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Faculty of Graduate Studies

Managerial Approach toward Enhancing Agriculture Management: Based on New Technology Methods

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Dedication

I would like to express my gratitude to my parents and family. Without their tremendous understanding and encouragement in the years of my study, it would be impossible for me to complete my study.

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First and foremost I am extremely grateful to my supervisors, Dr. Saed Tarabiah and Dr. Shadi Atallah for their invaluable efforts, continuous support, and patience during my study. Their immense knowledge and plentiful experience have encouraged me in all the time of my academic research and daily life. I would also like to thank Dr. Mohammed Othman for his technical support on my study. I would like to thank all the members in An-Najah National University.

Many Thanks

الإقرار

أنا الموقعة أدناه، مقدّمة الرسالة التي تحمل العنوان:

Managerial Approach toward Enhancing Agriculture Management: Based on New Technology Methods

أقر بأن ما اشتملت عليه هذه الأطروحة إنما هو نتاج جهدي الخاص، باستثناء ما تمت الاشارة إليه حيثما ورد. وأن هذه الرسالة كاملة، أو أي جزء منها لم يقدم من قبل لنيل أي درجة أو لقب علمي أو بحثي لدى أي مؤسسة تعليمية أو بحثية أخرى.

Declaration

The work provided in this thesis, unless otherwise referenced, is the researcher's own work, and has not been submitted elsewhere for any other degree or qualification.

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Date: 2021/08/10 **التاريخ:**

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List of Abbreviations

CIT	Computer Information Technology
E-Waste	Electronic Wastes
EVOO	Extra Virgin Olive Oil
HCIE	Higher Council for Innovation & Excellence
ICT	Information & Communication Technology
IoT	Internet of Things
IVR	Internet Voice Response
GDP	Gross Domestic Product
OLF	Olive-Fruit Fly
R	Correlation coefficient
R^2	Coefficient of determination
SaaS	Software as a Service
Sig	significance level
SPIM	Smart Photovoltaic Irrigation Management
SPSS	Statistical Package for the Social Sciences
TAM	Technology Acceptance Model
TPB	Theory of Planned Behavior
TPACK	Technological Pedagogical Content Knowledge
TRA	Theory of Reasoned Action
WSN	Wireless Sensor Networks

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Abstract

Despite the availability of many modern methods that rely on smart technologies to monitor farmers' fields with adequate and real data, Palestinian farmers continue to use traditional methods of field management based on past experience and information. To help farmers understand the need to use modern systems, we determine the problems they face then evaluate their intentions to adopt smart systems and influencing factors. To collect data, a survey on 91 olive farmers in Jenin district of Palestine was conducted. The data was tested and analyzed using the SPSS. Olive farmers in Jenin revealed that the two major challenges they face are the weather change and the pest control, and therefore, they intend to adopt smart management systems. The developed smart system combines irrigation, fertilization and pest control. The system helps in: reduces resources, identifies the disease in the early stages, and reduces the risk of disease spreading in the field. To achieve this smart approach the collaboration among many institutions is needed. Implementing such practices will strengthen farmers in their new journey which will lead to a new agricultural revolution in developing countries such as Palestine.

Chapter One

Introduction

In this chapter, an overview for olive sector was executed to know the real situation and what is needed for the sector to grow olives with high quality and quantity.

1.1 Background

Agriculture sector is the base to sustain life and to keep this life cycle alive, and consequently, governments have to take care of this sector. Therefore, we need to determine the challenges that stand against reaching a sustainable level of production. From the near past and for the future many approaches were invented to overcome these challenges; one of which is the technology innovation that is still considered as the most used approach to deal with these challenges.

Palestine, as one of the developing countries in the world, still suffers from many problems that affect the agriculture sector; the gross domestic product (GDP) declined through the years from 10% in 2000 to 3.4% in 2013 (ARIJ, 2015). The decline in the GDP was caused by many changes happened such as the growth in other sectors such as the services and technology. Other causes due to the interventions of the Israeli occupation include the prohibition of access of farmers to their lands, the exploitation of existing natural resources, and the climate change that mainly affects the agricultural production qualitatively and quantitatively (ARIJ, 2015).

In the present study the olive sector was chosen depending on the high areas of olive cultivation that covers 47% of the total agricultural land in the West Bank (Kashiwa, 2017). The olive tree is considered one of the main agricultural production in Palestine, and Palestinians believe that their holy lands are blessed by this particular tree. Also the olive tree has many other considerations such as:

- The economic importance of the olive sector in Palestine shows that it is an important source of income for a large proportion of farmers.
- The olive tree is the basic of the basket food for most Palestinian families.
- In terms of social and cultural importance, the olive tree is a national symbol, used as an icon or emblem of several institutions such as Birzeit University.
- Its political significance is reflected in the fact that olive cultivation is a part that shows the love of the homeland, the embodiment of national belonging, and the resistance to the occupation.
- It should be noted that the olive tree in Palestine was and continues to be the focus of the occupation to steal its crop, and to seize and confiscate the land. Israeli occupation prohibits many farmers from carrying out the agricultural operations required for the olive groves. In effect, such interventions adversely affect the productivity and the economic return of the sector in the areas fully controlled by occupation.

To sum up, the olive sector is the most important for Palestinians since the olive plays supportive role in many other sectors and industries. Now it is the time to take a deep look to the olive in figures at Palestine.

1.1.1 The state of olives in Palestine

Olive cultivation is mainly practiced in the Palestinian mountains and some coastal areas. The reason for the spread of olive cultivation in the West Bank is due to its ability to withstand harsh natural conditions. Its cultivation is preferred in the areas of land unsuitable for the cultivation of grains or urban uses. Olive cultivation in the West Bank differs from a year to another due to climate variability, which mainly affects olive production and productivity (ARIJ, 2015).

The olive lands represent 47.1% of the whole agricultural lands in the West Bank of Palestine (ARIJ, 2015). The average productivity of olive oil is 47 kg/dunum, and a total annual production of 23,947 tons in the West Bank (ARIJ, 2015). Jenin district, which is located in the northern West Bank, has the highest rate of olive oil production in terms of the total production with a 29% rate (ARIJ, 2015). The profit margin of olive oil is approximately 28.1% from the total profits (ARIJ, 2015). In good years the Palestinian olive sector is worth between $160 and $191 million per year (ITC, 2018).

In 2013 Palestine exported approximately $57,000 of olives and $8,842,000 of olive oil (ARIJ, 2015). Many Palestinian industries that rely on olives support the local economy in various approaches; e.g., olive oil, Makdous olive, olive honey spread, and olive oil so. Many reasons affect the production of olive trees and challenge the sector against growing. Some of these challenges are (Al-khateb, 2008):

- The fragmentation of olives cultivated.
- The increase in the production costs.
- The transition from production for the purpose of consumption to a market economy.
- The rising costs of labors and other inputs.
- The changes in the climatic conditions.
- The continuing work on traditional patterns and methods of production that dominate all stages of the value chain of olives.
- In addition to what the occupation policies and rules imposed especially the denial of access to irrigation water, as well as the closure of large areas of olive trees and the appropriate land for its cultivation.

The development of the olive sector management can achieve high values by focusing on supplementary irrigation, and controlling pests and diseases. The development was according to a recommendation made by Oxfam and Horizon for sustainable development about improving the olive orchards management (FAO, 2019).

1.1.2 Modern Agriculture Management Approaches

Modern agricultural management is imitated as auto technological systems. High technology qualities provide opportunities to use such technologies for monitoring the agriculture environment to gain the best agriculture management. Continuous developing in information technology leads the world to replace available technological systems with smart systems. Smart systems are the latest technology available; the systems aim to sense the environment around and send adequate information through internet to a database to process the data and take the best action. The base of these smart systems is the Internet of Things (IoT) approach, which enables everything to be connected directly to the internet without human interaction (Talari et al., 2017). The IoT technology proofs its efficiency in increasing competitiveness and sustainability in the agricultural production.

Wireless Sensor Networks (WSN) are extended applications from the IoT, which contain a group of sensors for monitoring the physical conditions of the environment and organizing the collected data at a base station which is responsible for sending data to users through an access point as shown in Figure 1.1. The adequate data helps the users take the best decision related with the available situation. Nowadays, these smart systems are used to support decision making management to overcome many real-world problems (Phillips-Wren, 2017).

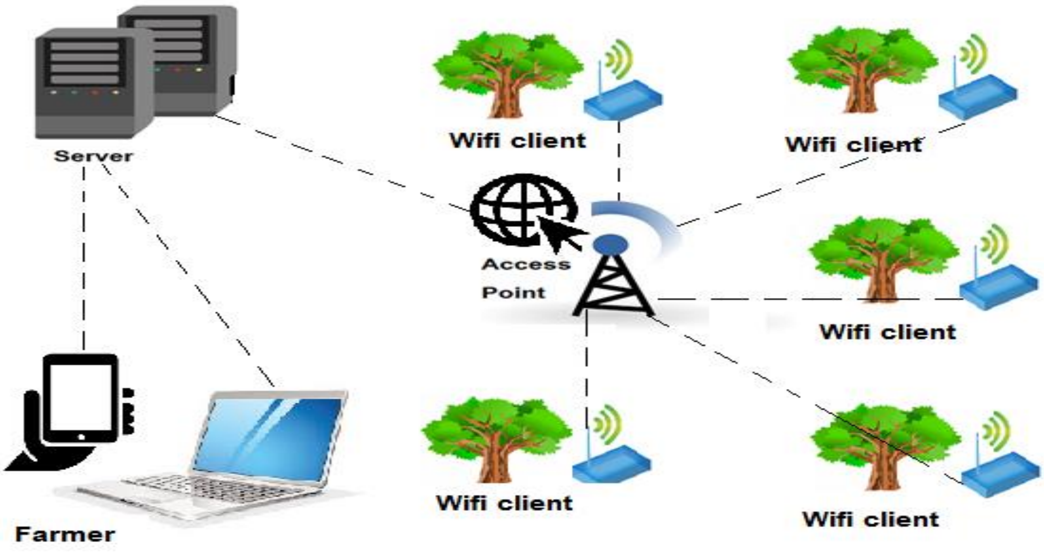

Figure 1.1: System model for a managerial approach used in managing agricultural systems.

Smart agriculture is a new concept of science that appears in many developed and developing countries. Smart and precision agriculture focuses on studying agricultural problems that affect the agriculture process generally using the latest technologies. Here we use some of these smart systems in order to manage agricultural fields to achieve high agricultural productivity and quality with available capabilities.

1.2 Motivations

Olive sector is very important since the olive plays a main value in Palestine; it is a major source of income for a large proportion of farmers, it is one of the basic of the flip, and it is a national symbol for most of the Palestinian families. In addition, olive fields approximately cover half of the lands in Palestine (ARIJ, 2015). Despite the challenges farmers face, the sector still grows in a low rate (ICT, 2018). To overcome the current challenges, we want to merge the latest technologies with agriculture, especially the huge development in technology fields that serves many other sectors to bloom. This interacts with the National Agricultural Sector Strategy in Palestine (ICT, 2018), which plans for the five coming years to achieve particular values such as the agricultural development and the enhancement of the agricultural services and administrative program.

1.3 Problem Statement

Like in any developing country, farmers in Palestine depend on their own experience to manage their agricultural fields using classical managerial methods. Several advanced methods to manage farmers’ fields exist using smart technologies and creative applications. Through the present study we examine the most appropriate management systems that farmers need to overcome the problems they face in the field. In addition, the intentions of the farmers to adopt modern technological management systems in their fields are determined.

Modern technologies help farmers manage their fields to solve many problems they face such as the climate change, the drought, the irrigation scheduling, agricultural diseases, etc. Increasing the proportion of farmers using modern technologies will increase the quantity and quality of agricultural production. This is because such technologies rely on accurate and reliable data and reduce the spread of diseases that might affect the fields. To achieve the objectives of the study, a questionnaire is distributed to farmers in Jenin district of Palestine and analyzed to find out what services the farmers need to include in the proposed smart system. This study aims to determine: 1. the intentions of the farmers to adopt modern technologies that particularly rely on the Technology Acceptance Model (TAM) methodology, and 2. the factors that affect the farmers' decision to accept the adoption of smart systems in the agricultural fields, especially for the olive sector in Jenin district.

1.4 Objectives

The study objectives are to:

- Study and analyze the olive sector in Jenin district and determine the problems farmers face.
- Determine the intentions of the local farmers to adopt the smart applications in agricultural fields and factors affecting their intentions.
- Develop model that overcomes such problems and considers available resources and existing capacities.

1.5 Study Questions

The present study answers the following questions:

1. What are the problems Palestinian farmers face?
2. What are the factors that affect farmers to accept adopting smart agriculture services?
3. How can smart agriculture systems be used to overcome farmers' problems?

1.6 Study Scope

The study purpose is to identify the most important modern systems that help olive farmers manage their fields and to determine their intentions to adopt modern managerial systems. To achieve this purpose, a questionnaire was distributed to 100 samples of olive farmers in Jenin district of Palestine. The researcher received 91 questionnaires only back from the local farmers.

1.7 Thesis Structure

This thesis is organized as follows: Section 1 is an introductory chapter, Section 2 investigates the previous related works in the literature, Section 3 introduces data gathering methods used throughout the study, Section 4 shows the results from the Statistical Package for the Social Sciences (SPSS) analysis and discussion, Section 5 concludes the work.

1.8 Study Hypotheses

The seven alternative hypotheses adopted in this study can be summarized as follows:

1. The perceived usefulness has a significant positive effect on farmers' intentions to adopt smart agriculture services.

2. The perceived ease of use has a significant positive effect on farmers' intentions to adopt smart agriculture services.

3. The farmers' capabilities to use smart systems have a significant positive effect on farmers' intentions to adopt smart agriculture services.

4. The high cost of smart systems has a significant positive effect on farmers’ intentions to adopt smart agriculture services.

5. The high source of income has a significant positive effect on farmers’ intentions to adopt smart agriculture services.

6. The age of olive trees has a significant positive effect on farmers’ intentions to adopt smart agriculture services.

7. The role of municipalities and relevant institutions has a significant positive effect on farmers’ intentions to adopt smart agriculture services.

Chapter Two

Literature Review

Chapter Two represents the advantages and disadvantages of the Wireless Sensor Networks (WSN). It also gives an overview of the WSN in the real agricultural fields then reviews some models for user acceptance. At the end of this chapter studies were reviewed about using TAM model.

2.1 An Overview

Several solutions have been proposed with the aim to improve the efficiency of smart agricultural approaches in the world. This chapter represents useful information about smart agriculture in general and shows smart agriculture applications in olive fields. These applications are reviewed to select which is best, suitable to the local conditions, has the maximum benefit to the farmers. Thereby, farmers must start to deeply rethink about how to strengthen their management practices of olive fields based on the most successful applications. Finally the researcher discusses some acceptance models that help us understand the user behaviors toward using smart applications.

2.2 Smart Agriculture

2.2.1 Definition

In the era of rapid technological development, many new technologies have changed different areas of life. Smart technologies, which are now the latest technology, have played an important role in improving the quality and value of agricultural services provided to farmers. Smart agriculture is one such technique that the researcher would like to focus on in order to encourage farmers to use smart applications in the region. Smart agriculture is the approach that uses smart technologies to manage farms by optimizing the use of the least amount of available resources in real time monitoring, and making a high level of accurate decision to obtain the best production of the selected crops. Therefore, this type of agriculture represents a future option for achieving sustainable agricultural production and addressing the problems the agricultural sector faces.

The most advanced smart agriculture applications depend on the Internet of Things (IoT) technique. The IoT is a worldwide network of "things" connected to each other over the internet. Links can be between people and people, people and things, and things and things. The IoT includes devices that can work on the internet, and can collect, send, and process data they receive from their surroundings using built-in sensors, processors, and communication media. Humans can interact with smart units to give instructions or access to data, but the devices perform most of their tasks without human interventions. These devices are linked by the WSN which contain nodes with one sink which is responsible for collecting data. The sink sends the data through access points to the internet to analyze and provide the best decision made according to the input data. The node is a unit with four components: sensors, a radio transceiver, a microprocessor unit, and an energy source as shown in Figure 2.1.

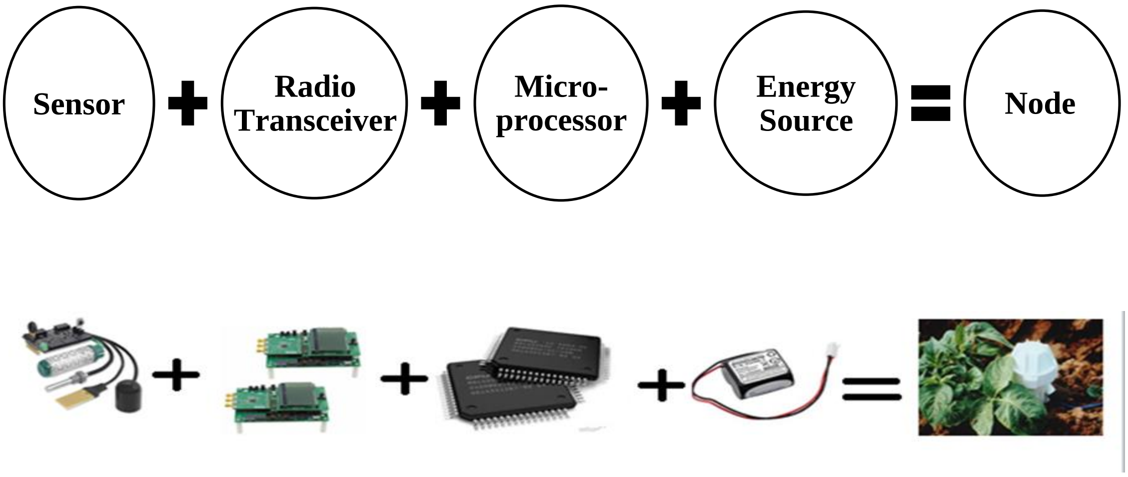

Figure 2.1: The four components of the node in the WSN.

To implement the IoT applications, Sebastian and Ray (2015) mentioned the functional blocks that form a smart system which:

- Sensor: to sense, and monitor activities.
- Communication block: to communicate remote servers with devices.
- Management block: to make the best decision possible.
- Services: including device modeling, device discovery, and data analysis.
- Security functionalities: such as message data security.
- Applications: to analyze the system status to the users at present stage of action.

The implementation of smart systems differs from a region to region considering many factors, i.e., the local conditions. In effect, the best management practices needed to propose suitable smart systems are to be determined.

2.2.2 Smart agriculture techniques

Smart agriculture does not work only to increase the productivity and quality of agricultural crops, but also it reduces greenhouse gas emissions and adapts to the effects of climate change. Smart agriculture techniques differ according to the application purpose; here the researcher mentions some of these techniques.

- **Hybrid seed technology**: is one of the modern methods of agriculture. It includes the fertilization of two different but interrelated plants to produce a new plant that has certain characteristics that consumers want. Hybridization has produced some crops such as watermelon (Yahia, 2019).

- **Intelligent irrigation control devices**: is the most advanced irrigation technology. The irrigation of plants must have the right amount of water based on weather and time of year. The benefit of intelligent control devices is that it can control water consumption in irrigation by scheduling the process of irrigation, knowing the amount of water needed by the plant and soil (Li et al., 2019).

- **Agricultural microbiology:** is the approach used in farm management and crop control through Information and communications technology (ICTs), sensors, remote control systems, and self-operated machinery to obtain accurate data, and to invest these data in accurately targeting agriculture towards greater production at lower cost, high quality (Zamora-Izquierdo., 2019).

- **Unmanned aerial vehicles:** are used for crop monitoring and assessment, agricultural land mapping and measurement of air components, rapid and safe spraying of crops with pesticides. Immediately, data is transmitted to software and then analyzed. This process guides farmers to implement better procedures (Maes and Steppe, 2019).

- **Robotic farmer**: is a farm in which robots play the role of farmers rather than humans, through the implementation of many human tasks such as minimize soil damage, increase farming resolution and lower the cost of automation. These tasks are done by swarm robotics with potential to revolutionize precision agriculture (Millard et al., 2019).

2.2.3 Advantages of smart agriculture

Smart agriculture is a trend to the future in which technologies help farmers in many aspects. A few pros of the smart agriculture can be summarized as follows (Gayatri et al., 2015; Suma et al., 2017):

- The immediate and live monitoring techniques provide adequate data. These data increase the quality of decision making since the decision is based on accurate data.

- The huge data problems which are generated from WSN are solved using cloud computing.

- The use of smart devices helps to monitor and provide analytical information for the product life cycle from start to finish, which in turn improves the quality of the crop, increases its quantity, increases resource efficiency, and reduces losses.

- The use of smart farming methods leads to a significant increase in productivity, improved resource efficiency, accurate traceability of crops especially large quantities, as well as increased crop acceptance for export.
- The use of smart farming methods is less harmful to the environment and less likely to consume land resources.
- The ineffective monitoring of crops is a major obstacle for local formers. Captured images can be taken at regular intervals by drone to show the evolution of crops and to detect any imbalance in production to reach better management.
- The crop health assessment is examined with visible and near-infrared light via mobile devices on unmanned aerial vehicles. This helps to track changes in plants and their health indicators and alert farmers to the presence of any diseases.
- The continuous production ignores the seasons, eliminates all manifestations of pollution, and leads to significant savings in energy and water.
- The modern machines used in agricultural operations, which are used extensively in agriculture and harvesting, are important in saving time and effort.

2.2.4 Challenges of smart agriculture

Moving toward smart agriculture is a hard issue and poses risks to farmers if they did not study it from all sides. In this section some challenges should be taken into consideration so that the smart management is implemented with a high level of benefits (Mehta and Patel, 2016; Partey et al., 2018). The challenges are:

- Less awareness of farmers using smart applications may stand against them to move to smart applications.
- Network connectivity in some areas is not available intermittent. For a smart network, there is a need for a reliable internet connectivity as well as a high performance and bandwidth speed.
- Technical failures which are linked with these technologies form a risk on the crops if failures are not solved immediately.
- Energy that is used for powerful data stores and gateways is to be replenished to operate these smart networks and to lead to a optimal consumption.
- Electronic Wastes (E-wastes) is a new risk appearing with these smart applications from the devices that are useless. These wastes must be disposed of in an appropriate way to preserve the environment.
- The benefits that farmers receive from smart applictions are not clear and understandable to them. This lack of clarity leads to fear to use the smart agriculture applications.

2.3 An Overview of Smart Agriculture Applications

In this section, the experiences of other countries to use the IoT applications in the agriculture fields are explored. Mobile devices, internet connectivity, and cameras are devices integrated together to minimize the negative effect of pests on crops and reduce the economic loss in the farm (Labaña et al., 2019). This framework plays the role in the early stage by detecting the pest and preventing it from spreading. All what is needed for the framework can be given by:

- Collecting a large number of images related to each of the relevant conditions to recognize the pest.
- Gathering knowledge about the appropriate treatments conceived to deal with these pests and diseases.

In Labaña et al. (2019) tests, their initial set of pests to be tested were the Parlatoria pergandii and the Aonidiella aurantii. To be connected with the farmers and to provide them with suitable services to detect the pest, a prototypical responsive web application had been developed. In the web page the farmer can upload the image for inffected crops from cameras in the field then a diagnosis request is submitted. The success of this process is translated as the treatment proposed to the user. The proposed application was tested to a very limited number of pests but with an accuracy of 90% as a first prototype. Labaña et al. (2019) planned to extend their work using other indicators like weather conditions to improve the diagnosis accuracy.

GeoFarmer is a framework implemented to exchange monitoring practices and feedback systems for agricultural projects (Eitzinger et al., 2019). It was implemented in the East and West Africa and Latin America regions. GeoFarmer was designed to house geospatial information and provide efficient feedback from farmers' implementation of agricultural practices. The GeoFarmer inputs can be both directly online or via a specially developed smartphone application and alternatively through an interactive voice response (IVR) service. The users of the GeoFarmer system are: moderator who is a system administrator and farmers whom are responsible for user registration who can edit farmers' profiles, and communicate with others. These functions are performed by a smartphone application and experts whom are responsible for solving problems.

GeoFarmer indicates that it provides a value for farmers to communicate and share experiences interactively between themselves and with experts as they continually try new agricultural practices. GeoFarmer also enables farmers to share information and interchange ideas on how to better manage their crops and farms. Yet, the feedback loops that form a part of the discussion process with questions and answers shared between users' needs are to be further developed (Eitzinger et al., 2019).

An IoT Block Chain-Based Framework for Certifying Extra Virgin Olive Oil Supply Chain (EVOO) application was proposed by Arena et al. (2019). In the research they proposed a block chain-based system that aimed to support the certification of the olive oil product by tracing its entire supply chain. This tracing starts from the plantation to the shops. Through EVOO the end customer will know the product history including: the farming, harvesting, production, packaging, conservation, transportation, and distribution processes.

The EVOO is an emblematic product for Italy. Italians used the latest IoT technology which depends on interconnected sensors to detect the EVOO quality control. The EVOO supply chain involves four different parts:

- **Farmers**: responsible for farming and harvesting.
- **Makers**: responsible for transformation from olives to EVOO process and packaging process.
- **Couriers**: responsible for olives and EVOO transportation.
- **Sellers**: responsible for EVOO distribution to the customer.

In the farming process sensors are deployed in every tree to collect data in an olive farming profile for the temperature, the humidity, the air pollution indicators, the chemical treatments on plantation and the chemical composition of the fields. For harvesting profile, data are collected for the time of harvesting and the period from store to transform.

The transformation process, which is getting EVOO data from olives, depends on the temperature through all the processes. In the transformation profile the collecting data is the temperature in the factories within this process. Also, in the transport process profile the collected data is the temperature for the vans which are used to transport the EVOO to the markets. In this process the temperature should not have large variations. The last profile collects data from a web application for every single bottle of olive oil of EVOO. This application reads the transactions and reconstructs the history of the EVOO.

Arena et al. (2019) evaluated the system to insure its effectiveness by simulations. They concluded that the application cannot be correct in real industrial scenarios. The transaction arrival rate may vary over time so they proposed a dynamic auto-tuning of the block to be sure that the information can be published in a timely manner.

In southern Spain olive field, a simulation was conducted in the real field (García et al., 2018). The simulation was run to evaluate the management system for photovoltaic irrigation. The aim is to implement seasonal Smart Photovoltaic Irrigation Management (SPIM) module for crops using solar energy to pump water into the network. Energy requirements are estimated as per the following: location, size, soil, and crop parameters.

García et al. (2018) clarified that the system produces energy; and uses it to pump water and irrigate the field. The work was tested on a research field in Cordoba University and climate data was obtained from a weather station located within the campus. The network feeds 13 hydrants grouped into three sectors, each of which is controlled by an electro valve. The trees are watered by drip irrigation using pressure compensating emitters that work between 1 and 4 bars. Concerning the soil features, trees are cultivated in a clay-loamy soil with an increasing clay content in deeper soil profiles. The photovoltaic system is located on the roof of a storehouse located 200 m from the pump. The system provides a peak power of 15.4 kW by 120 photovoltaic panels that occupy 168 m^2 of surface area. A solar irradiance sensor located near the solar panels provides information in real time. The pump operating point is controlled by a variable frequency drive, which matches pressure and flow according to the instantaneous solar irradiance.

The generation of photovoltaic energy within the day was estimated depending on the irradiance on the horizontal access. In general, on clear days, there is a progressive increase in the produced energy until noon when the maximum value is reached. García et al. (2018) mentioned that the remaining energy that was not used on a raining day, can be used in other activities.

In conclusion, the findings of the García et al. (2018) study were positive, as they involved the reduction of supply source for isolated areas. The main finding of their work was that solar irrigation in areas with appropriate irradiance levels is a feasible alternative to use renewable energy sources. This is particularly true when tools like SPIM are available, increasing the sustainability and profitability of irrigated agriculture.

A research was conducted to analyze the olive-fruit fly (OLF) life-cycle (Karydis et al., 2013). The name of the pest was from the way that it feeds, which is the fruit of olive trees. This insect was classified as the most effective insect on olive trees (Chomchalow, 2003). The research proposed a service which is a Software as a Service (SaaS). This service allows others to benefit from the application without the necessary information technology requirements such as infrastructure, implementation, and maintenance costs. Karydis et al. (2013) only they need a framework in Hypertext Preprocessor language in the server side for the SaaS application.

The service considers information about pest traps and their measurements, traps geo-information such as their height from sea level and orientation as inputs. Some simulation is run as a black box to receive information about localized temporal predictions on pests' lifecycle as an output. In Figure 2.2 the reader can see the architecture of the SaaS.

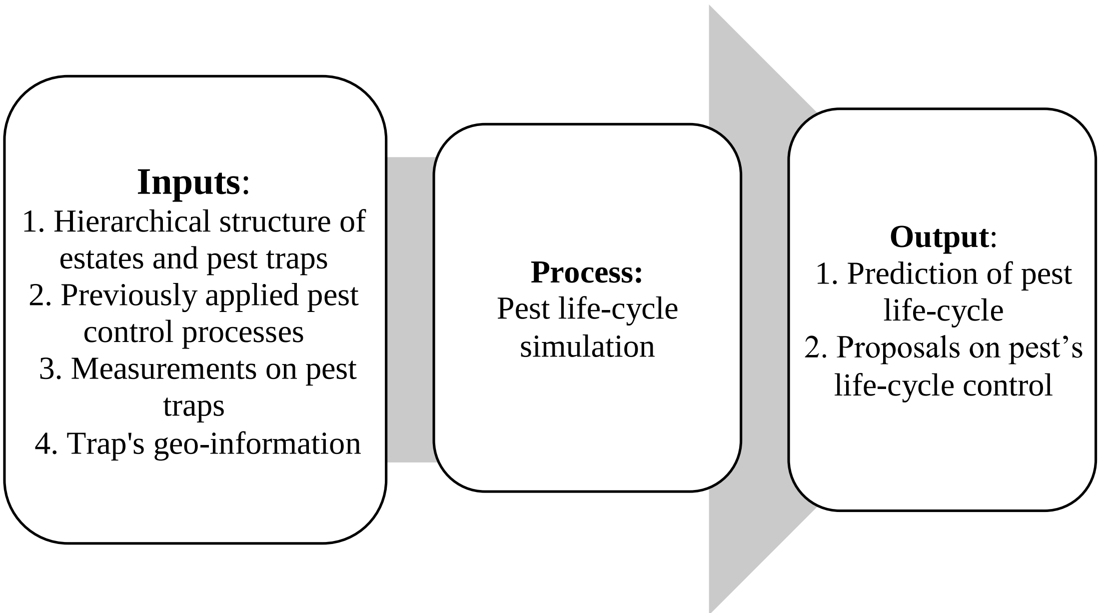

Figure 2.2: The architecture of the Software as a Service.

The adoption of the SaaS approaches is an alternative to standalone applications which support data management processes for pests' life-cycle and control simulations. For their future intention, Karydis et al. (2013) mentioned that the service could easily be expanded to include a documented API. The API description documents, are the collection of references, tutorials, and examples that help developers use API.

2.4 User Acceptance Models

It is essential for every innovation to test the acceptance and the satisfaction of the users to measure its success. The literature shows many models and theories for user acceptance; here we explain some:

2.4.1 Technology Acceptance Model (TAM)

Venkatesh and Davis (2000) modified a model for predicting the acceptability to adapt technological development from the user's view. The model emphasized that whenever the user's view of technology is easy and useful there has been a positive direction towards it and a desire to use it. Venkatesh and Davis (2000) focused on their model on the following two factors:

- **Perceived usefulness**: is a factor refers to the degree to which the person believes that the use will enhance and improve his performance at work.
- **Perceived ease of use**: is concerned with the degree to which the person believes that the use does not require any effort or suffering.

Several studies have benefited from the adoption of the technology acceptance model as an indicator of user orientation towards specific applications of technology. Koufaris (2002) studied the effectiveness of online shop sites through the technology acceptance model. It was found that there is a stronger impact of the usefulness factor than the ease of use factor.

A study conducted in 2007 revealed the impact of interactive e-learning on students and students' acceptance of education in web-based environments (Proske et al., 2007). Three aspects were studied: the enjoyment of tasks, the appropriateness of the learning tool, and the progress of education. The results indicated that the students show high levels of satisfaction with education in an interactive online environment.

2.4.2 Theory of Reasoned Action (TRA)

This model is based on the use of internal individual components such as complexes and trends to explain and predict a behavior (Otieno et al., 2016). The variables included in the model referred to what happens in the minds of individuals when they seek to engage in a behavior. According to the theory, there are four elements to focus on when studying a behavior: action, target, context, and time. Another four factors are to be discussed here (Hussain et al., 2016):

- **Attitude toward behavior**: includes the feelings of the individuals which support or oppose their performance of a behavior in a certain situation.
- **Behavioral beliefs**: includes the individuals' beliefs that direct their performance and lead their behavior towards specific outcomes**.**

- **Subjective norms**: the individual's awareness of the desires and wishes of the community regarding his/her performance or lack of conduct**.**
- **Normative beliefs**: including beliefs with special connections, in which the individual intends whether or not he/she should perform a specific behavior**.**

The TRA is the base of other theories that had been derived from it. This theory focuses on people's behavior whether they accept or reject a new technology. The TRA depends on the behavioral intention, attitude, and subjective norm. Subjective norms are determined by beliefs and motivations, whereas attitudes are evaluated by beliefs and evaluations (Otieno et al., 2016).

2.4.3 Theory of Planned Behavior (TPB)

This theory is an updated version of the TRA theory with a focus on another new factor which is the perceived behavioral control. This variable refers to the conscious confidence of an individual on the intrinsic ability to perform a particular behavior. From the above, it turns out that the new variable directly affects the behavioral intention. The theory refers to different kinds of influence on the behavior including personal skill, time, money, and helping others. These factors have the ability to study behaviors that may not be controlled by the individual. This theory is more effective than its predecessors in the field of environmental education and the study of environmental behavior.

The ability to control a behavior is due to individuals' perceptions of how easy or difficult it is to behave and to believe in the self-efficiency required to conduct such a behavior. The experience with a particular behavior is an important source of information for the extent to which the behavior is controlled, so the ability to control a behavior is considered to be a mediator between the past and present behaviors (Ajzen, 1991).

2.4.4 Delone and McLean model

Delone and McLean (1992) proposed a model depending on the TAM, the TRA, and the TPB. The model expands the theories' factors to focus more on six variables which are related more to the information system and the users. These variables are (Ammenwerth et al., 2003):

- **System quality**: is due to the characteristics of the information system itself, including system flexibility, system integration, response time, user expectation, system reliability, ease of use, ease of learning, and system benefits.
- **Quality of information**: refers to the standards and characteristics of the information and data used such as accuracy, reliability, completeness, conciseness, relevance, understandability, meaningfulness, modernity, comparability, and appropriate form.
- **Usage**: indicates the extent to which the results provided by the end-user information system are used.

- **User satisfaction**: indicates user responsiveness to the effective use of the information system.
- **Individual impact**: is the extent to which information affects the behavior of the user.
- **Institutional influence**: assesses the impact of the information system on the overall performance of the organization.

The model states that the quality of the information system and the quality of the information affect the user satisfaction, and the degree of use affects the user's satisfaction positively or negatively. Also, user use and satisfaction precede direct individual performance, which in turn directly affects institutional performance (Ammenwerth et al., 2003). In 2003 they updated their model to increase the use intent, to measure the user's trends, as the intention to use is a trend, while the use is considered behavior. The understanding of the use should be as follows (Delone and McLean, 2003):

- User’s use and satisfaction are highly interrelated variables, and the use must precede the user satisfaction.
- A good experience in the use will result in a better user satisfaction (causal relationship).
- An increased user satisfaction will result in a greater intent to use and thus increase the use (causal relationship).

The model explained that quality has three dimensions: quality of information, system quality, and quality of services. Each of the three dimensions must be measured separately, because it has a significant impact on the user usage and satisfaction.

Technology is useless until it is accepted to adopt and be used, therefore we have to determine the best appropriate theories and models to ensure the efficiency of the desired technology. According to the previous explanations we can conclude that for the purpose and the goal of the present research, it is clear that the study focuses on the farmer reaction toward the acceptance of smart agriculture by considering the farmer's willingness, capacity, ability, knowledge, behavior, and attitude.

The TRA and TAM are more likely to be used since these theories are used worldwide with different subjects especially Computer Information Technology (CIT) (Han et al., 2003). In the literature, the TRA still suffers from some limitations which are: a significant risk of confounding between attitudes and norms since attitudes can often be reframed as norms and the assumption that when someone forms an intention to act, he/she will be free to act without limitations (Samaradiwakara & Gunawardena, 2014).

The TAM, however, proves its success within previous studies as the most popular technological acceptance model used. The TAM is easier and gives a quick and clear response in gathering information about human's perception for any new technology (Legris et al., 2003). The study model according to the attributes that we have to focus on is the TAM since it tests the user's capabilities, the user's beliefs, and the user's attitudes towards a system.

2.4.5 Overview of TAM implementation in information technology applications

Since it hard to test the behavior and thought which are attributes that most of acceptance models test. We have decided to implement the TAM methodology to judge if the farmers are to accept the adoption of smart systems in the olive fields, many cases had been studied from the literature in the following examples:

To identify the most widely used external factors of the TAM concerning the e-learning acceptance, a study was conducted on university students using the TAM to determine the factors that affect their decisions (Salloum et al., 2019). In this study they examined the student's acceptance of e-learning in five different universities in the United Arab Emirates. The findings showed that the system quality, the computer self-efficacy, and the computer playfulness have a significant impact on the perceived ease of use of e-learning systems. Moreover, the information quality, the perceived enjoyment, and the accessibility were found to have a positive impact on the perceived ease of use and the perceived usefulness of e-learning systems.

Abd Ghani et al. (2017) evaluated e-customer services in Pakistan in one of the conventional banks therein. In the study the internet banking adoption issues were identified by implementing the TAM to investigate both customer service and satisfaction. The results of the study highlighted that the adoption of internet banking services in Pakistan could be motivated by the perceived usefulness, the perceived ease of use, the customer service and satisfaction. It is worth to mention that the customer service and satisfaction played a significant mediating role among the other variables.

The Azerbaijani researchers wanted to determine the factors that affect undergraduate students’ behavioral intentions to use e-learning (Chang et al., 2017). To collect the necessary data, 714 undergraduate and master students were asked to analyze their responses using a structural equation modeling. The findings showed that each of the subjective norm, experience, and enjoyment influenced positively on both students' perceived usefulness and ease of use of e-learning. The self-efficacy, nevertheless, positively affected the students’ perceived ease of use of e-learning in particular. Similarly, the subjective norms affected students’ behavioral intentions to use e-learning. It was noticed that the factor of the computer anxiety had a negative effect on the students’ intentions to use e-learning.

Studying the factors that affect teachers’ intentions to use technology was the topic of a study conducted by Joo et al. (2018). Based on the TAM the researchers wanted to analyze the pre-service teachers’ Technological Pedagogical Content Knowledge (TPACK) and identify their conceptions of learning and teaching with technology (Durdu & Dag, 2017). The significant factors to use technology were the teacher’s self-efficacy, perceived ease of use, and perceived usefulness. To gather the data 296 responses from three Korean universities were analyzed. The results proved that pre-service teachers' TPACK affected teacher self-efficacy and perceived ease of using technology. It was shown that all teacher self-efficacy, perceived ease of use, and perceived usefulness of using technology affected teachers' intentions to use technology. However, TPACK did not directly affect teachers' intentions to use technology.

Translation industry wants to increase the use of machine translation in the education field, so the factors that could influence the students' intentions to use machine translation must be understood. To achieve the purpose to develop such a machine translation, researchers depend on the TAM. The study of Yang and Wang (2019) was implemented on 109 student translators in China. The results highlighted that the perceived usefulness has an effect on behavioral intention to use machine translation and is significantly influenced by the experience. The experience was influenced by the motivation which was affected by the perceived ease of use.

Sondakh (2017) predicted the behavior of the taxpayer's interest to use the e-tax technology using the TAM. As a sample the researchers took 156 taxpayers from Manado and Bitung in Indonesia. The findings showed that the perceived ease of use had a positive effect on the perceived usefulness and attitudes towards using e-tax. The perceived usefulness had a positive and significant effect on the attitudes towards the use of e-tax, but it had no significant effect on the behavioral intention to use e-tax. The attitude towards e-tax had a positive and significant effect on the behavioral intention to use e-tax.

Chapter Three

Methodology

This chapter contains a description of the methods followed in the thesis to determine the study community and calculate its sample size. In addition, this chapter explains how to examine the validity and reliability of the study tools, the variables of the study, and statistical processors to data analysis.

3.1 Study Approach

In the present study, a quantitative and qualitative methodology was used to achieve the objectives of this study. In order to identify the farmers' intentions towards using the application of smart agriculture, the tool selected was the questionnaire. The questionnaires were distributed personally to the targeted farmers. To support the thesis, unstructured interviews were also conducted with associated agricultural organizations. The interviews were to identify institutional capacities of associated organizations and how they can support and help farmers adopt new technologies.

3.2 Study Community

The study community is defined as all individuals related to the study problem. The researcher seeks to generalize the study findings to the local community which consists of the olive farmers in the Jenin district of Palestine during the year of 2020 (see Figure 3.1).

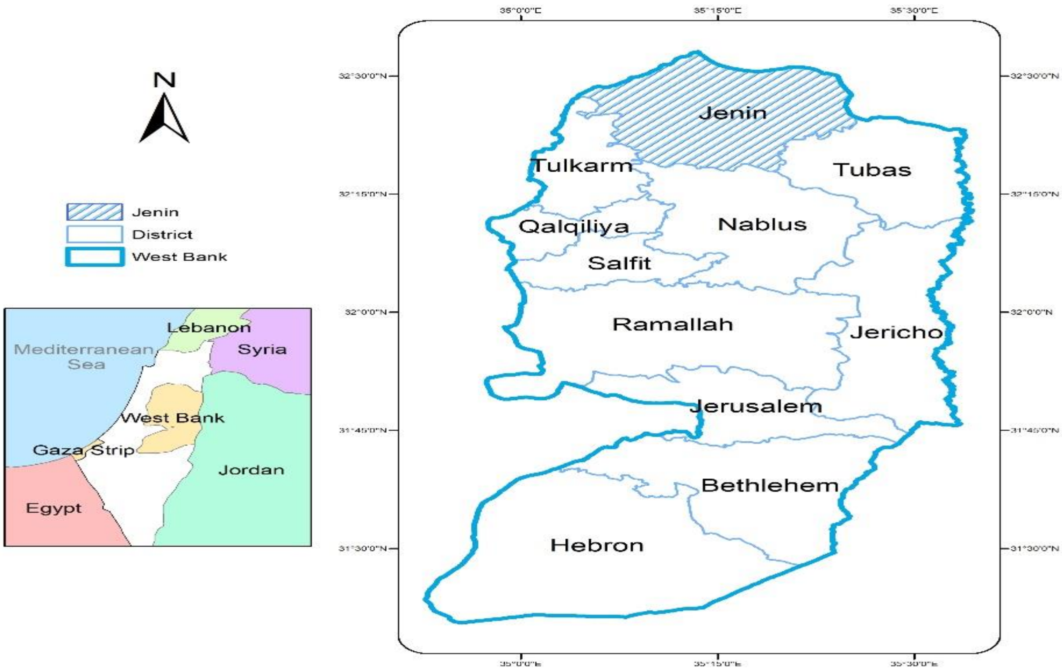

Figure 3.1: West Bank map contains Jenin district which is highlighted in red (Dr. Fathi Anayah).

3.3 Study Sample

The researcher selected a random sample representing a number of farmers in the Jenin district. According to the following equation, the sample size is 68 farmers out of the 20,000 olive farmers (Eng. Ashraf Faleh, Jenin directorate of agriculture, personal communication) from the Jenin district:

$$n = \frac{N * P(1-P)}{\left[[N-1] * \left[\frac{d^2}{z^2}\right] + P\,(1-P) \right]}$$

where:

n: the required sample size.

N: the study population = 20,000 olive farmers.

P: the percentage occurrence of a state or condition = 50%

d: the percentage maximum error required = 0.10 (McLeod, 2019)

z: the value corresponding to the level of confidence (90%) required = 1.65

From the previous equation and using the values assigned for each parameter according to similar studies, the sample size can be calculated as follows:

n: 20000*0.5(1-0.5)/[(20000-1) $\left[\frac{0.1*0.1}{1.65*1.65}\right]$+(0.5(1-0.5))]= 68

The questionnaires were distributed by hand, and the number of retrieved questionnaires on which the statistical analysis was conducted was 91 out of the 100 questionnaires. We distributed 100 questionnaires to cover more samples which support the result to generalize and reflect opinions for the target sample. The respondents vary in terms of qualification, land ownership, land space, number of perennial olive trees they have, number of non-perennial olive trees they also have, olive oil production in a fertile season, olive oil production in an infertile season, and kind of olive trees.

3.4 Study Design

The study methodology consists of the following six stages:

Step one: identifying the problem of the study and building the study questions in order to get the required data about ***"Managerial Approach toward Enhancing Agricultural Management: the Role of Technology".***

Step two: reviewing the literature associated with the topic of study by checking survey textbooks, scholarly published articles, master theses, and any other sources relevant to the study.

Step three: designing the study using analytical correlated methodology that includes selecting the data collection tools for the quantitative data to get the required results from this study.

Step four: collecting required data from the different sources.

Step five: analyzing the data to highlight the major results.

Step six: highlighting the findings of the study.

Step seven: obtaining conclusions and introducing main recommendations.

3.5 Study Methods

The choice of the data collection tool is influenced by the type of study design used. Thus, the data collection tool has been selected based on the nature of the explanatory sequential methods and the involved quantitative data. Both primary and secondary data sources are used in order to gain the information about the statement problem. The primary data were collected using quantitative data tools. While adequate secondary data were obtained from the published articles and books about the topic of this study which can be found in the references list.

The questionnaire is considered an important method of quantitative data collection used in this study. It was mainly developed based on the study objectives and questions. The final draft of the questionnaire was given to the study sample in order to be distributed within the Palestinian district of Jenin. It took about five weeks in the fall of 2020 for the questionnaire to be distributed, collected. The return rate of the questionnaires was 91%. The questionnaires were organized into two highly structured sections as follows:

Section 1 aims to collect data and information about the targeted respondents and their olive fields such as the respondent's qualification, land ownership, land space, number of perennial olive trees they have, number of non-perennial olive trees they have, olive oil production in a fertile season, olive oil production in an infertile season, and kind of olive trees. Section 2 consists of 36 statements of the questionnaire distributed among three domains of the problems facing the agricultural land, the economic and social issues, farmers' perceptions towards smart agriculture and the suggested smart system. To evaluate the range of the scores of responses, each statement was calculated according to a four-point Likert scale for the responses as shown in Table (1). The researcher believes that the four-point Likert scale is the best for the present study since such scale is widely used in relevant studies. Furthermore, the four-point Likert scale ignores the neutral responses which is believed to add no information to the study. The proper evaluation of the farmers' intentions requires a strict and clear position towards a certain issue, whether acceptance or opposition.

Table 1: The key responses according to a four-point Likert scale.

No	Domain	Four-point Likert scale for the responses			
		1	2	3	4
1.	Problems facing the olive fields	***Strongly disagree***	***disagree***	***Agree***	***Strongly agree***
2.	Economic and social issues				
3.	Farmers' perceptions towards smart agriculture				

3.6 Validity

For verification, the researcher had submitted the questionnaire to a group of arbitrators (three experts) with experience and competence in the Palestinian universities expertise (see Appendix A for expert's information). The arbitrators were asked to express their opinion on the paragraphs of the study tool in order to ensure that the contents of the paragraphs are true, relevant to the study, and suitable to the objectives of the study. They were asked to indicate the validity of the method to achieve the study goals. The researcher had got the approval of the experts with some adjustments in drafting the paragraphs. The opinion of the majority taken in the arbitration process. Thus, the validity of the questionnaire had been achieved, and the study method had become in its final form as shown in Appendix B for both Arabic and English drafts.

3.7 Reliability

Reliability refers to the extent to which the same answers can be obtained using the same tools more than one time. The consistency of the questionnaire was calculated through Cronbach Alpha Formula for all sections of the questionnaire as shown in Table (2).

Table 2: Cronbach Alpha Formula for measuring the reliability of the questionnaire domains and total degree of responses.

No	Domain	Statements	Cronbach Alpha
1.	Problems facing agricultural land	6	58.9 %
2.	Economic and social issues	5	60.9 %
3.	Farmers perception towards smart agriculture	24	74.9 %
Total degree		**35**	**77.5 %**

Table (2) depicts the Cronbach Alpha values for the three questionnaire domains and the total degree of responses. The Cronbach Alpha values ranged from 0.589 for the first domain of the "problems facing agricultural land" to 0.749 for the third domain of the "farmers perception towards smart agriculture". The total degree of the Cronbach Alpha value for all the questionnaire domains was 77.5% which is accepted for the study purpose and comparable with corresponding values of similar studies (Tavakol and Dennick, 2011).

3.8 Statistical Analysis Approach

The data collected were analyzed using the SPSS software to provide answers to the questions and hypotheses of the study. The values of the averages, frequencies, standard deviations, and linear regressions were calculated to find out the descriptive statistical analysis. Accordingly, the researcher used a scale to represent the estimation level of sample responses shown in Table 4. In order to limit the length of the cells of the four-point Likert scale, minimum and maximum limits were determined, the range was calculated (4-1=3), the range was divided on 4 (3/4=0.75), and the output was added to the lowest value of the scale (1) in order to reach the highest limit of this cell. The different cell limits were computed as depicted in Table (3).

Table 3: Scale to represent the estimation level of sample responses on the study tool.

Average value	Estimation level
3.26 and more	Very high
2.51-3.25	High
1.76-2.50	Moderate
Less than 1.75	Low

3.9 Statistical Analysis

The statistical process used in this study includes the following:

1. Averages, standard deviations, and percentages to describe the responses and show the ratio weights of the study tool statements (descriptive statistics).

2. Cronbach Alpha formula to measure the reliability of the study tool.

3. Linear regression tests in order to answer the thesis's hypotheses.

Chapter Four

4. Results and Discussion

This chapter shows the results from the SPSS analysis for the study tools. Also shows discussion for the results. And the developed framework for better agriculture management.

4.1 Results

This study aims to identify farmers' intentions towards adopting the smart agriculture in the Jenin district. To achieve the goal of the study, a valid and reliable questionnaire was developed, responses were entered, encoded into a computer, and statistically processed using the SPSS program. This chapter includes the answers of the study questions and responses to the hypotheses identified earlier. It is important to identify the key problems Jenin farmers face in their olive fields and what smart systems they need to improve these fields. To attain the objectives of the study, the data was analyzed in accordance with the study hypotheses and questions.

4.2 Features of Targeted Respondents and Their Olive Fields

In this section the researcher discusses the farmers' attributes and the farm characteristics (see Figure 4.1). Olive farmers in Jenin are males with 100%. In Figure 4.1a, it is obvious that half of the Jenin farmers of olive trees have a Bachelor degree or higher which means that these farmers are highly educated. This makes the possibility that these farmers can easily adopt and work on smart systems. Olive trees aged less than 10 years (Figure 4.1b) needs the greatest attention and the intensive care from the farmers as agricultural activities including the proper planting, irrigating, pruning, trimming, fertilizing, pests and disease treating, and harvesting to remain healthy (see IOC, 2007).

In the Jenin district, most farmers (86%) own the land of their olive fields as shown in Figure 4.1c. Owning the land increases the probability that the farmers would like to develop their olive fields and use technology to improve the productivity of the olive trees. However, the low percentage of farmers not owning the land of their olive fields (i.e., 14%) makes it more difficult to recognize the difference between the two groups towards the application of technology in agriculture. It is noticed that 79, 19, and 2% of the olive trees are of the Nabali Baladi, Improved Nabali, and K18 types, respectively (see Figure 4.1d). It is no surprise that the Nabali Balabi dominates the olive tree types in the Mediterranean region since K18 need more irrigation. The most common type of olive trees in Palestine is the Nabali Baladi which requires less attention from the farmers, particularly irrigation and fertilization (see Houshia et al., 2019).

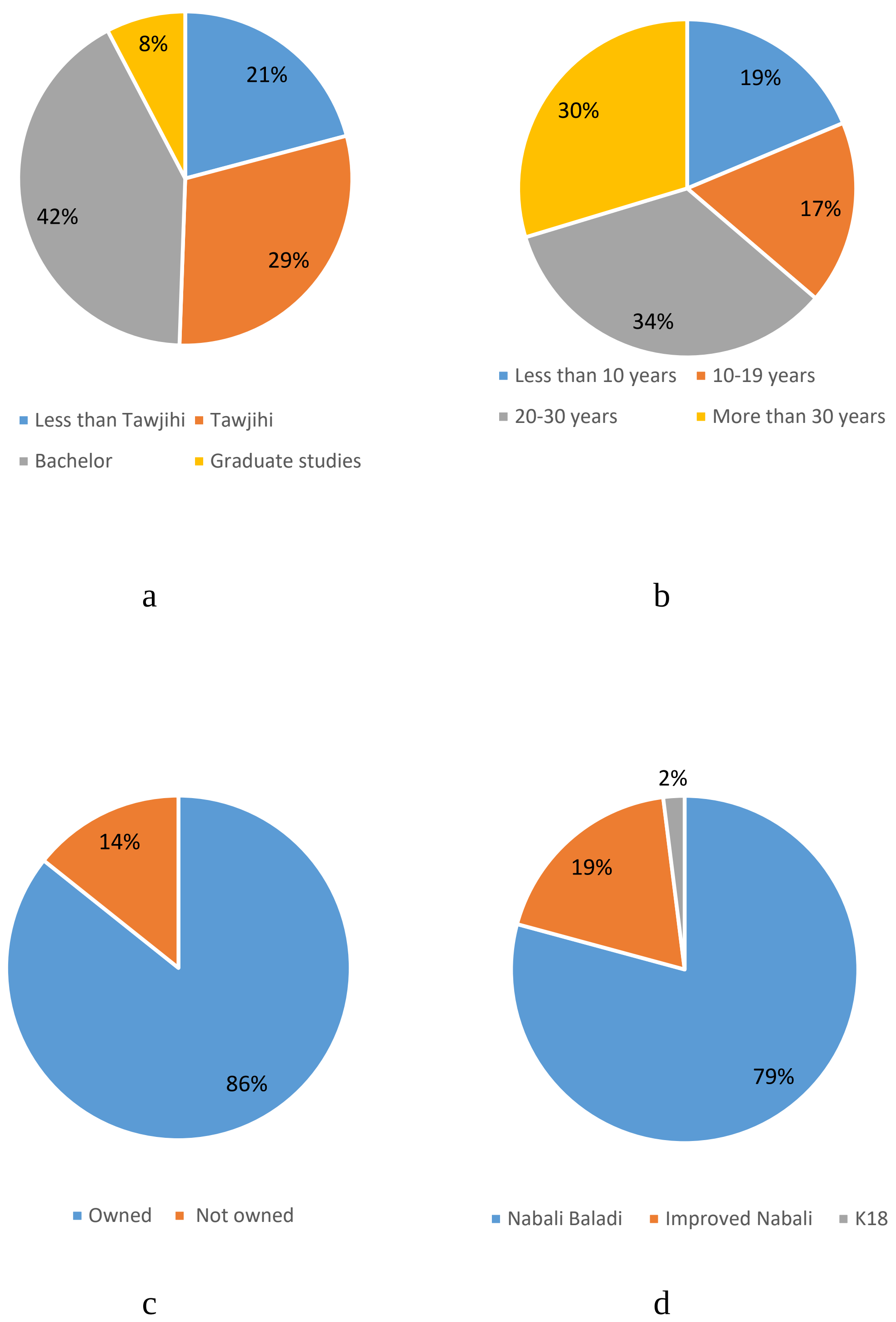

Figure 4.1: The attributes of the farmers and characteristics of the farms (a. the education level, b. the age of olive trees, c. the ownership of land, and d. the type of the tree).

4.3 Answers to the Study Questions

As shown in Chapter One, there are three study questions: What are the problems Palestinian farmers face? What are the factors that affect farmers to accept adopting smart agriculture services? How can smart agriculture systems be used to overcome farmers' problems? The first and the third questions were directly answered through the responses of the Jenin farmers to the questionnaires. Whereas the third question which is a major concern to the study is addressed differently as different hypotheses have to be imposed to get the right and accurate answer.

4.3.1 Addressing the first question

There are many common problems in the agricultural lands of Palestine. The agricultural crops are exposed to agricultural pests that reduce crop production and quality. The preventive methods to protect the crop from pests are underused. However, chemical methods of disease prevention are widely used for pest control and treatment. In the study area, olive trees are mainly rain fed crops and the study area currently experiences high rainfall variations from a year to year. Therefore, changes in weather conditions significantly affect the olive fields in Jenin district. All of the above indicate that there are many problems agricultural lands encounter. Nevertheless, and unlike the other districts of the West Bank, farmers in Jenin district are lucky because most of them have the freedom to reach their lands without any struggle with the Israeli occupation or the chance to find their crops burned by Israeli settlers but sure still the Israeli occupation is a major problem for exporting and marketing.

The first study question is “What are the problems that farmers face?” To answer this question, some statistics (i.e., average, standard deviation, and estimation level values) were calculated for the first domain (i.e., problems facing agricultural land) as shown in Table 4.

Table 4: Some statistics from the first domain.

No.	Statements	Average	Standard deviation	Estimation level
1.	The irrigation method is based on rainfed	3.62	0.72	Very high
2.	You get free access to field	3.66	0.68	Very high
3.	You are exposed to fire risk	1.77	0.84	Moderate
4.	The crop is exposed to agricultural pests	2.55	0.89	High
5.	Preventative methods are used to protect the crop from pests (for prevention)	2.43	1.05	Moderate
6.	Non-chemical methods of protection are used to protect the crop from pests (for protection)	2.51	1.12	High
Total		**2.75**	**0.42**	**High**

It is clear from Table 4 that the total average reaches 2.75 with a standard deviation of 0.42 on the first domain. In effect, the reliance of olive trees on rainfed irrigation is of a very high estimation level (average value > 3.26). Therefore, the variability of climatic conditions has a high impact on the olive fields. The climate does not only impact the crop production of the olive trees in Palestine (Houshia et al., 2019), it might also influence their life cycle including the resistance to pests and diseases (IOC, 2007). In a similar study, Al-Khatib (2008) proved that climate change does affect the olive production in the West Bank of Palestine.

The other major problem facing agricultural lands is the pests that affect the crops negatively. This is due to the lack of both using preventive methods and utilizing non-chemical pesticides. Labaña et al. (2019) offers creative solutions to such problems using the IoT. Nevertheless, farmers access their lands freely and the risk of fire for the olive trees is rare in the study area.

4.3.2 Addressing the second question

The second study question is "What are the factors that affect farmers to accept adopting smart agriculture services?" This question is different than the other questions. In order to identify the key influencing factors, the researcher has to correlate them with the farmers' intentions using different hypotheses.

4.3.3.1 Considering the first hypothesis

The first hypothesis is "The perceived usefulness has a significant positive effect on farmers' intentions to adopt smart agriculture service." A hypothesis is typically written to precisely answer one of the study questions. To test this hypothesis, a linear regression between the farmers' intentions and their perceived usefulness was developed as shown in Table 5.

Table 5: The linear regression test to determine the relationship between farmers’ intentions and their perceived usefulness.

Model	Sum of Squares	df	average	F	Sig.*	B	R^2	R
Regression	4.240	1	4.240	21.329	0.000*	0.911	0.193	0.440
Residual	17.691	89	0.199			0.488		
Total	21.931	90						

The average difference is significant at the 0.05 alpha level. Table 5 shows that the calculated F-statistic has a value of 21.329 with a significance level (Sig.) less than the 5% alpha level (α). This means that there is a significant statistical relationship between farmers’ intentions and their perceived usefulness (at $\alpha = 0.05$). The values of the coefficient of determination (R^2) and the correlation coefficient (R) are 0.193 and 0.440, respectively. Hence, the "perceived usefulness” interprets 19.3% of the “farmers' intentions.”

The best fitting equation is $Y = 0.911 + 0.488\ X$. The results confirm a positive statistically-significant relationship between the farmers’ intentions and their perceived usefulness. This totally agrees with the findings of the previous studies in the literature (e.g., Sondakh, 2017; Joo et al., 2018; Yang & Wang., 2019).

4.3.3.2 Considering the second hypothesis

The second hypothesis is “The perceived ease of use has a significant positive effect on farmers’ intention to adopt smart agriculture service.” To test this hypothesis, a linear regression between the farmers’ intentions and their perceived ease of use was developed as shown in Table 6.

Table 6: The linear regression test to determine the relationship between farmers' intentions and their perceived ease of use.

Model	Sum of Squares	df	average	F	Sig.	B	R^2	R
Regression	1.702	1	1.702	7.490	0.007	1.531	0.078	0.279
Residual	20.229	89	0.227			0.247		
Total	21.931	90						

As shown in Table 6, the calculated F-statistic has a value of 7.490 with a significance level (0.007) less than the 5% alpha level. This means that there is a significant statistical relationship between farmers' intentions and their perceived ease of use (at $\alpha = 0.05$). The R and R^2 values are 0.279 and 0.078, respectively. Hence, the "perceived ease of use" interprets 7.8% of the "farmers' intentions."

The best fitting equation is Y= 1.702 + 0.227 X. The results confirm a positive statistically-significant relationship between the farmers' intentions and their perceived ease of use. This is so comparable with the findings of the recent studies of Abd Ghani et al. (2017), Chang et al. (2017), Sondakh. (2017), Joo et al. (2018), and Yang & Wang. (2019).

4.3.3.3 Considering the third hypothesis

The third hypothesis is "The farmers' capabilities to use smart systems have a significant positive effect on farmers' intentions to adopt smart agriculture services." To test this hypothesis, a linear regression between the farmers' intentions and the farmers' capabilities to use smart systems was developed as shown in Table 7.

Table 7: The linear regression test to determine the relationship between farmers' intentions and the farmers' capabilities to use smart systems.

Model	Sum of Squares	df	average	F	Sig.	B	R^2	R
Regression	1.430	1	1.430	4.392	0.039	3.478	0.047	0.217
Residual	28.987	89	0.326			-0.255		
Total	30.418	90						

The F-statistic has a value of 4.392 with a significance level (0.039) less than the 5% alpha level (see Table 7). It is clear that a significant statistical relationship between farmers' intentions and the farmers' capabilities to use smart systems exists (at $\alpha = 0.05$). The R^2 and R values are 0.047 and 0.217, respectively. Hence, the "farmers' capabilities to use smart systems" explains 4.7% of the "farmers' intentions."

The best fitting equation is $Y = 3.478 - 0.255 X$. The results confirm a positive statistically-significant relationship between the farmers' intentions and the farmers' capabilities to use smart systems.

4.3.3.4 Exploring the rejected hypotheses

It is obvious in the previous three sub-sections that the first three hypotheses were accepted. The hypotheses no. 4 to no. 7 (see section 1.8), however, had been rejected. The linear regression tests to determine the relationship between the independent variable and the dependent variable were conducted and the key results are depicted in Table 8.

Table 8: The key results of the linear regression tests of the hypotheses from 4-7.

Hypothesis No.	Independent variable	F	Sig.*	R^2	R
4.	The high cost of smart systems	0.103	0.749	0.001	0.034
5.	The high source of income	2.106	0.150	0.023	0.152
6.	The age of olive trees	0.380	0.539	0.004	0.065
7.	The role of municipalities and relevant institutions	1.156	0.285	0.013	0.113

As shown in Table 8, the significance levels for the four hypotheses are less than the 5% alpha level (α), and therefore, there are insignificant statistical relationships between each of the independent variable and the dependent variable (i.e., farmers' intentions). According to the values of the two coefficients (i.e., R^2 and R), indicate no interpretation power between every independent variable mentioned in Table 10 and the dependent variable.

4.3.2 Addressing the third question

It is not a secret that the Jenin farmers of olive fields has positive perspectives towards the adoption of the smart agricultural applications. Smart agriculture has positive benefits to the farmers and positive impacts on the olive fields. The smart systems can be used for irrigation, fertilization, pest control, pest prevention, and supply chain that follow the crop from the field to the market (see Karydis et al., 2013; García et al., 2018; Arena et al., 2019; Labaña et al., 2019). Such smart systems enhance the crop production and quality, and as a result the farmer's profit increases (e.g., Eitzinger, et al.; Arena et al., 2019; García, et al., 2018; and Karydis et al., 2013; Labaña et al., 2019).

The third study question is “How can smart agriculture systems be used to overcome farmers’ problems?” To answer this question, some statistics (i.e., average, standard deviation, and estimation level value) were calculated for the third domain (i.e., farmers’ perception towards smart agriculture) as shown in Table 9.

Table 9: Some statistics from the third domain.

No.	Statement	Average	Standard deviation	Estimation level
1.	Using smart agriculture improves the performance of field management	2.31	0.57	Moderate
2.	The use of smart agriculture helps farmers make decisions based on correct and accurate information	2.20	0.52	Moderate
3.	Using smart agriculture saves efforts and time	2.36	0.54	Moderate
Total		**2.28**	**0.44**	**Moderate**

Table 9 shows that the total average and standard deviation values of how smart agriculture systems can be used to overcome farmers’ problems are 2.28 and 0.44, respectively, which suggests a moderate level of estimation. It is clear that the farmers believe that smart farming can save time and efforts which has the highest average value in Table 9. Farmers has little information about the smart agriculture and its technologies are not well perceived and still vague to most of them. Therefore, the statement number 2.

In Table 9 (The use of smart agriculture helps farmers make decisions based on correct and accurate information) has the lowest average value which is 2.20. The previous result was because of the lake of information about smart systems and how they work. So here appears a need for trainings and integration with technology specialized with farmers to clarify smart systems.

4.4 Prioritizing the Needed Smart Systems

Smart systems vary based on the agricultural activity they intend to serve. The smart agricultural systems can be used for: irrigation and fertilization, pest control (prevention and treatment), harvesting practices, and fire extinguishing. In this section, the farmers were asked to prioritize the different smart systems according to the need for such a system are shown in Table 10.

Table 10: Some statistics to prioritize the smart systems needed according to the farmers' perspectives.

No.	Statement	Average	Standard deviation	Estimation level
1.	Irrigation and fertilization	3.18	1.018	High
2.	Pest control	3.13	0.957	High
3.	Harvesting practices	2.08	0.763	Moderate
4.	Fire extinguishing	1.62	0.827	Low

As shown in Table 10, the different smart systems used for agricultural applications are stored in descending order. It is obvious that the farmers highly believe that the most important system to adopt is the irrigation and fertilization system. The second most important system is the pest and disease control, which is almost as significant as the irrigation and fertilization system. As shown in Table 5, the farmers revealed that the risk of fire is law, and therefore, it is not surprising that the fire extinguishing system has the least importance among the other smart systems.

4.5 Identifying the Influencing Factors

In summary of the previous sections, the influencing factors that significantly affect the farmers' intentions to adopt smart agricultural systems are shown in Figure 4.2.

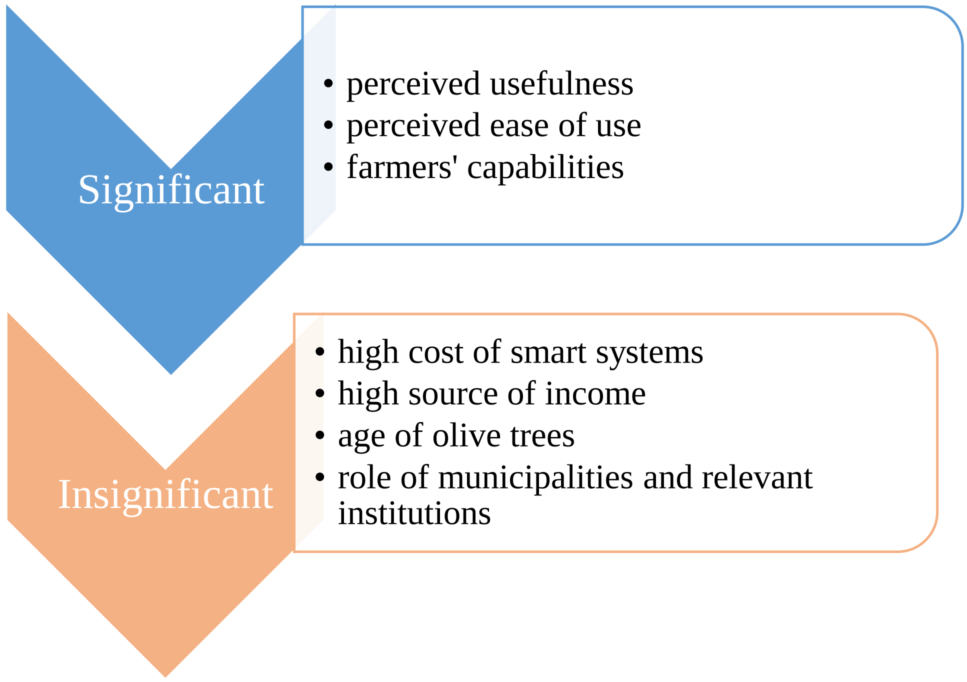

Figure 4.2: The significant and insignificant factors that affect the farmers' intentions to adopt smart agriculture.

In this study, it was found that both the perceived ease and the expected benefit of use of smart devices have the highest impact on farmers' decisions to adopt smart systems. The farmers believe that the smart systems are able to analyze the data in the olive fields and make accurate and correct decisions. This is in contrast to the current situation of the farmers in which they depend on their previous experiences and their limited knowledge in making decisions. Some farmers have seen many successful modern agricultural experiments on social media only. Such experience has a good impact on the farmers and motivates them to implement such smart systems. The local farmers think that the smart systems cannot be implemented without the generous financial assistance and technical help of the agricultural institutions. The farmers do believe that the costs of such smart systems are beyond their financial capabilities.

Looking for the high cost of smart systems, the farmer is often unable to pay for the high cost of such systems. Therefore, the implementation of these systems is based on external financing by supportive organizations at the beginning, and maybe after the success of the project in the future, it is possible to expand it from the profits that will be gained. The supporting organizations will adopt the issue of maintenance, especially in the early stages of the project to the point at which the project is successful and standing alone.

It seems that the age of the olive trees does not affect the farmers' decisions. This is because the olive tree needs the same care and attention despite of its age. The diligent care of the olive trees from the beginning of the formation of the fruit to the stage of harvest improves the production quality and quantity (Markakis et al., 2021). Olive trees services vary from peripheral pruning, supplemental irrigation, fertilization, and application of insecticides to prevent pests from growing up and spreading.

The role of municipalities and relevant institutions which help in managing and developing the olive fields has an insignificant effect on farmers' intentions. This is because of the weak and limited financial and technical support provided by these institutions. The target group of Jenin farmers refers this to several reasons: the use of traditional methods of management to the olive fields, the limited knowledge and experience of agricultural extension agents and agronomists about advanced agricultural systems, and the shortage of financial resources allocated to support the local farmers.

4.6 Unstructured Interviews

Supporting the study results, unstructured interviews were conducted with three experts from three supporting organizations which are: 1. the Faculty of Agricultural Sciences and Technology at Palestine Technical University – Kadoorie (PTUK) which is an education and research governmental institution based in Tulkarm, 2. the Higher Council for Innovation and Excellence (HCIE) which is a host to incubate creative projects and innovative techniques and located in Ramallah, and 3. the Sabi Trading Company which is a private enterprise working in marketing agricultural products and systems resides at Qalqilya. The three experts had been interviewed by telephone in winter 2020 and the study questions given in section 1.5 were posed to them. The analysis for the interviews can be inductive approach which is (thematic content analysis or narrative analysis) and deductive approach. In the thesis analysis we highlighted the main ideas for the interview and generated the needed data.

4.6.1 Addressing the first question by the experts

The first study question which is "What are the problems that farmers face?" was posed to the experts. The replies of the experts can be summarized in this section. Farmers in the olive sector of Palestine face many problems that reduce the quality and quantity of the crop production. Many of the problems are in the field and others are considered as external factors like the Israeli occupation. Recently, Palestine has suffered from climate change that affects the life cycle of the olive crop. Rainfall, temperature, humidity, and pests are commonly influenced by climate change. Farmers until now still deal with climatic changes in traditional ways and according to their previous experiences. Now, when it comes to the occupation; it can affect farmers in many aspects such as: access to agricultural lands, transportation difficulties and delays, human induced fires by settlers, and export obstacles.

Smart systems are supposed to use the least resources of land and the least amount of water to produce the best crops. It is aimed to achieve sustainable agricultural production while preserving natural resources for future generations. Hence, all the institutions that were interviewed, highlighted that the Palestinian farmers need a comprehensive system that begins with coaching and guidance of the farmers in their olive fields, to provide supportive programs for farmers to adopt smart agriculture, and establish follow-up and monitoring schemes. Agricultural development can be grown with the collaboration between the donors' organizations for funds and the agricultural experts for knowledge and technology.

4.6.2 Addressing the second question by the experts

The second study question which is “What are factors that affect farmers to accept adopting smart agriculture services?” was posed to the experts. The replies of the experts are illustrated in this section. Like any other new technology, it needs to be accepted and approved by the relevant persons particularly the end users. As all the interviewed institutions confirmed their approval to adopt a smart agricultural system and promote it among farmers, they insisted that more efforts have to be exerted to convince farmers to apply such smart technologies.

Despite the services provided by smart agricultural systems for farmers to improve their crop production, they are reluctant to adopt these systems because of their lack of experience with new technologies, the high costs of the new systems, and the limited financial and technical support of agricultural institutions. As per the experts, these are the most important issues that will affect farmers’ intentions to adopt smart systems. In order to encourage farmers to adopt smart agriculture, the experts assure that they can help and support farmers in their decision to adopt the new smart systems. The experts might support farmers through funding the new projects and providing necessary training to help farmers understand the new systems.

4.6.3 Addressing the third question by the experts

The third study question which is “How can smart agriculture systems be used to overcome farmers’ problems?” was posed to the experts. The replies of the experts are illustrated in this section. Farmers in their fields still have worked depending on their previous knowledge and experience. The traditional methods cause them more materials to use, less product to gain, more cost to spend, and more time and effort to waste. Because smart systems around the world proved their efficiency in many aspects, interviewer agree that farmers can get huge benefits if they apply such systems properly.

Smart systems provide accurate data that senses the environment in the field and takes the best action immediately. Such systems also compromise the requirements of the olive field and this saves available resources and increases profits. Smart systems can also help farmers detect the pest in its early stage which helps in reducing the spread to the whole olive field and the cost of treatment for the disease.

4.7 Proposed Smart System

In the survey farmers in Jenin highlighted that in high priority they need irrigation and fertilization systems and pests control systems, in this section we will provide design for both.

4.7.1 Smart irrigation and fertilization systems

The smart irrigation and fertilization systems mainly depend on installing some sensors. Such sensors can be: temperature and humidity, soil moisture, and rain sensors. The mission of these sensors is to provide accurate information on how much water and fertilize the soil needs. The system is also linked to internet devices to transmit information directly to the farmer through applications on smartphones or messages sent to farmer's devices. Also irrigation pumps and fertilizer drums are associated with the systems to control the amount and time of irrigation and fertilization from the farmer's side according to the needs of the farm.

4.7.2 Smart system for agricultural pest control and prevention

One of the smart systems used to monitor plants is to install cameras that take pictures of the trees and send these pictures as data to database. These data is entered into special treatments that analyze the pictures and, diagnose the existing disease and then provide appropriate solutions to prevent the disease. This information is sent over the internet to the farmer to provide the necessary measures for immediate control of the farm and the crop.

4.7.2.1 Olive pests

Olive trees in Palestine face many agricultural pests that mainly affect the yield and (Batta, 2019):

- **Spilocaea oleaginium**: It is fungal disease that affects olive trees. The disease activity is frequent in March and April. It performs to change the color and fall off the leaves, this scenario continue to reach the fruit also. This may causes to decrease the half of production. For prevention, trees are sprayed in September.

- **Dacus olea**: A fly whose larvae feed on olives, weakening it and causing it to fall off. Because the fly lays its eggs inside the olive fruits, which hatch from larvae. This fly is considered a serious pest for olive farmers, as larvae feed on the contents of the fruit, and then fall to the ground. All that causing a huge loss in the crop. For prevention, special care must be taken to clean the ground, fertilize, and use yellow traps.

- **Phlocotribus olea**: An insect infesting olive branches leads to dehydration, and it can infect the stem and lead to tree death. The infection abounds in strong trees and weakens in weak trees. One of the most important methods of prevention is to pay attention to irrigation and fertilization, as well as monitoring the branches.

4.7.3 Smart system design

The proposed smart system combines irrigation, fertilization, and pest control. The system determines the appropriate amount and time for supplementary irrigation of the olive tree and determines the changes that occur in the tree as a result of agricultural pest infestation. The previous practices help in identifying the disease in the early stages and reduces the risk of disease spreading in the field. The system relies on temperature in the soil and moisture sensors fixed in the soil, in addition to cameras that take instant pictures of trees. The data generated by these devices is sent over the internet and analyzed to take appropriate decisions as: the suitable amount for irrigation and fertilization, the suitable time for irrigation, the precise way to treat the pest, etc.). (See Figure 4.3).

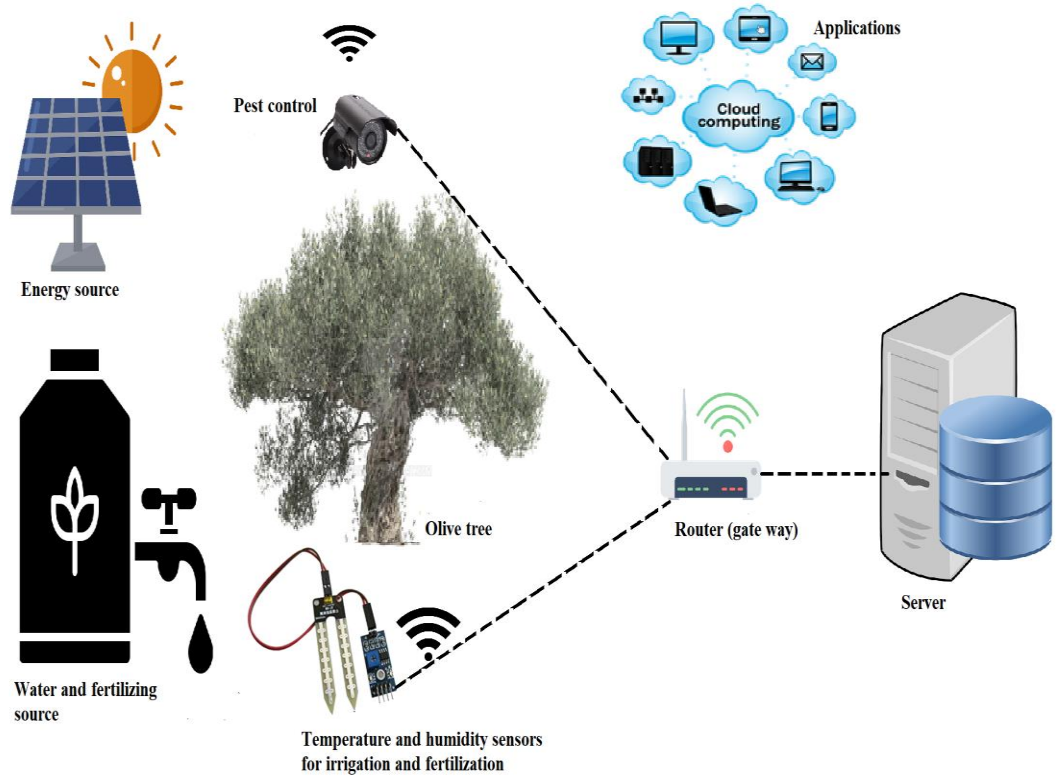

Figure 4.3: Wireless Sensor Networks for irrigation and fertilization as well as control pest system

4.7.4 Architecture of the proposed smart system for olive field

The system is clarified in five parts as follows:

Data Acquisition: Sensors and cameras are main sources of data which will send the data through Wi-Fi modules to database server. Sensors generate data for: temperature, humidity, soil moisture, and rain amounts. When it comes to cameras, they generate pictures for the tree and send these pictures to the database server.

Data Monitoring: The gathered data is stored in the database for future use and for taking suitable action for the tree such as: irrigation amount and time.

Pictures from cameras are compared with pictures stored for infected olive's tree to detect the pest and then the system sends a command with an action for treatment.

Communication: Microcontrollers, Wi-Fi modules, and web services are devices which allow to transfer and receive data through it. The data which send is related to sensors itself and data gathered from it then send the data through Wi-Fi modules to receive data which means actions to solve the need for the tree. Regarding to the energy source of the system devices, they are supplied from solar energy system.

Data Processing: Data from cameras will detect the pest and will provide adequate treatment process. For sensors data, suitable amount of irrigation and fertilization will generate.

Storage: There is a need to store the data we get from sensors and cameras. So we need a database server to store the data for device itself and device reading. This data can be retrieved any time.

4.8 Developed Agricultural stockholders management

The role for agricultural stockholders management in agricultural revelation presented in Figure 4.4.

Farmer	• Have to intensify agricultural activities including the proper planting, irrigating, pruning, trimming, fertilizing, pests and disease treating, and harvesting to remain healthy.
Agricultural Institutions	• Provide guidance, assistance, and support to the local olive farmers in order to encourage them to adopt and use smart agriculture applications.
Experts from Academic and Research Agencies	• Increase the researches that implement in the integration of technology with agriculture. And collaborate with agronomists because they are the link with the farms.
Private Agricultural Sector	• provide trainings and materials that support farmers and encourage them to implement and use the smart systems in their olive fields.
Agronomists	• Collaborate with technology specialists to help olive farmers understand smart systems, provide support for farmers to improve the managerial practices.
NGOs	• Provide proposals for olive smart systems and the investment for these projects so they can encourage farmers to use such systems.

Figure 4.4: the Roles for Agricultural Stockholders Management

4.9 limitations

Some challenges faced the research presented as follow:

- Formulation of research aims and objectives because a lot of information have to gain and collect from many sides maybe if the researcher consider the intention of farmers and their willing to pay for smart projects will be great result.
- Implementation of data collection method especially in Corona pandemic.
- Lack of previous studies in the smart agriculture in the area of the study which is Palestine.
- Scope of discussions.

Chapter Five

5. Conclusions and Recommendations

Chapter five contains the study conclusions and introduces the recommendations the researcher comes up with after applying the methodology of the study, making sure that the objectives of the study are fully attained.

5.1 Conclusions

The implementation of modern methods built on smart technologies to manage agricultural fields is of great importance to Palestinian farmers who continue to use traditional methods. This study aims to understand the olive sector in Jenin district of Palestine, identify the problems farmers confront, evaluate the intentions of the local farmers to adopt smart applications in agricultural fields, determine the influencing factors in the decision of the farmers, and finally develop a smart model that best fits the domestic conditions. In this study, the researcher learns lessons from the international researchers through the literature review, the local farmers through the survey questionnaires, and the domestic experts through the unstructured interviews.

Recent previous studies of similar topics had been covered in this study to explore the up-to-date smart technologies used in developing agricultural management systems. As for the questionnaires, the sample size was 68 while the researcher was able to collect 91 responses from the Jenin farmers of olive fields. In order to better understand the situation and answer the study questions, unstructured interviews were conducted with three domestic experts from an innovation incubator, an academic and research institution, and a private enterprise. All three experts work in institutions that contribute to the development of agricultural systems in Palestine.

After the completion of the data collection from the target group, the Statistical Package for the Social Sciences (SPSS) was used to analyze the responses. As per the olive farmers in Jenin district, the two major challenges they face are the climate change and the pest control, and therefore, they are looking for creative solutions that employ smart technologies. Many factors affect the farmers' intentions to adopt smart management systems. It is found that the farmers' perceived usefulness, perceived ease of use, and capabilities have statistically significant effects on their intentions to adopt smart agriculture. However, the factors of insignificant impacts on the farmers' intentions in managing their olive fields using smart technologies are the high cost of smart systems, the age of olive trees, the high income of the farmers, and the role of municipalities and relevant institutions.

In the agricultural systems, there are several smart systems that can accomplish agricultural tasks and help farmers manage their olive fields efficiently and effectively. In this study, the Jenin farmers of olive fields were asked to prioritize the different smart systems according to their needs. The smart agricultural systems suggested by the farmers' stored in descending order are: the irrigation and fertilization, the pest control, the harvesting practices, and finally the fire extinguishing systems. The proposed smart system is a system that combines irrigation, fertilization, and pest control. The system determines the appropriate amount and time for supplementary irrigation of the olive tree and decides the changes that occur in the tree as a result of agricultural pest infestation. Which helps in identifying the disease in the early stages and reduces the risk of disease spreading in the field. The system relies on temperature and moisture sensors fixed in the soil, in addition to cameras that take instant pictures of trees. The data generated by these devices is sent over the internet and analyzed to take appropriate decision for the field.

It is clear that adopting smart technologies in agriculture has great benefits to the farmers and their olive fields. This entails the full collaboration between all involving entities that include the farmers, agricultural extension agents and agronomists, and specialists in agriculture and technology, and experts from academic and research agencies. Such collaboration cannot be successful without the integration of the governmental, semi-governmental, non-governmental, and private sectors involved in developing agriculture in Palestine. In addition, it is essential to increasing the proportion of the governmental sector spent on the agricultural projects and raising awareness through seminars and programs that motivate and support adopting smart technologies to manage agricultural fields.

5.2 Recommendations

After all, the researcher would like to identify the most important recommendations that will improve the reality of agricultural management systems to overcome the obstacles farmers may confront and increase the quality and quantity of the crop production of olive fields. Based on the abovementioned findings of the study, we come up with the following recommendations:

- The necessity to conduct a study related to the application of smart agriculture on vegetable crops that are grown in Palestine.

- Farmers need to apply smart agricultural systems to better prevent and protect the crop from pests and diseases and maintain the plants healthy through their whole life cycle.

- The need for governmental agencies and agricultural institutions to provide real and generous support in order to develop the agricultural fields.

- Agricultural institutions should provide guidance, assistance, and support to the local farmers in order to encourage them to adopt and use smart agriculture applications.

- Implement a feasibility study for the smart agriculture systems.

- Implement the same study in other districts of Palestine.

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Appendices

Appendix A

Arbitrators for the questionnaire:

- Dr. Mohammed Al-Tamimi: Dr. Al-Tamimi earned his Ph.D. in Functional Food and Food Biotechnology from Reading University/ U.K, 2004. He was the Head of Department of Nutrition and Food Technology at An Najah National University 2014-2016, where he has been a staff member since 2013. Dr. Al-Tamimi has published on various topics in Functional food and bioactive food ingredients over the years.

- Dr. Yacoub Batta: Distinguished Professor at An-Najah National University. He is faculty staff member with professor rank. He is teaching courses in Plant Pathology and Agricultural Entomology in the Faculty of Agriculture and Veterinary Medicine, An-Najah National University, Nablus, Palestine. He is also senior researcher leading a research group in biological control of plant diseases and agricultural insects using antagonistic and entomopathogenic fungi.

- Dr. Faysal Shraim: Academic at An-Najah National University. He studies at the College of Agriculture. He holds several positions such as: He is the head of the Palestinian Agricultural Engineers Association, and the President of the Union of Agricultural Engineers.

Appendix B

Arabic and English final form of the questionnaire:

جامعة النجاح الوطنية

كلية الدراسات العليا

برنامج الإدارة الهندسية

استكمالاً لمتطلبات درجة الماجستير يرجى من مزارعي الزيتون في محافظة جنين الإجابة على الأسئلة التالية من أجل المساعدة في إتمام بحث بعنوان "النهج الإداري نحو تعزيز الإدارة الزراعية دور التكنولوجيا".

الزراعة الذكية: هي أحد التقنيات الحديثة التي تصب في خدمة المزارع والزراعة من خلال استخدام أمثل للأرض والمياه في الحصول على أعلى عائد من الإنتاج. تتنوع الزراعة الذكية لتشمل تطبيقات عديدة مثل: أنظمة الرّي والتسميد ومكافحة الآفات وبعض الممارسات الزراعية خاصة القطف.

الأسئلة المرفقة تتضمن أربع فروع تحتاج 10 دقائق لتعبئتها مع العلم أن المعلومات الواردة في هذه الاستمارة محصورة لأغراض البحث العلمي فقط.

مع تحيات الباحثة: ياسمين عمر غانم

بإشراف الدكتور: سعد طربيه وشادي عطالله

القسم الأول يتضمن الأسئلة المتعلقة بالمزارع والمزرعة:

يرجى التكرم بوضع إشارة (X) في مربع الإجابة التي تناسبك		
.1	المؤهل العلمي	أقل من ثانوية عامة ______ ثانوية عامة ______ بكالوريوس ______ دراسات عليا ______
.2	الأرض الزراعية مُلك شخصي	نعم ______ لا ______
.3	المساحة الكلية من الأرض المزروعة بالزيتون	____________________(دنم)
.4	عدد أشجار الزيتون	________________(شجرة)
.5	عمر أشجار الزيتون	أقل 10 سنوات ______ 10- 19 ______ 20- 30 ______ أكثر من 30 ______
.6	إنتاج الأرض من الزيت كمعدل في الموسم الماطر في الدونم الواحد	____________________(كغم)
.7	إنتاج الأرض من الزيت كمعدل في الموسم الغير الماطر في الدونم الواحد	____________________(كغم)
.8	نوع أشجار الزيتون	نبالي بلدي ______ نبالي محسن ______ K18 ______

القسم الثاني يتضمن الأسئلة الخاصة في المشاكل التي تتعرض لها الأرض الزراعية

يرجى التكرم بوضع إشارة (X) في مربع الإجابة التي تناسبك					
الرقم	**السؤال**	**دائما (4)**	**غالبا (3)**	**أحيانا (2)**	**أبدا (1)**
.1	طريقة الرّي تعتمدة على مياه الأمطار				
.2	لك حرية الوصول إلى الأرض الزراعية				
.3	يتعرض الحقل ل خطر الحرائق				
.4	يتعرض المحصول للآفات الزراعية ويؤثر على المحصول				
.5	تستخدم طرق وقاية لحماية المحصول من الآفات (للوقاية)				

6.	تستخدم طرق وقاية غير كيماوية لحماية المحصول من الآفات (للوقاية)				

القسم الثالث يتضمن الأسئلة المتعلقة بالمحاور الاجتماعية والاقتصادية:

يرجى التكرم بوضع إشارة (X) في مربع الإجابة التي تناسبك					
الرقم	**السؤال**	**موافق بشدة**	**موافق**	**غير موافق**	**غير موافق بشدة**
1.	مصدر الدخل الأساسي مرتفع				
2.	إدارة الحقل تحتاج تكاليف عالية				
3.	تقدم البلديات والجهات المختصة المساعدة في إدارة وتطوير الحقول				
4.	يشكل الإحتلال عائق في إدارة الحقل				
5.	لدي الرغبة في إستثمار 1000$ في النظام الذكي				

القسم الرابع: يتضمن الأسئلة الخاصة بالمزارع ونظرته للزراعة الذكية

يرجى التكرم بوضع إشارة (X) في مربع الإجابة التي تناسبك					
السؤال		**موافق بشدة**	**موافق**	**غير موافق**	**غير موافق بشدة**
الفائدة	الزراعة الذكية تحسن من الأداء				
	الزراعة الذكية تساعد على اتخاذ القرارات بناءا على معلومات صحيحة ودقيقة				
	الزراعة الذكية توفر الجهد والوقت				
سهولة الاستخدام	تطبيقات الزراعة الذكية سهلة الاستخدام				
	تطبيقات الزراعة الذكية واضحة ومفهومة				
	تطبيقات الزراعة الذكية تسهل إدارة المزرعة				
المؤهلات والقدرات	أملك القدرات اللازمة لاستخدام الزراعة الذكية				
	أملك الموارد والوسائل اللازمة لاستخدام الزراعة الذكية				
	أملك المعرفة اللازمة لاستخدام الزراعة الذكية				
دور المؤسسات	الجهات المختصة تساهم بالإعلان والترويج والدعاية لتوجه نحو الزراعة الذكية				
	الجهات الداعمة تحفز المزارعين لاستخدام الزراعة الذكية				

والجمعيات الزراعية	الجهات الداعمة تقدم الدعم المادي لتعزيز المزارع لاستخدام الزراعة الذكية				
	الجهات الداعمة تقدم الندوات التعريفية لتمكين استخدام الزراعة الذكية				
الرغبة في الاستخدام	أرغب في استخدام التطبيقات الزراعية الذكية في حقل الزيتون				
	أود الاستفادة من فوائد الخدمات الزراعية الذكية				
	أسعى لإستخدام التكنولوجيا في تحسين مستوى مزرعتي				
خطورة الآداء	قد يكون نظام الزراعة الذكية معطلا لذا لا أستطيع التحكم بالمزرعة				
	نظام الزراعة الذكية من المكن أن لا يعمل				
	الخدمات الزراعية الذكية غير متوفرة للاستخدام بطريقة صحيحة طيلة الوقت				
	نظام الزراعة الذكية لا يعمل بكفاءة بسبب بطء خطوط شبكة الاتصالات				
الخطورة المالية	النّظام مكلف وخارج قدرتي المالية				
	الصيانة الدّورية مكلفة				
	استبدال القطع التالفة مرهق ماديا				
	عائد الرّبح قليل				

إذا تم اقتراح نظام ذكي يساعد المزارعين في إدارة حقولهم ما هي الأمور التي يجب على النظام أن يوفرها الرجاء ترتيبها حسب الأولوية بوضع الأرقام من (1 إلى 4).

الري والتسميد ____________

مكافحة اللآفات الزراعية ____________

ممارسات زراعية خاصة بالقطاف ____________

نظام إطفاءالحرائق ____________

An-Najah National University
Faculty of Graduate Studies

Engineering Management Program

In order to complete the requirements for the master degree, olive farmers in Jenin were requested to answer the following questions in order to help complete a research entitled "**Managerial Approach toward Enhancing Agriculture Management the Role of Technology".**

Smart agriculture is one of the modern technologies that serves farmers throughout the best use of land and water to obtain the highest revenues of production. Smart agriculture varies to include many applications such as: irrigation systems, fertilization, pest control, and some agriculture practices, especially crop picking.

The attached questions include four sections that require 10 minutes to fill out, the information contained in this form to be used for scientific research purposes only.

Researcher: Yasmeen Ghanem

Supervisor: Dr. Saad Tarabiyeh

Dr. Shady Ataallah &

Part1 includes statements related to farms.

Please put an X in the answer line that suits you.		
1.	Qualification	Less than Tawjihi ______ Tawjihi ______ Bachelor ________ Graduate studies ________
2.	Land ownership	Owned ______ Not owned _______
3.	The total area of land planted with olives	______________________ (dunum)
4.	Number of olive trees	______________________ (Tree)
5.	Olive tree age (year)	Less than 10 _______ 10-19 _______ 20-30 _______ More than 30 _____
6.	Olive oil production in an infertile season	___________________________(Kg/dunum)
7.	Olive oil production in a fertile season	___________________________(Kg/dunum)
8.	Olive tree kind	Nabali Baladi ______ Improved Nabali _____ K18______

Part2 includes statements related to the problems facing agricultural land.

	Please put an (X) in the answer box that suits you				
No.	**Statements**	**Always (4)**	**Often (3)**	**Rarely (2)**	**Never (1)**
1.	The irrigation method is based on rainfed				
2.	Your field get free access to field				
3.	You are exposed to fire risk				
4.	The crop is exposed to agricultural pests				
5.	Preventative methods are used to protect the crop from pests (for prevention)				
6.	Non-chemical methods are used to protect the crop from pests (for protection)				

Part3 includes statements related to economic and social issues.

	Please put an (X) in the answer box that suits you.				
No.	**Statements**	**Strongly agree (4)**	**Agree (3)**	**Disagree (2)**	**Strongly disagree (1)**
1.	High source of farmer income				
2.	Field management requires high costs				
3.	Municipalities and relevant departments help in managing and developing the olive fields				
4.	The occupation constitutes a direct obstacle in managing the olive field				
5.	Willing to invest 1000$ for the smart system				

Part4 includes statements about the farmers' perceptions towards smart agriculture.

please put an (X) in the answer box that suits you.					
Statements		**Strongly agree (4)**	**Agree (3)**	**Disagree (2)**	**Strongly disagree (1)**
Benefit	Using smart agriculture improves the performance of field management				
	The use of smart agriculture helps farmers make decisions based on correct and accurate information				
	Using smart agriculture saves efforts and time				
Usability	Smart agriculture applications are easy to use				
	Smart agriculture applications are clear and understandable				
	Smart agriculture applications facilitate farm management				
	Have the capabilities to use smart agriculture systems				

Qualifications and capabilities	Have the needed resources to use smart agriculture systems				
	Have the needed knowledge to use smart agriculture systems				
The role of agricultural institutions and associations	The agricultural institutions contribute to advertise to move towards smart agriculture				
	The agricultural institutions motivate farmers to use smart agriculture				
	The agricultural institutions provide training to enhance farms to use smart agriculture				
	The agricultural institutions provide fund to use the smart agriculture				
Willing to use	Intend to use smart agricultural applications in the olive field management				
	Would like to take the benefits of smart agricultural services				
	Seek to use technology to improve the quality of crops in my farm				
The risk of performance for smart systems	The smart agriculture system may fail so I cannot control the farm				
	The smart agriculture system is not working properly				
	The smart agricultural services are not available all the time				
	System does not work efficiently due to slow communication network lines				
Financial risk	The system is expensive and beyond my financial capacity				
	Regular maintenance for smart systems is expensive				
	Replacing damaged parts of smart systems is expensive				

	The profit from smart systems is low				

If a smart system is proposed to assist farmers in managing their fields, what are the services that the system must provide? Please priory them according to your needs (from 1 to 4):

1. **Irrigation and fertilization _________**
2. **Pest control ___________**
3. **Harvesting agricultural practices ________**
4. **Fire extinguishing systems _________**

Appendix C

Table D1: The linear regression test to determine the relationship between the high cost of smart systems and farmers' intentions.

Model	Sum of Squares	Df	average	F	Sig.*	B	R^2	R
Regression	0.025	1	0.025	0.103	0.749	2.082	0.001	0.034
Residual	21.906	89	0.246			-0.027		
Total	21.931	90						

Table D2: The linear regression test to determine the relationship the high source of income and farmers' intentions.

Model	Sum of Squares	Df	average	F	Sig.*	B	R^2	R
Regression	0.507	1	0.507	2.106	0.150	1.861	0.023	0.152
Residual	21.424	89	0.241			0.084		
Total	21.931	90						

Table D3: The linear regression test to determine the relationship between and the age of olive trees and farmers' intentions.

Model	Sum of Squares	df	average	F	Sig.*	B	R^2	R
Regression	0.093	1	0.093	0.380	0.539	1.946	0.004	0.065
Residual	21.838	89	0.245			0.030		
Total	21.931	90						

Table D4: The linear regression test to determine the relationship between the role of municipalities and relevant institutions and farmers' intentions.

Model	Sum of Squares	df	average	F	Sig.*	B	R^2	R
Regression	0.281	1	0.281	1.156	0.285	1.884	0.013	0.113
Residual	21.650	89	0.243			.064		
Total	21.931	90						

جامعة النجاح الوطنية

كلية الدراسات العليا

نهج إداري لتعزيز الإدارة الزراعية: بالاعتماد على وسائل تكنلوجية حديثة

إعداد

ياسمين عمر محمد غانم

إشراف

د. سعد طربية

د. شادي عطا الله

قدمت هذه الأطروحة استكمالاً لمتطلبات الحصول على درجة الماجستير في الإدارة الهندسية، بكلية الدراسات العليا، في جامعة النجاح الوطنية، نابلس، فلسطين.

2021

نهج إداري لتعزيز الإدارة الزراعية: بالاعتماد على وسائل تكنلوجية حديثة

إعداد

ياسمين عمر محمد غانم

إشراف

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د. شادي عطا الله

الملخص

على الرغم من توفر العديد من الأساليب الحديثة التي تعتمد على التقنيات الذكية لمراقبة حقول المزارعين ببيانات كافية وحقيقية، يواصل المزارعون الفلسطينيون استخدام الأساليب التقليدية لإدارة الحقول بناءً على الخبرات والمعلومات السابقة. لمساعدة المزارعين على فهم الحاجة إلى استخدام الأنظمة الحديثة، حددنا المشكلات التي يواجهونها ثم قيمنا نواياهم في تبني أنظمة ذكية وعوامل مؤثرة على قرارهم. لجمع البيانات، وزعت استبيانات على 91 مزارع زيتون في محافظة جنين في فلسطين. تم اختبار البيانات وتحليلها باستخدام SPSS. كشف مزارعو الزيتون في جنين أن التحديين الرئيسيين اللذين يواجهانهما هما التغير المناخي ومكافحة الآفات، وبالتالي لديهم النية لاعتماد أنظمة إدارة ذكية. النظام الذكي المطور يجمع بين الري والتسميد ومكافحة الآفات. يساعد النظام في: تقليل استهلاك الموارد، والتعرف على المرض في مراحله المبكرة، وتقليل مخاطر انتشار المرض في الحقل. لتحقيق هذا النهج الذكي، هناك حاجة إلى التعاون بين العديد من المؤسسات والافراد. إن تطبيق مثل هذه الممارسات يؤدي إلى تعزيز المزارعين في رحلتهم الجديدة التي ستؤدي إلى ثورة زراعية جديدة في البلدان النامية مثل فلسطين.