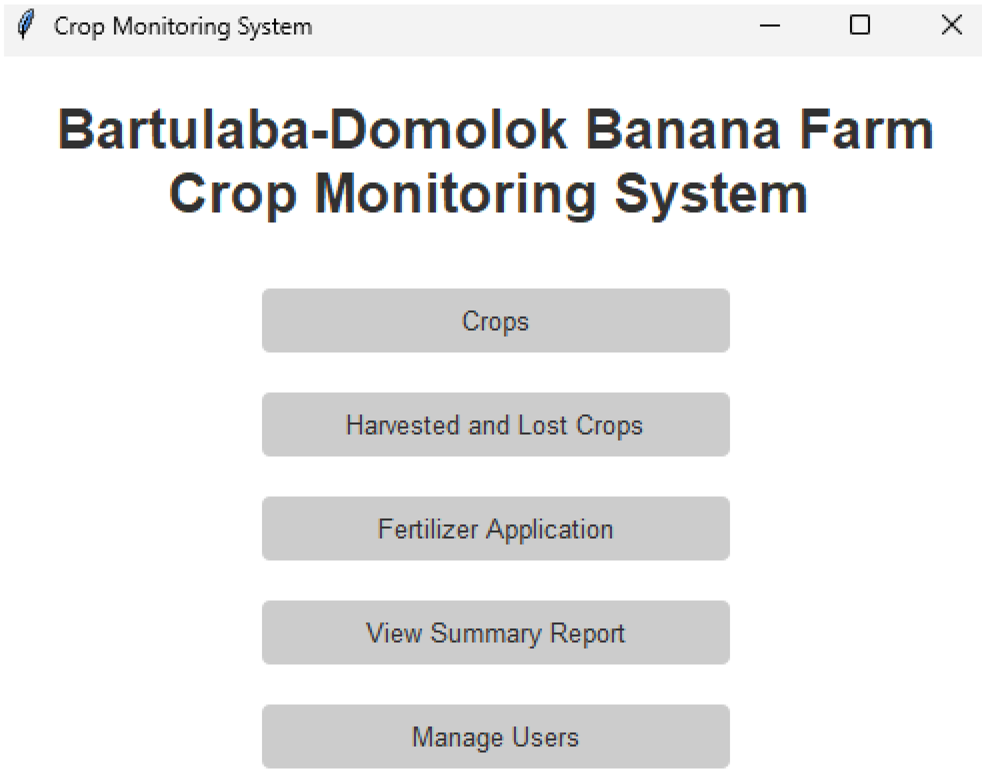


Figure 3.4 Admin Main Menu

Figure 3.4 shows the admin main menu of the system. This main menu consists of five buttons: Crops, Harvested and Lost Crops, Fertilizer Application, View Summary Report, and Manage Users.

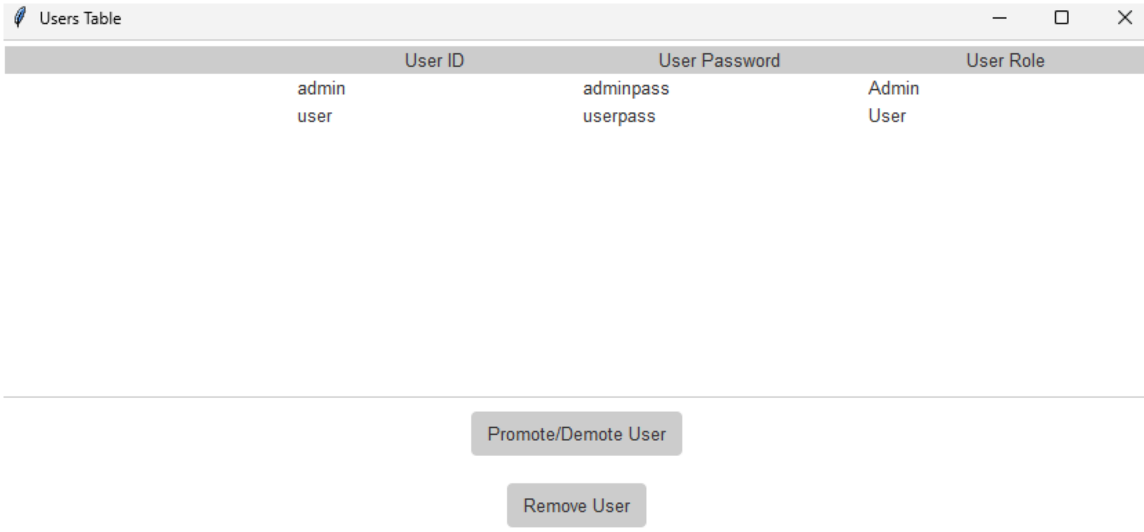


Figure 3.5 User Management Module

Figure 3.5 shows the user management module of the system. Only an admin account can access this module. In this module, the admin can look up the username, password, and roles of the users. The admin can promote and demote a user's role depending on their current role. If their current role is a "User", clicking the button will promote the user to "Admin." And if the current role of the user is "Admin", clicking the button will demote them to the "User" role. The admin also has the authority to remove users from the system.

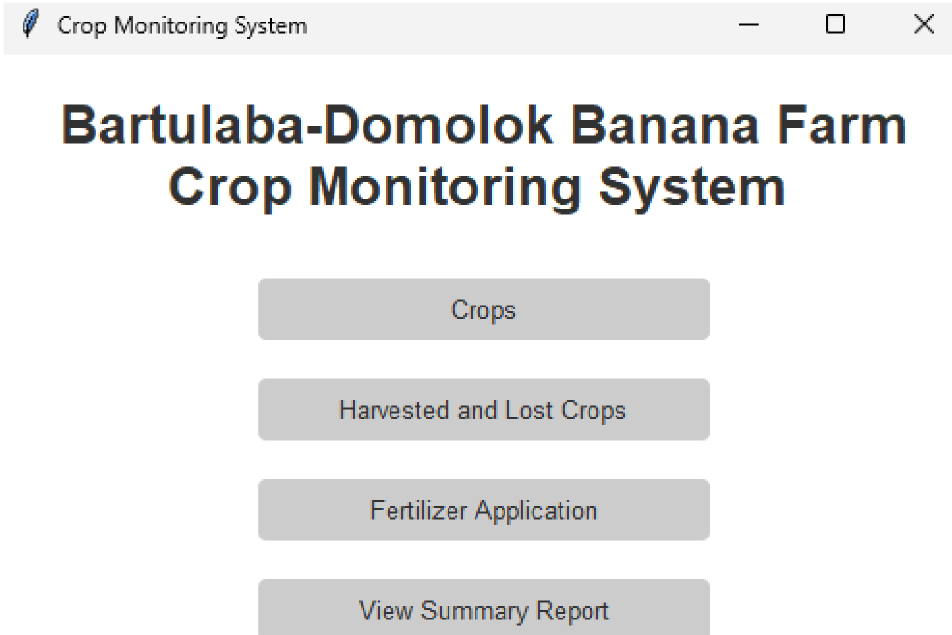


Figure 3.6 User Main Menu Module

Figure 3.6 shows the user main menu module of the crop monitoring system. In this menu, the user can choose between four different modules, the crop de-budding and harvesting date monitoring module, the harvested and lost crops module, fertilizer application module, and the harvesting date summary report module.

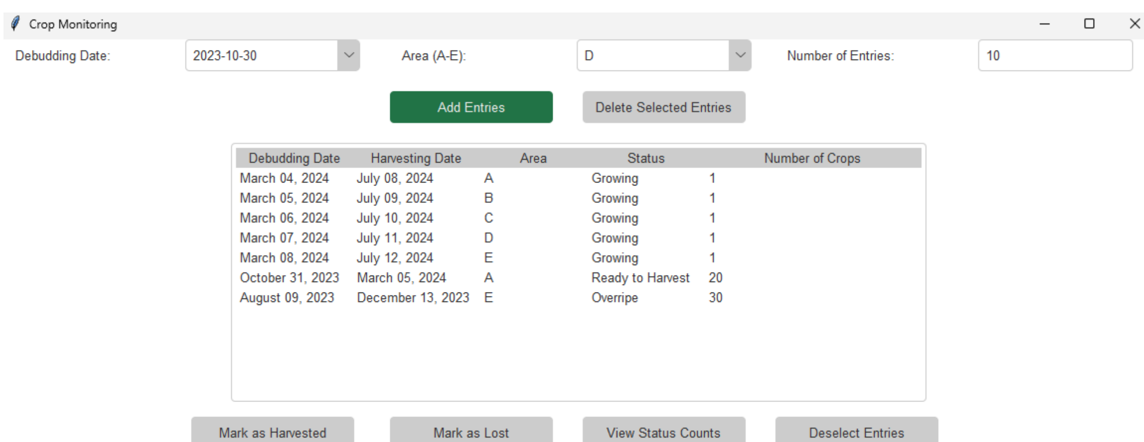


Figure 3.7 Crop Module

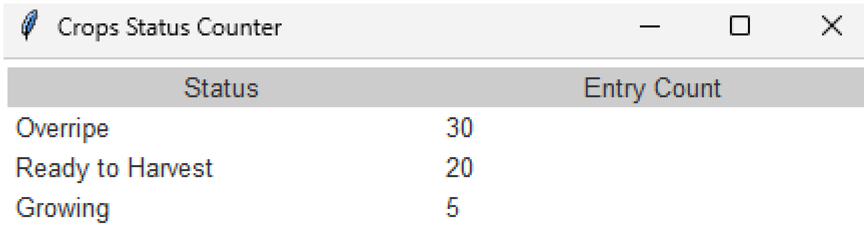


Figure 3.8 Crop Module Counter Window

Table 3.3 Crop Status Based on Weeks

Weeks	**Status**
Less than 17 weeks	Growing
17-19 weeks	Ready to harvest
More than 19 weeks	Overripe

Figure 3.7 shows the crop de-budding and harvesting date monitoring module. In this module, the user can add an entry by entering the de-budding date, area, and number of entries. The table in the module will then display the de-budding date and area entered, and it adds a harvesting date and status of the crop. The user can sort the entries by de-budding date, harvesting date, area, or status in ascending or descending order, by clicking the header in the table. The harvesting date is 18 weeks (about four and a half months) added to the de-budding date entered. The status, as shown by table 3.2, indicates the ripeness and readiness of the crop to be harvested. The user can also delete selected entries

if they accidentally entered the wrong data. The user can check the count of each status by clicking the "View Status Counts" (as seen on figure 3.8). Lastly, the user can move the crop entries to the harvested/lost module by selecting entries and clicking either "Mark as Harvested" or "Mark as Lost."

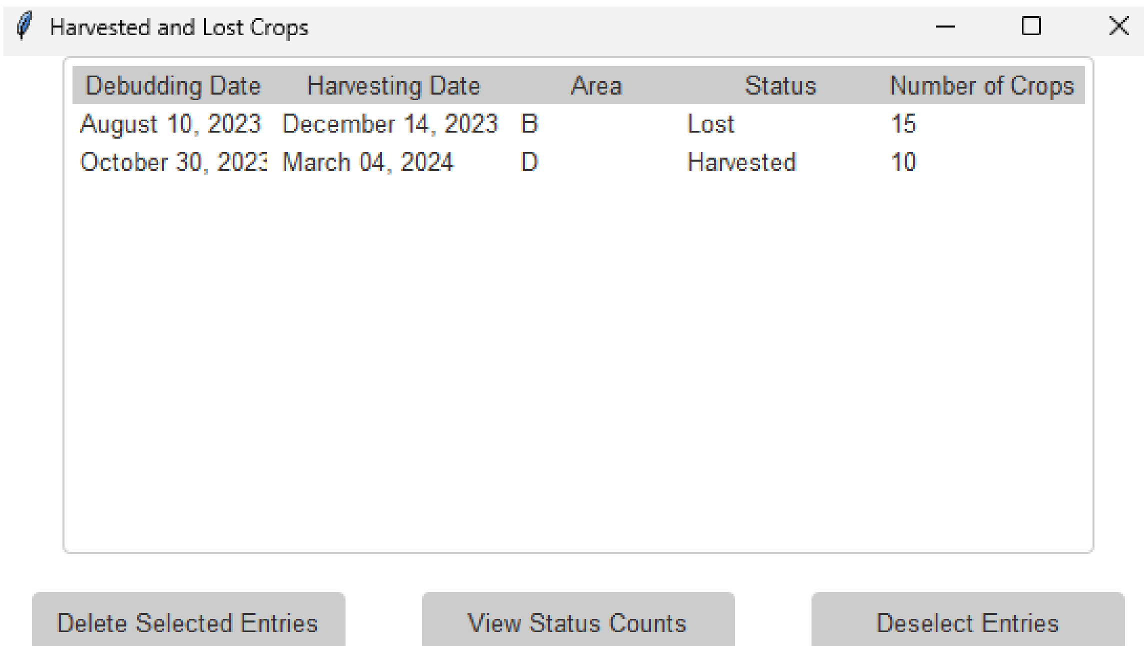


Figure 3.9 Harvested and Lost Crops Module

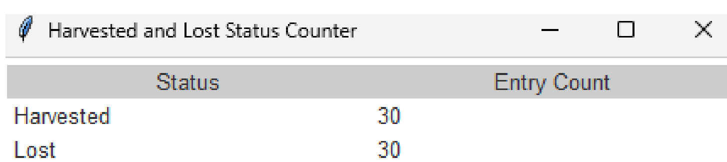


Figure 3.10 Harvested and Lost Crops Module Counter Window

Figure 3.9 shows the harvested and lost crops module. In this module, the user can see the crops they marked as harvested or lost. The user can delete selected entries if they choose to in the future. The user can also view the count per status (see figure 3.10).

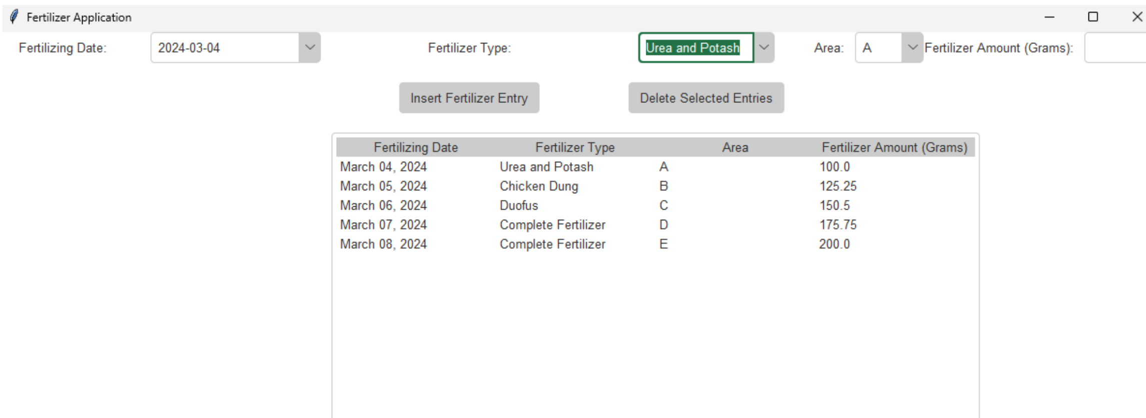


Figure 3.11 Fertilizer Application Module

Figure 3.11 shows the fertilizer application module of the crop monitoring system. In this module, the user enters the date the fertilizer was applied, the type used, which area was applied, and the amount of fertilizer applied. Based on the needs analysis done, they only use four types of fertilizer: duofus, chicken dung, urea and potash, and complete fertilizer, which is a mixture of the first three mentioned. Thus, the fertilizer type has a dropdown menu as its input which consists of the four fertilizers. In this way, the farm manager can keep track of their fertilizer application on the farm.

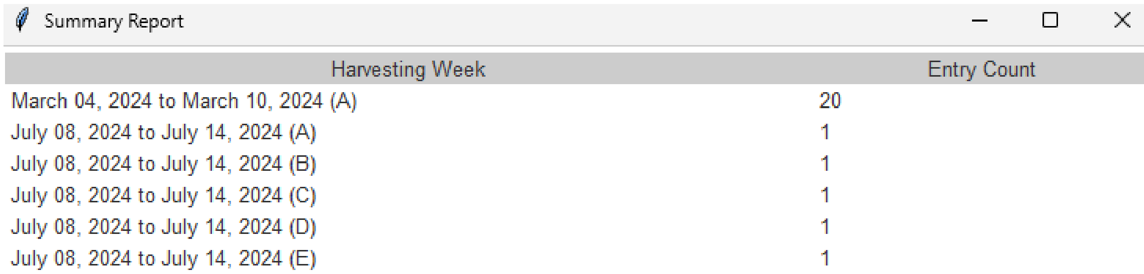


Figure 3.12 Harvesting Date Summary Report Module

Figure 3.12 shows the harvesting date summary report module of the crop monitoring system. In this module, the system counts how many crops are ready to be harvested each week.

Testing

User acceptance training and testing was conducted with the farm manager to verify the successful implementation of the system. The testing consisted of two types: Preliminary Testing and Parallel Testing. The following tables consists of the preliminary testing modules and test cases, and the test plan.

Table 3.4 Preliminary Testing Modules and Test Cases

Module	**Test Cases**
1. Login	a. Create an account b. Login in the account
2. User Management	a. View user’s details b. Promote/demote a user

	c. Remove user
3. Crop	d. Add de-budding date, area, and number of entries e. Delete crop entry f. Sort by de-budding date, harvesting date, area, or status g. Mark crop as “harvested” h. Mark crop as “lost” i. View crop count per status
4. Fertilizer Application	a. Add fertilizing date, fertilizer type, and amount used b. Delete fertilizing application entry
5. View Harvested and Lost	a. View harvested and lost crop entries b. Delete crop entries c. Sort by de-budding date, harvesting date, or area
6. View Summary Report	a. View summary report of crops to be harvested

Table 3.5 Test Plan

Test Case	Expected Outcome
1a	Create an account in the system
1b	Login the account in the system
2a	View the users' usernames, passwords, and roles
2b	Promote/demote a user
2c	Delete a user in the system
3a	Add de-budding date, area, and count in the system
3b	Delete crop entry
3c	Sort by header of user's choice
3d	Mark crop as "harvested"
3e	Mark crop as "lost"
3f	View crop count per status
4a	Add fertilizing date, fertilizer type, and amount used
4b	Delete fertilizing application entry
5a	View harvested and lost crop entries
5b	Delete crop entries
5c	Sort by header of user's choice
6a	View summary report of crops to be harvested

Data Analysis

For the data analysis phase, a 19-item survey was handed out to 20 farm managers. Mean and multiple logistics regression was performed to evaluate the results from the survey. Performing multiple logistic regression analysis evaluated how the perceived innovation attributes affected the intent to adopt the crop monitoring system.

Deployment

Once all phases are completed and finished, the crop monitoring system will be deployed at the farm.

4. RESULTS AND DISCUSSION

This section of the paper shows the results from survey data analysis and user acceptance testing. The findings serves as a basis to determine the effect of the perceived innovation attributes on the intent of farmers to adopt a crop monitoring system. This section also contains the implications of the results and the limitations of this study.

4.1 Results

To confirm that the system was successfully implemented, the farm manager participated in user acceptance training and testing. The following tables show the results of the preliminary testing done by Kagie Angelo Maruyama, and the user training and parallel testing done by Kent Bartulaba.

Table 4.1 User Acceptance Testing: Preliminary Testing Results

Test Case	Tested By	Date	Expected Outcome	Actual Outcome	Remarks
1a	Kagie Angelo Maruyama	February 15, 2024	Create an account in the system	User was able to create an account	Successful
1b	Kagie Angelo Maruyama	February 15, 2024	Login the account in the system	User was able to login the created account	Successful
2a	Kagie Angelo Maruyama	February 15, 2024	View users' usernames, passwords, roles	Was able to view the users' login details	Successful
2b	Kagie Angelo Maruyama	February 15, 2024	Promote/demote a user	Was able to promote and demote a user's role	Successful

2c	Kagie Angelo Maruyama	February 15, 2024	Delete a user in the system	Was able to delete a user	Successful
3a	Kagie Angelo Maruyama	February 15, 2024	Add de-budding date, area, and count in the system	De-budding date, area, and number of entries added into the system. Function that adds 18 weeks to the de-budding date works as intended.	Successful
3b	Kagie Angelo Maruyama	February 15, 2024	Delete crop entry	Deleting selected (individual or multiple) entries works.	Successful
3c	Kagie Angelo Maruyama	February 15, 2024	Sort by header of user’s choice	Left-clicking header of the user’s choice sorts the entries below it.	Successful
3d	Kagie Angelo Maruyama	February 15, 2024	Mark crop as “harvested”	Entries (individual or multiple) were marked as “harvested” and sent to the harvested and lost table.	Successful
3e	Kagie Angelo Maruyama	February 15, 2024	Mark crop as “lost”	Entries (individual or multiple) were marked as “lost” and sent to the	Successful

				harvested and lost table.	
3f	Kagie Angelo Maruyama	February 15, 2024	View crop count per status	Function shows crop count per status both with and without entries selected.	Successful
4a	Kagie Angelo Maruyama	February 15, 2024	Add fertilizing date, fertilizer type, and amount used	Function that adds fertilizing date, fertilizer type, and amount of fertilizer used works.	Successful
4b	Kagie Angelo Maruyama	February 15, 2024	Delete fertilizer application entry	Deleting selected (individual or multiple) entries works.	Successful
5a	Kagie Angelo Maruyama	February 15, 2024	View harvested and lost crop entries	Harvested and lost crop entries are shown on a table.	Successful
5b	Kagie Angelo Maruyama	February 15, 2024	Delete crop entries	Deleting selected (individual or multiple) entries works.	Successful
5c	Kagie Angelo Maruyama	February 15, 2024	Sort by header of user’s choice	Left-clicking header of the user’s choice sorts the entries below it.	Successful

6a	Kagie Angelo Maruyama	February 15, 2024	View summary report of crops to be harvested	Function shows summary of crops.	Successful

Table 4.1 shows the preliminary user acceptance testing done by Kagie Angelo Maruyama on February 15, 2024. All test cases were successfully tested, and no bugs were found.

Table 4.2 User Training Results

Date	Module	User	Remarks
February 16, 2024	Login	Kent Bartulaba	The training was administered successfully.
February 16, 2024	User Management	Kent Bartulaba	The training was administered successfully.
February 16, 2024	Crop	Kent Bartulaba	The training was administered successfully
February 16, 2024	Fertilizer Application	Kent Bartulaba	The training was administered successfully
February 16, 2024	View Harvested and Lost	Kent Bartulaba	The training was administered successfully
February 16, 2024	View Summary Report	Kent Bartulaba	The training was administered successfully

Table 4.2 shows the user training results. The training was done on February 17, 2024 at General Santos City by Jhon Louise Tan. The farm manager, Kent Bartulaba, was trained successfully on the test cases in each module.

Table 4.3 User Acceptance Testing: Parallel Testing Results

Test Case	Tested By	Date	Expected Outcome	Actual Outcome	Remarks
1a	Kent Bartulaba	February 16, 2024	Create an account in the system	Was able to create an account in the system	Successful
1b	Kent Bartulaba	February 16, 2024	Login the account in the system	Was able to login the created account	Successful
2a	Kent Bartulaba	February 16, 2024	View the users' usernames, passwords, and roles	Was able to view the users' login details	Successful
2b	Kent Bartulaba	February 16, 2024	Promote/demote a user	Was able to promote and demote a user's role	Successful
2c	Kent Bartulaba	February 16, 2024	Delete a user in the system	Was able to delete a user	Successful
3a	Kent Bartulaba	February 16, 2024	Add de-budding date, area, and count in the system	Was able to enter all inputs and adding 18 weeks to de-budding date is functioning	Successful
3b	Kent Bartulaba	February 16, 2024	Delete crop entry	Was able to delete single and multiple entries	Successful
3c	Kent Bartulaba	February 16, 2024	Sort by header of user's choice	Was able to sort in ascending or descending order by	Successful

				any header of choice	
3d	Kent Bartulaba	February 16, 2024	Mark crop as “harvested”	Was able to mark crop as “harvested” and entry was moved to harvest and lost crop module	Successful
3e	Kent Bartulaba	February 16, 2024	Mark crop as “lost”	Was able to mark crop as “lost” and entry was moved to harvest and lost crop module	Successful
3f	Kent Bartulaba	February 16, 2024	View crop count per status	Was able to correctly view crop count per status	Successful
4a	Kent Bartulaba	February 16, 2024	Add fertilizing date, fertilizer type, and amount used	Was able to enter all inputs	Successful
4b	Kent Bartulaba	February 16, 2024	Delete fertilizer application entry	Was able to delete single and multiple entries	Successful
5a	Kent Bartulaba	February 16, 2024	View harvested and lost crop entries	Was able to view harvested and lost crops	Successful
5b	Kent Bartulaba	February 16, 2024	Delete crop entries	Was able to delete single and multiple entries	Successful

5c	Kent Bartulaba	February 16, 2024	Sort by header of user's choice	Was able to sort by ascending or descending order by header of user's choice	Successful
6a	Kent Bartulaba	February 16, 2024	View summary report of crops to be harvested	Was able to view summary report of crops to be harvested	Successful

Table 4.3 shows the user acceptance parallel testing results. The test was done by Kent Bartulaba on February 16, 2024 at General Santos City. All expected outcomes were met on test cases in each module.

The results of the survey were analyzed using mean and multiple logistic regression analysis on jamovi, an open-source statistical tool. Mean was used to analyze each statement of each perceived attribute. For the parameters of the regression analysis, the intent to adopt a CMS was set as the dependent variable, and the independent variables were the perceived innovation attributes: relative advantage, compatibility, complexity, trialability, and observability. A 95% confidence interval was set in this regression analysis.

Table 4.4 Mean Interpretation

Mean	Interpretation
1.00 - 1.80	Strongly Disagree
1.81 - 2.60	Disagree
2.61 - 3.40	Neutral

3.41 - 4.20	Agree
4.21 - 5.00	Strongly Agree

Table 4.5 Mean Table for Perceived Relative Advantage Dimensions

Dimension	**Mean (x)**
ADV1	2.65
ADV2	3.65
ADV3	3.95
ADV4	4.05
ADV5	3.70
Average	3.60

Table 4.5 shows the mean of each dimension under the perceived relative advantage construct. With an average mean of 3.60, generally, the respondents believe that a CMS will strengthen the farm's competitive power, increase its efficiency, and enhance its reputation. However, ADV1 has a mean of 2.65, which interprets to a neutral opinion with the statement “A CMS is relatively cheaper to use compared to the traditional crop monitoring methods. This indicates that the respondents see a CMS as either a cheaper or more costly crop monitoring method compared to the traditional ones.

Table 4.6 Mean Table for Perceived Compatibility Dimensions

Dimension	**Mean (x)**
COMP1	3.95
COMP2	3.85
COMP3	3.70
COMP4	3.85
COMP5	3.80
Average	3.83

Table 4.6 shows the mean values of the perceived compatibility dimensions. With an average mean of 3.83, this finding indicates that the respondents agree that a CMS is compatible with the farm's needs and operations. The respondents also agreed that a CMS does not conflict with the traditional methods of crop monitoring, believing that it is instead a good complement to the traditional methods.

Table 4.7 Mean Table for Perceived Complexity Dimensions

Dimension	**Mean (x)**
CLEX1	3.15
CLEX2	3.20
Average	3.18

Table 4.7 shows the mean for the perceived complexity dimensions. With an average mean of 3.18, this finding means that the respondents have a neutral opinion on the complexity of a CMS. Furthermore, the respondents believe that setting up a CMS for the farm is either difficult or easy, and takes a normal amount of effort for the CMS to work.

Table 4.8 Mean Table for Perceived Trialability Dimensions

Dimension	**Mean (x)**
TRIL1	3.10
TRIL2	3.05
TRIL3	3.10
Average	3.08

Table 4.8 shows the mean values of the perceived trialability dimensions. With an average mean of 3.08, similar to the perceived complexity attribute, the respondents have

a neutral opinion about the trialability of a CMS. Moreover, before application of a CMS, the respondents believe that they have either access or no access to the technology and services related to CMS.

Table 4.9 Mean Table for Perceived Observability Dimensions

Dimension	**Mean (x)**
OBSR1	3.55
OBSR2	3.80
OBSR3	3.80
Average	3.72

Table 4.9 shows the mean of the perceived observability dimensions. With an average mean of 3.72, this finding indicates that the respondents generally agree that they have the proper information of the benefits of applying a CMS. In addition, the respondents also agreed that the benefits of a CMS are easy to understand, and that the result will be clear to them.

Table 4.10 Multiple Logistic Regression Result

		95% Confidence Interval				
Predictor	Estimate	Lower	Upper	SE	Z	p
Intercept	35.292	−3.64	74.22	19.862	1.777	0.076
Relative Advantage	−8.359	−20.39	3.67	6.138	−1.362	0.173
Compatibility	1.103	−5.51	7.72	3.373	0.327	0.744
Complexity	−0.203	−2.01	1.60	0.921	−0.220	0.826
Trialability	0.811	−1.77	3.40	1.318	0.615	0.538
Observability	−3.629	−8.94	1.68	2.709	−1.339	0.180

Note. Estimates represent the log odds of "Intent to Adopt CMS = no" vs. "Intent to Adopt CMS = yes"

Table 4.10 shows the result of the multiple logistic regression analysis. The results show the p-value of the five perceived attributes is all greater than 0.05, meaning that the alternative hypotheses are rejected. Therefore, there is no significant relationship between the dependent and independent variables. This indicates that in the study, the five perceived innovation attributes (relative advantage, compatibility, complexity, trialability, and observability) have no effect on the intent of the farm owners/managers to adopt a CMS.

4.2 Implications of the Study

The implications of this study are significant for Bartulaba-Domolok Banana Farm, future researchers, and other banana farms. For the main benefactor and other banana farms, adopting the CMS can improve data handling and monitoring of crops. For future researchers, following this study and its recommendations may serve as a guide and reference to improve the CMS and result of this study.

4.3 Limitations of the Study

The limitations the researchers anticipated for the study should provide a clear and solid understanding of its scope. The overall scope of the study is limited to evaluating the perceived innovation attributes of a CMS and determining if these attributes affect the intent of farm owners/managers in adopting a CMS for their farm. These attributes include relative advantage, compatibility, complexity, trialability, and observability. A survey was handed out to farm owners and managers, and the results were analyzed using mean and multiple logistics regression.

The system developed also has a scope and limitations that must be addressed. The functions of the crop monitoring system were specifically developed to fit the processes of Bartulaba-Domolok Banana Farm. The system was limited to monitoring the de-budding and harvesting date of the crops, and the fertilizer application in the farm.

5. CONCLUSION AND RECOMMENDATION

This section of the paper contains the conclusion statements of the study and the recommendations by the researchers.

5.1 Conclusion

This study aimed to evaluate the perceived innovation attributes of a crop monitoring system and determine if these attributes affect the intent of farm owners/managers to adopt this innovation. The study was able to develop and implement an information system with crop monitoring functionalities specifically for the de-budding, fertilizing, and harvesting processes of Bartulaba-Domolok Banana Farm. Implementing the system decreases the load and time of the farm manager when it comes to manually calculating harvest dates every time. Even though there is a slight increase in activity for the farm manager when implementing a crop monitoring system, these activities help in strengthening the data handling and monitoring of the de-budding, fertilizing, and harvesting processes of the farm.

In addition, the researchers evaluated the perceived innovation attributes of a CMS by giving a survey to 20 farm owners/managers. Mean was used to analyze each statement in the survey. The findings from this analysis show that, generally, respondents agree on the statements regarding perceived relative advantage, perceived compatibility, and perceived observability. However, for perceived complexity and perceived trialability, respondents generally have a neutral opinion about the statements under those attributes. These findings implicate that respondents believe that using or implementing a CMS for farm provides a relative advantage, that a CMS fits well in operations and processes of the farm, and that respondents clearly see and understand the benefits of applying a CMS.

Furthermore, multiple logistics regression analysis was used to test the hypotheses and to determine the relationship between the perceived innovation attributes and the intent to adopt a CMS. The hypotheses of this study state that relative advantage, compatibility, trialability, and observability positively affect the intent to adopt a CMS, while complexity negatively affects it. However, the result from the analysis shows that all p-values of the independent variables are greater than 0.05, therefore, rejecting the hypotheses. This finding indicates that the relative advantage, compatibility, complexity, trialability, and observability of the CMS do not affect the intent of farm owners/managers in adopting a CMS for the farm. This finding implies that factors such as cost, overall compatibility, setup difficulty, technology and service access, and benefit information and understanding, do not affect the intent of farm managers in opting to use CMS for the farm.

5.2 Recommendation

In conclusion, the five main perceived innovation attributes (relative advantage, compatibility, complexity, trialability, and observability) had no effects to the intent of farm managers in adopting a CMS for the farm. However, the researchers have devised several recommendations for future researchers who wish to conduct more research on the same subject and methods this study had delved into. The study and user recommendations are as follows:

Study Recommendations

1. Since this study modified a survey from an existing study, some statements were not fitting for the context of this study. Future researchers should consider developing survey questions tailored specifically to the context of their study. Conducting thorough reliability and validity testing on these customized questions will ensure that the survey accurately captures the perceptions and attitudes of respondents within the targeted domain.
2. To strengthen the findings, increasing the sample size beyond the current 20 respondents to at least 50 could provide a more robust dataset for analysis. Having a larger sample size could lead to more varied insights and potentially enhance the statistical power of multiple logistics regression and mean analysis.

User Recommendations

1. To improve the decision making of the farm manager, adding features to the CMS like integrating real-time monitoring of temperature, humidity, and soil moisture could provide comprehensive data for making informed decisions.
2. Develop a mobile application version of the CMS to facilitate on-site use during the de-budding, fertilizing, and harvesting processes. This mobile functionality will enable farm managers to access and utilize CMS features seamlessly, enhancing efficiency and responsiveness in farm management tasks.
3. Although SQLite is sufficient and efficient in handling small to medium amounts of data, the researchers recommend migrating the database to a more scalable SQL-

based system to handle large amounts of data in the future. This migration ensures that the CMS remains capable of managing larger datasets as the farm expands in the future.

4. In the current system, the area options are limited to areas A-E. If the farm decides to expand in the future, the researchers recommend adding a feature wherein the admin can add more areas in the system to support scalability and adaptability to changing farm requirements.

APPENDICES

Appendix A: References

Adesta, E. Y. T., Agusman, D., & Avicenna, A. (2017). Internet of Things (IoT) in Agriculture Industries. *Indonesian Journal of Electrical Engineering and Informatics*, *5*(4). https://doi.org/10.11591/ijeei.v5i4.373

Birt, A. G., Calixto, A. A., Tchakerian, M. D., Dean, A., Coulson, R. N., & Harris, M. (2012). Harnessing Information Technology (IT) for Use in Production Agriculture. *Journal of Integrated Pest Management*. https://doi.org/10.1603/ipm11008

Communications Theory. (n. d.). Diffusion of innovation theory. https://www.communicationtheory.org/diffusion-of-innovation-theory/

Daoud, J. (2017). Multicollinearity and Regression Analysis. *Journal of Physics: Conference Series 949 (2017) 012009*. doi :10.1088/1742-6596/949/1/012009

Dearing, J. W., & Cox, J. G. (2018). Diffusion Of Innovations Theory, Principles, And Practice. *Health Affairs*, *37*(2), 183–190. https://doi.org/10.1377/hlthaff.2017.1104

Dhudasia, M. B., Grundmeier, R. W., & Mukhopadhyay, S. (2021). Essentials of data management: an overview. *Pediatric Research*, *93*(1), 2–3. https://doi.org/10.1038/s41390-021-01389-7

Dogello, J. D. & Cagasan, U. A. (2021). A Review on the Status of Crop Production Innovations of the Philippines. *Eurasian Journal of Agricultural Research*. *5*(2), 130-136.

Duan, Y., He, Q., Feng, W., Li, D., & Fu, Z. (2010). A study on e-learning take-up intention from an innovation adoption perspective: A case in China. Computers & Education, 55(1), 237–246. doi: 10.1016/j.compedu.2010.01.009

He, Q., Duan, Y., Fu, Z., & Li, D. (2006). An Innovation Adoption Study of Online E-Payment in Chinese Companies. *Journal of Electronic Commerce in Organizations*, 4(1), 48–69. doi:10.4018/jeco.2006010104

Jha, K., Doshi, A., Patel, P. K., & Shah, M. (2019). A comprehensive review on automation in agriculture using artificial intelligence. *Artificial Intelligence in Agriculture, 2*, 1–12. https://doi.org/10.1016/j.aiia.2019.05.004

Kaminski, J. (2011). Diffusion of Innovation Theory. *Canadian Journal of Nursing Informatics*. https://cjni.net/journal/?p=1444

Kučera, M., & Látečková, A. (2006). Information and knowledge systems in the operation of Agricultural and food-processing enterprises. *Agricultural Economics (Zemědělská Ekonomika)*, 52(8), 353–357. https://doi.org/10.17221/5034-agricecon

Látečková, A., Bolek, V., & Szabo, Ľ. (2018). Information Systems in Agricultural Enterprises: An Empirical Study in Slovak Republic. *Agris On-line Papers in Economics and Informatics*, *10*(2), 49–60. https://doi.org/10.7160/aol.2018.100205

Manalo, J. A., Pasiona, S. P., & Bautista, A. M. (2021). Understanding the complexities in the adoption of the rice crop manager tool in the Philippines. International Journal of Agricultural Sustainability, 20(4), 381–392. https://doi.org/10.1080/14735903.2021.1934363

Mata, M. A., Oguis, G. F., Ligue, K. D., Gamot, R. M., Abaro, K. R., Fordan, Y., & Digal, L. (2020). Model Simulation Approach for Exploring Profitability of Small-scale Cavendish Banana Farmers in Davao Region from Harvest Allocation to Enterprises. *The Philippine Journal of Science*, *149*(2). https://doi.org/10.56899/149.02.07

Miles, J. (2014). Tolerance and Variance Inflation Factor. Wiley StatsRef: Statistics Reference Online. https://doi.org/10.1002/9781118445112.stat06593

Menard, S. (1995). Applied logistic regression analysis (Sage university paper series on quantitative application in the social sciences, series no. 106) (2nd ed.). ThousandOaks, CA: Sage.

Moore, G. C., & Benbasat, I. (1991). Development of an Instrument to Measure the Perceptions of Adopting an Information Technology Innovation. *Information Systems Research*, 2(3), 192–222. doi:10.1287/isre.2.3.192

Nelson, A., Setiyono, T. D., Rala, A., Quicho, E. D., Raviz, J., Abonete, P. J., Maunahan, A., Garcia, C., Bhatti, H. Z. M., Villano, L., Thongbai, P., Holecz, F., Barbieri, M., Collivignarelli, F., Gatti, L., Quilang, E. J., Mabalay, M. R., Mabalot, P., Barroga, M., . . . Ninh, N. H. (2014). Towards an Operational SAR-Based Rice Monitoring System in Asia: Examples from 13 Demonstration Sites across Asia in the RIICE Project. *Remote Sensing*, *6*(11), 10773–10812. https://doi.org/10.3390/rs61110773

Ortiz, R. (1995). Plot Techniques for Assessment of Bunch Weight in Banana Trials under Two Systems of Crop Management. *Agronomy Journal*, *87*(1), 63–69. https://doi.org/10.2134/agronj1995.00021962008700010011x

Parker, C. E., & Sinclair, M. A. (2001). User-centered design does make a difference. The case of decision support systems in crop production. *Behaviour & Information Technology*, *20*(6), 449–460. https://doi.org/10.1080/01449290110089570

Ramírez-Orellana, A., Ruiz-Palomo, D., Rojo-Ramírez, A., & Burgos-Burgos, J. E. (2021). The Ecuadorian banana farms managers' perceptions: Innovation as a driver of environmental sustainability practices. *Agriculture*, 11(3), 213.

Robinson, L. (2009). A summary of Diffusion of Innovations. Enabling change. https://twut.nd.edu/PDF/Summary_Diffusion_Theory.pdf

Rogers, E.M. (1995). *Diffusion of Innovations, 4th Edition*. THE FREE PRESS.

Rogers, E. M., Simon, H. D., & Schuster. (2003). *Diffusion of Innovations, 5th Edition*. https://www.amazon.com/Diffusion-Innovations-5th-Everett-Rogers/dp/0743258231

Ryan & Gross (1943), The Diffusion of Hybrid Seed Corn in Two Iowa Communities, Rural Sociology 8 (March): 15

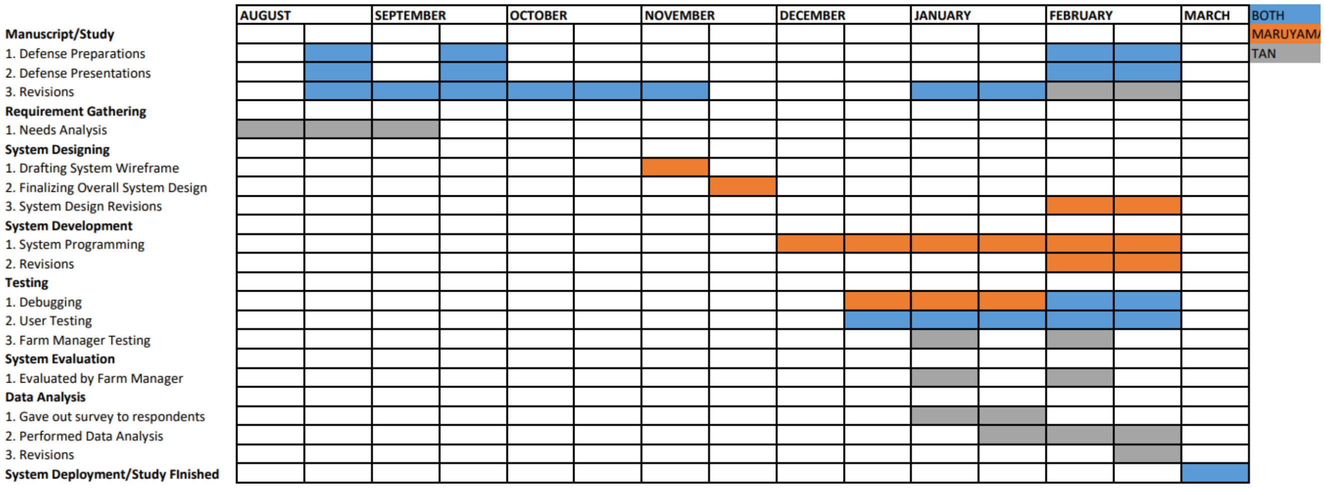
SDLC - Waterfall model. (n.d.). https://www.tutorialspoint.com/sdlc/sdlc_waterfall_model.htm

Shuen, Y. S., Arbaiy, N., & Jusoh, Y. Y. (2017). Fertilizer information system for banana plantation. JOIV: International Journal on Informatics Visualization, 1(4-2), 204-208.

Tiausas, F., Co, J. T., Macalinao, M. J. M., Guico, M. L., Monje, J. C., & Oppus, C. (2017). Design of autonomous sensor nodes for remote soil monitoring in tropical banana plantation. *Fifth International Conference on Remote Sensing and Geoinformation of the Environment*. https://doi.org/10.1117/12.2279132

Zulham, Lubis, Z., Zarlis, M., & Aulia, M. R. (2023). Performance Analysis of Oil Palm Companies Based on Barcode System through Fit Viability Approach: Long Work as A Moderator Variable. *Aptisi Transactions on Technopreneurship (ATT)*, *5*(1), 40–52. https://doi.org/10.34306/att.v5i1.288

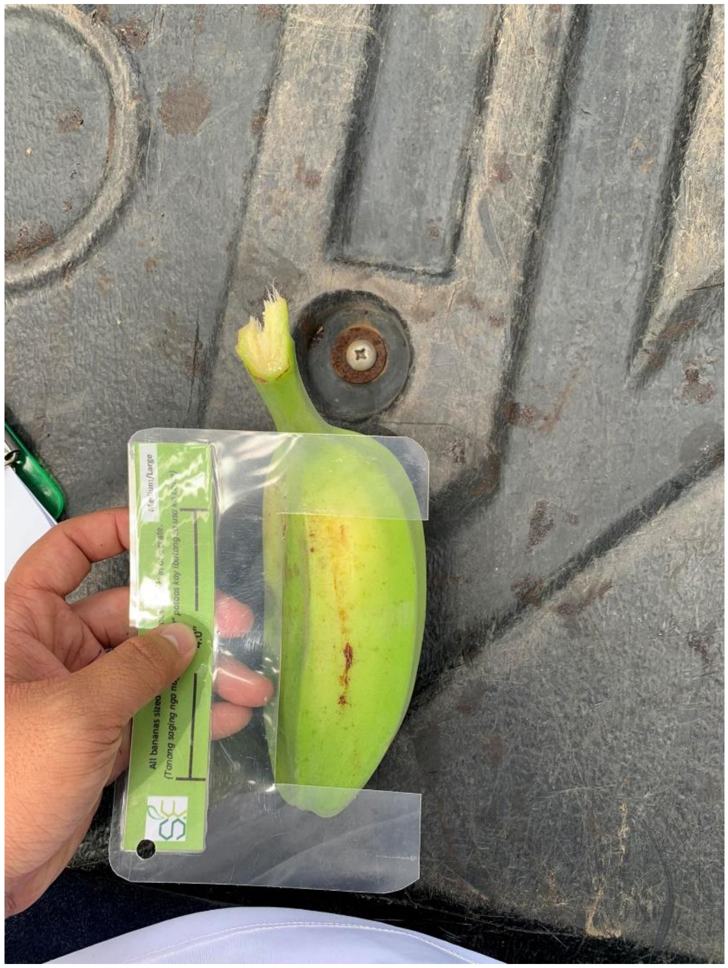
Appendix B: Gantt Chart



Appendix C: Documentation

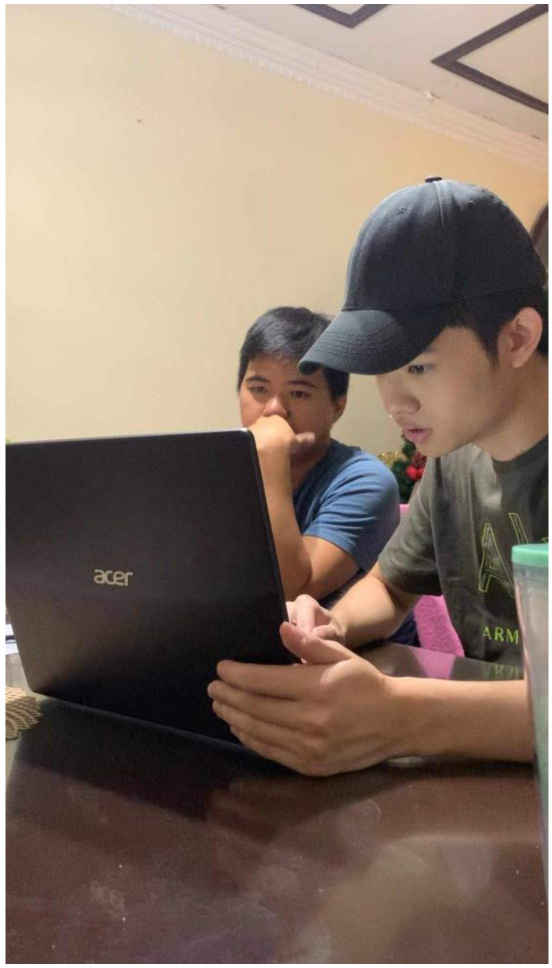
Bartulaba-Domolok Banana Farm

Example of De-budding Practice



Measuring Fruit’s Size

Crates for Different Sizes of Fruit



Presentation and Demo of CMS to Farm Manager

Appendix D: Survey Questions

Crop Monitoring System (CMS) Adoption Survey

Please indicate your level of agreement or disagreement with each of these statements regarding the adoption of a crop monitoring system. Tick the box of your answer.

Legend:

1 – Strongly Disagree 2 – Disagree 3 – Neutral 4 – Agree 5 – Strongly Agree

Do you intend to use a CMS? ________

Questions	1	2	3	4	5
1. A CMS is relatively cheaper to use compared to the traditional crop monitoring methods.					
2. A CMS will strengthen your farm's profitability.					
3. A CMS will strengthen your farm's competitive power.					
4. A CMS will increase the efficiency of your farm.					
5. Utilization of a CMS will enhance your farm's prestige.					
6. A CMS fits your farm's needs					
7. A CMS is a good complement to the traditional crop monitoring methods					
8. A CMS does not conflict with the traditional crop monitoring methods.					
9. A CMS fits well with the operation style of your farm.					
10. A CMS is compatible with the overall operation of your farm.					
11. A CMS is difficult to set up compared to traditional crop monitoring methods					
12. It takes your farm a lot of effort to get a CMS to work.					
13. Your farm has proper access to the technology related to a CMS before application.					
14. Your farm has proper access to the services related to a CMS before application.					
15. Your farm has opportunities to try out a CMS before application.					

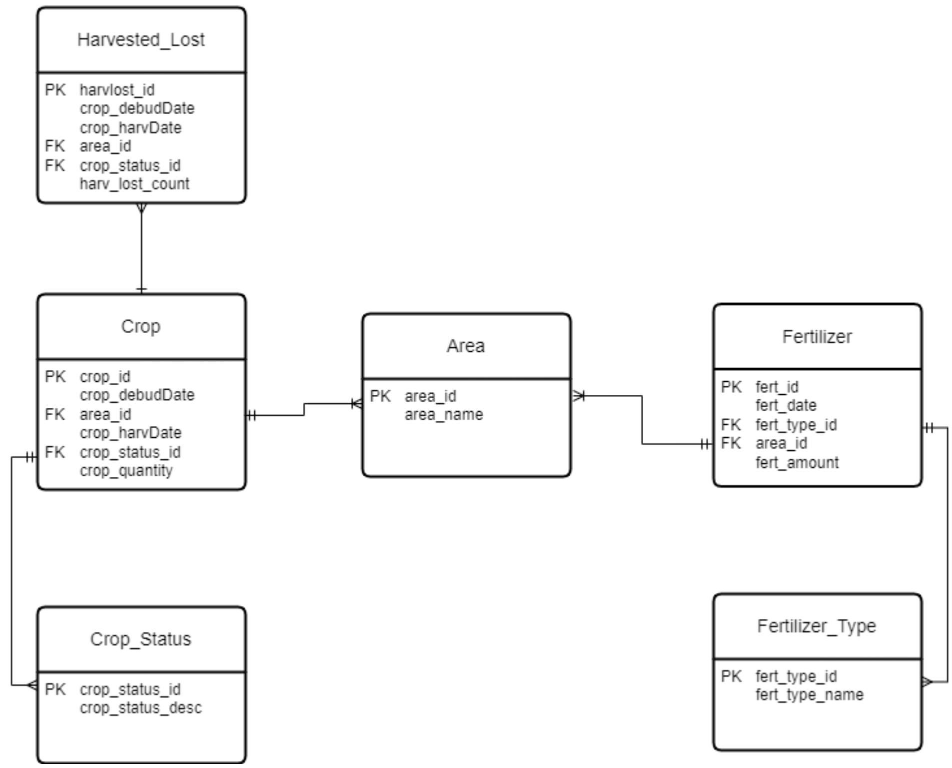
16. Your farm has proper information on the benefits of a CMS.					
17. The result of applying a CMS would be apparent to you.					
18. Benefits of a CMS application is easy to understand.					

Appendix E: Additional Figures/Tables

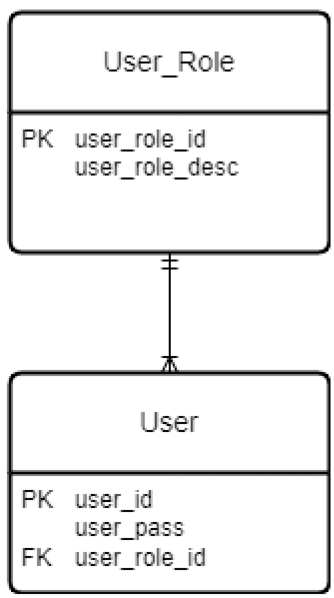
Original 22-item Survey (He et al.,2006)

Construct	Dimensions	Items
Perceived relative advantage	ADV 1: Operational Cost ADV 2: Relative Security ADV 3: Profitability ADV 4: Competitiveness ADV 5: Efficiency ADV 6: Prestige	E-payment system is relatively cheaper to use compared to the traditional payment methods. E-payment is more secure than traditional payment methods. E-payment system will strengthen your company's profitability. E-payment system will strengthen your company’s competitive power. E-payment system will increase the efficiency of your company. Utilization of e-payment will enhance your company’s prestige.
Perceived Compatibility	COMP 1: Fit Needs COMP 2: Complement COMP 3: Conflict COMP 4: Fit Style COMP 5: Overall Compatibility	E-payment fits your company’s needs. E-payment is a good complement to the traditional payment methods. E-payment does not conflict with the traditional payment methods. E-payment fits well with the operation style of your company. E-payment system is compatible with the overall operation of your company.
Perceived Complexity	CLEX 1: Setup Difficulty CLEX 2: Maintenance Difficulty CLEX 3: Operation Difficulty CLEX 4: Overall Effort	E-payment is difficult to set up compared to traditional payment methods.

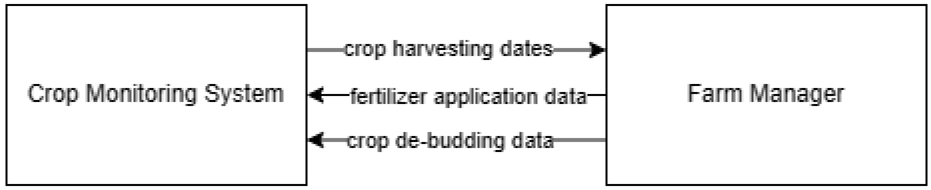
		E-payment system is difficult to maintain compared to traditional payment methods. E-payment system is difficult to operate compared to traditional payment methods. It takes your company a lot of efforts to get e-payment system to work.
Perceived Trialability	TRIL 1: Technology Access TRIL 2: Service Access TRIL 3: Try Out Opportunities	Your company has proper access to the technology related to e-payment system before application. Your company has proper access to the services related to e-payment system before application. Your company has opportunities to try out the e-payment system before application.
Perceived Observability	OBSR 1: Benefit Information OBSR 2: Usage by Others OBSR 3: Result Apparentness OBSR 4: Benefit Understanding	Your company has proper information on the benefits of the e-payment system. There are lots of e-payment systems being used by other companies. The result of applying e-payment would be apparent to you. Benefits of e-payment application are easy to understand.



Main Database Entity Relationship Diagram



User Database Entity Relationship Diagram



Context Level Data Flow Diagram