**Chapter 2**

**Review of Related Literature**

This chapter discusses the study's linked literature, which includes books, journalism, and then the internet. gathered by the researchers from both foreign and local sources to ensure the validity of the study.

**Technical Background**

The conceptual literature is about giving the researchers a better understanding about the related topics on their desired topic to help them understand it.

A decision support system (DSS) is a computerized system that supports decision-making in organizations. It provides users with data analysis tools and models to help them make informed decisions. DSSs are used in a variety of different ways, depending on the organization’s needs. Some of the benefits of using a DSS include increased speed and efficiency of decision-making activities, reduced errors, improved planning and management, and increased management success. In addition to these benefits, DSSs can also help organizations to identify new opportunities and improve their overall performance. By providing users with access to real-time data and analysis tools, DSSs can help organizations to quickly identify trends and patterns that may not be immediately apparent. This can help organizations to make more informed decisions about their operations and strategies, which can ultimately lead to increased profitability and growth.

According to an article by “Prof. Dr. Marek Babicz and Dr. Magdalena Szyndler-Nędza” Modern pig breeding and production requires knowledge of the basic factors that determine the productive value, breeding value, behavior, and health of this livestock species. To maximize the effects, it is necessary to use the latest achievements in different fields of science: animal science, biotechnology, genomics, etc. These components interpenetrate and complement each other, resulting in valuable breeding and fattening material. The major focus of pig farming and breeding is to produce pork of the quality desired by consumers. This necessitates the use of various measures, such as selection of native and commercial breeds, crossbreeding schemes, feeding, housing conditions, pork production, and processing technology. Each of these elements is at the same time treated as a separate research issue. Their understanding contributes to improving pig farming efficiency while identifying new relationships of potential scientific and practical significance.

The design of a user interface affects a DSS's usefulness, validity, and applicability. A good user interface design must make sure that: The screen design is visually appealing, the layouts are uniform, the arrangement of options and menus is appropriate, the screen layout is simple to understand and use, the design doesn't have to be artistic, but it should definitely be pleasing to the eye, and working on it is simple and enjoyable. With the necessary information at hand, begin. A DSS is not a predefined package; rather, it is tailored to the demands of end customers. Therefore, a DSS user interface developer must avoid making any suppositions or assumptions. When designing the software, pay attention to the hierarchy of importance. Create user interfaces with an emphasis on the communication between the user and the machine. Create the instructions and operations that will be used to execute the operations. Describe what happens when a command is given by the user. Create the program by working backward. Designers strive to produce user-friendly and enjoyable interfaces. Graphical user interfaces and other types, such as voice-controlled interfaces, are referred to as "UI design". Before starting to create a DSS user interface, it is crucial to define representations, operations, and memory and control aids because each DSS has a unique function.

**Android Studio**

Android Studio is the official integrated development environment ([IDE](https://www.techtarget.com/searchsoftwarequality/definition/integrated-development-environment)) for Android application development. It is based on [IntelliJ IDEA](https://www.theserverside.com/definition/IntellJ-IDEA), a [Java](https://www.theserverside.com/definition/Java) integrated development environment for software, and incorporates its code editing and developer tools. Android Studio uses an Apply Changes feature to push code and resource changes to a running application. A code editor assists the developer with writing code and offering code completion, refraction and analysis. Applications built in Android Studio are then compiled into the [APK format](https://www.techtarget.com/whatis/definition/APK-file-Android-Package-Kit-file-format) for submission to the Google Play Store.

The following are the system requirements for Android Studio on Windows.

* 64-bit Microsoft Windows 8/10/11
* x86\_64 CPU architecture; 2nd generation Intel Core or newer, or AMD CPU with support for a [Windows Hypervisor](https://developer.android.com/studio/run/emulator-acceleration#vm-windows)
* 8 GB RAM or more
* 8 GB of available disk space minimum (IDE + Android SDK + Android Emulator)
* 1280 x 800 minimum screen resolution

**Java**

Java is a widely-used programming language for coding web applications. It has been a popular choice among developers for over two decades, with millions of Java applications in use today. Java is a multi-platform, object-oriented, and network-centric language that can be used as a platform in itself.

**XML**

The researchers used XML (eXtensible Markup Language) for the separation of the appearance of an application from its code and enabling a clean designer-developer workflow. XML is used to implement UI-related data, and it’s a lightweight markup language that doesn’t make layout heavy. It only contains tags, while implementing they need to be just invoked.

**Common Breeds of Swine**

Listing and understanding the different breeds of swine to give base information about swine for the researchers.

**Large White**

Large white breeds are entirely white with medium, erect ears. It is the most common breed in the Philippines. As the name suggests, the Large White pig is large in size and of pure white coloration. It has white or pink skin, dished face, and erect ears of pink color. A mature boar has weights between 300 kg and 450 kg and a mature sow weigh between 250 kg and 350 kg.

**Landrace**

This breed is white, short-legged, and has medium to large drooping ears. Most of the nations in central and eastern Europe are home to the white, lop-eared Landrace pig. It raises huge litters and is renowned for its exceptional farrowing abilities. The breed lacks black hair and has white skin. They have long bodies and long snouts. The average mature sow weighs 204–272 kg, and the average mature boar weighs 272 to 408kg.

**Duroc**

An older domestic pig breed that was developed in the US is the duroc. It has golden yellow and reddish-brown coloring, a medium length, a muscular build, and ears that are partially drooped. By mating different red pig strains, the breed was created in New England in the early 1800s. The Jersey Red and the elder Duroc from New York were crossed to create the present breed. The Duroc pig is one of the friendliest, most affectionate, and approachable breeds you can discover.

**Ideal Food for Pigs**

The basic formulation of pig feed changes as the pigs grow to meet the needs of your growing pigs. You simply select the feed based on the pigs' weight. You've probably heard that pigs can eat almost anything, you can find people raising pigs on very different diets all over the world. What is the best thing to feed pigs to keep them happy and healthy according to a blog by kathy mccune on the website “[What’s The Best Thing To Feed Pigs? – Family Farm Livestock](https://familyfarmlivestock.com/whats-the-best-thing-to-feed-pigs/)” The best feed for pigs depends on the pig's age and weight, but most commonly**corn-based feeds** are used because they are high in digestible carbohydrates, low in fiber, and cost-effective the best feed for pigs depends on the pig's age and weight, but most commonly corn-based feeds are used because they are high in digestible carbohydrates, low in fiber, and cost-effective

**Vitamins for Pigs**

Pigs require a variety of vitamins and minerals in their diets. B-complex vitamins, including riboflavin, niacin, pantothenic acid, and vitamin B12, are added to swine diets, while folic acid, pyridoxine, choline, and biotin are included in sow diets due to their influence on reproductive performance. This information is from a study called “Kansas State University Applied Swine Nutrition” by Menegat, Mariana B., Robert D. Goodband, Joel M. DeRouchey, Mike D. Tokach, Jason C. Woodworth, and Steve S. Dritz. (2019).

**Research Literature**

**Local Studies**

The study entitled “Pig Farming in the Philippines: How to Raise Fattening Pigs” by Arturo Brosas (2022). Raising fattening pigs on the other hand is very different from raising piglets at home. Growers of fattening pigs must be constantly monitoring their feeding, making sure they are eating their respective ration and are gaining weight at par. Pork is also delicious, high content of proteins, vitamins, and minerals, so it is highly sought after in the market and very easy to sell. The problem is knowing how they should be fed correctly and in what conditions they should be raised.

A study conducted by Mark Edmund I Legaspi, Miguelle Banjo P. Manalo, Jerome B. Opeña, Eymard B. Pempiña, Maria Vicky S. Solomo, and Dave A. Yadao entitled “Project Investocks: Online Investment System for Poultry and Swine Raisers with Decision Support System” (2020). Online-based technology in relation to the investment system for poultry and swine in the Philippines is not well known. Thus, study aimed to develop a Web-based Investment System that would help investors look for the best poultry and/or swine farm which could generate better investment returns. An Investor – Farmer matching system with decision process was developed using a user-friendly online interface for Pork Producers Federation of the Philippines Incorporated (formerly National Federation of Hog Raisers Inc. or NFHFI). This will contain a dashboard on the system administrator side that would reflect the overall performance and financial standing of participating livestock farms as well as comprehensive dashboard for investors which would display the historical and current investment data of every investor account. Main functions of the system include account management, enhanced decision making, maximizing the profit through Return on Investment analysis based on farmers’ production data and profile. One-on-one interviews, focused groups and direct observations will be employed to collect primary data required for the system development. The effectiveness of the system and client satisfaction were discussed and presented after months of deployment in PPFPI website.

The study entitled “Decision support system for richdess poultry and egg farm” by Michelle Renee Ching, Shaun Cassidy Calagos, Katrina Michaela Delfin, Carlos Miguel Dignadice, Joshua Macuja (2018). The most important enterprise in the world is Agriculture for it provides human's basic needs of survival. Because of the advancements in technology today, management of agricultural data and information related to the performance of livestock is vital for successful farms to compete in the market. This could be achieved through accurate Farm Management Information Systems that can provide decision support to achieve sustainability, optimum efficiency, and effectivity. Through Agile and Scrum development frameworks, the researchers specifically developed a Decision Support System for RichDess Poultry and Egg Farm that aids its farm employees in storing and utilizing data that would provide the necessary information to the farm manager in creating key business decisions. The system aims to maximize the assets and minimize the expenses of the farm through the four main modules: Poultry and Egg Management module, Pig Management module, Feeds and Medicine Inventory Tracking module, and Financial Management module. The system can suggest the best chicken breed to purchase based on each chicken breed's total egg production; moreover, it can suggest the type of medicine to cure certain illnesses based on past data. Additionally, it can monitor the weight and breeding status of the pigs. It can also display a clear picture of the farm's cash flow for easy decision-making, and it can track the quantity of feeds and medicines used. © Proceedings of 2018 the 8th International Workshop on Computer Science and Engineering, WCSE 2018. All rights reserved.

The article entitled “A Decision Support System for Urban Agriculture Using Digital Twin: A Case Study With Aquaponics” by Adam Ghandar, A. Ahmed, Shahid Zulfiqar, Zhengchang Hua, Masatoshi Hanai, G. Theodoropoulos (2021). There are many pressures on the global food system such as urbanization, climate change, and environmental degradation. Urban agriculture is an approach to producing food inside cities where, globally, more than half the world’s population live. It has been shown to have a range of potential benefits, for instance in reducing waste and logistics costs. Increased uptake of urban farming can even relieve pressure on the natural environment by reducing the burden of production required from farmland by creating space for it to recover from accumulated damage as a result of the use of unsustainable farming practices historically. This article describes an approach for a new type of decision support system suitable for urban farming production. We discuss differences between the requirements and the users of decision support in urban agriculture, and those of ordinary agribusiness enterprises. A case study is performed using a novel technology for urban farming: a cyber-physical implementation of aquaponics is enhanced with adaptive capabilities using a digital twin system and machine learning. Aquaponics is a farming technique that utilizes a harmonious nutrient exchange cycle for growing plants and fish together, while conserving water, and possibly without the need for soil or even sunlight. Empirical results are provided that evaluate the use of data driven decision analytics and a digital twin model to plan production from the aquaponic system during a three month trial. Another set of results evaluate a proposed modelling framework for large scale urban agriculture ecosystems. This concept forms the basis of the suggested approach for an urban farming decision support system that coordinates the activities of many independent producers to target collective goals.

The study entitled “Cooperative information management and decision support system in Pototan Farmers Multi-purpose Cooperative” by Abadiano, Ezel Mark ( 2013). Management of information in cooperatives that invests in different types of businesses requires numerous processes to guarantee the smooth flow of business. Handling this manually takes an ample amount of time and manpower, which can be lessened by utilizing the aid of software applications and networking. The researchers of this study, entitled “Cooperative Information Management and Decision Support System of Pototan Farmers Multi-Purpose Cooperative”, implements agile method as the systems development lifecycle model. Consisting of the following steps: planning/requirement analysis, design, development, testing, implementation, and operational maintenance with a monitoring stage after every step to minimize errors.

This study focuses on the storage and retrieval 3\*of data and information, monitoring of sales and inventory, management and maintenance of individual members records, dividends computation, report generation and a decision support system that generates data to aid in the immediate approval of loans. It also utilizes wireless local area network to transmit data in between the main office and the drug store, grocery, and hardware of the cooperative.

The outcome of the development indicates that the Pototan Farmers Multi-Purpose Cooperative will benefit in the proposed system through its ease of use and efficiency in managing data. In conclusion to this, it is recommended that further enhancement of the study such as inclusion of flexible maintenance setting and a wider coverage of the decision support system to include the sales and inventory will greatly improve the cooperative.

**Foreign Studies**

According to an article entitled “Smart Decision-Support System for Pig Farming” by Hao Wang, Boyang Li, Haoming Zhong, Ahong Xu, Yingjie Huang, Jingfu Zou, Yuanyuan Chen, Pengcheng Wu, Yiqiang Chen, Cyril Leung, and Chunyan Miao (2022). There are multiple participants, such as farmers, wholesalers, retailers, financial institutions, etc., involved in the modern food production process. All of these participants and stakeholders have a shared goal, which is to gather information on the food production process so that they can make appropriate decisions to increase productivity and reduce risks. However, real-time data collection and analysis continue to be difficult tasks, particularly in developing nations, where agriculture is the primary source of income for the majority of the population. In this paper, we present a smart decision-support system for pig farming. Specifically, we first adopt rail-based unmanned vehicles to capture pigsty images. We then conduct image stitching to avoid double-counting pigs so that we can use image segmentation method to give precise masks for each pig. Based on the segmentation masks, the pig weights can be estimated, and data can be integrated in our developed mobile app. The proposed system enables the above participants and stakeholders to have real-time data and intelligent analysis reports to help their decision-making.

A review of the study entitled “A review of visualizations in agricultural decision support systems: An HCI perspective” by Francisco Gutiérrez, Nyi Nyi Htun, Florian Schlenz, Aikaterini Kasimati, and Katrien Verbert (2019). Decision Support Systems (DSSs) are used in precision agriculture to provide feedback to a variety of stakeholders, including farmers, advisers, researchers, and policymakers. However, increments in the amount of data might lead to data quality issues, and as these applications scale into big, real-time monitoring systems the problem gets even more challenging. Visualization is a powerful technique used in these systems that provides an indispensable step in assisting end-users to understand and interpret the data. In this paper, we present a systematic review to synthesize literature related to the use of visualization techniques in the domain of agriculture. The search identified 61 eligible articles, from which we established end-users, visualization techniques and data collection methods across different application domains. We found visualization techniques used in various areas of agriculture, including viticulture, dairy farming, wheat production and irrigation management. Our results show that the majority of DSSs utilize maps, together with satellite imagery, as the central visualization. Also, we observed that there is an excellent opportunity for dashboards to enable end-users with better interaction support to understand the uncertainty of data. Based on this analysis, we provide design guidelines towards the implementation of more interactive and visual DSSs.

Another study entitled “Decision support systems for agriculture 4.0: Survey and challenges” by Zhaoyu Zhai, José Fernán Martínez, Victoria Beltran, and Néstor Lucas Martínez (2020). Undoubtedly, high demands for food from the world-wide growing population are impacting the environment and putting many pressures on agricultural productivity. Agriculture 4.0, as the fourth evolution in the farming technology, puts forward four essential requirements: increasing productivity, allocating resources reasonably, adapting to climate change, and avoiding food waste. As advanced information systems and Internet technologies are adopted in Agriculture 4.0, enormous farming data, such as meteorological information, soil conditions, marketing demands, and land uses, can be collected, analyzed, and processed for assisting farmers in making appropriate decisions and obtaining higher profits. Therefore, agricultural decision support systems for Agriculture 4.0 has become a very attractive topic for the research community. The objective of this paper aims at exploring the upcoming challenges of employing agricultural decision support systems in Agriculture 4.0. Future researchers may improve the decision support systems by overcoming these detected challenges. In this paper, the systematic literature review technique is used to survey thirteen representative decision support systems, including their applications for agricultural mission planning, water resources management, climate change adaptation, and food waste control. Each decision support system is analyzed under a systematic manner. A comprehensive evaluation is conducted from the aspects of interoperability, scalability, accessibility, usability, etc. Based on the evaluation result, upcoming challenges are detected and summarized, suggesting the development trends and demonstrating potential improvements for future research.

The study entitled “Pig Farming in Alternative Systems: Strengths and Challenges in Terms of Animal Welfare, Biosecurity, Animal Health and Pork Safety” by Maxime Delsar, Françoise Pol, Barbara Dufour, Nicolas Rose and Christelle Fablet (2020). In pig production, the widespread conventional indoor system with a slatted floor currently dominates. However, this production system is becoming less socially acceptable. In addition to general environmental protection issues, animal welfare, the absence of suffering and distress, and the management of pain also constitute societal concerns. In this context, alternative production systems are gaining ground. Although they are popular with consumers and other citizens, these alternative systems have their critical points. Here, we reviewed the international scientific literature to establish the state of the art of current knowledge regarding welfare, biosecurity, animal health and pork safety in this type of farming system. In general, alternative farms give pigs the opportunity to express a broader range of behaviours than conventional farms. However, the management of feeding, watering, temperature and predators is often more complicated in these outdoor systems. In addition, biosecurity measures seem to be applied less strictly in alternative farms than in conventional farms, especially in free-range systems, where they are more difficult to implement. On the other hand, pigs kept in these farming systems seem to be less affected by respiratory diseases, but parasitism and piglet crushing (in farrowing units) both remain a real challenge. Furthermore, the higher prevalence of many zoonotic pathogens in these farms may represent a risk for human health.

The study entitled “e-Agriculture: Developing a Decision Support System for Precision Farming” by Loukas Konstantinou (2019). The present thesis, entitled “e-Agriculture: Developing a Decision Support System for Precision Farming”, was pursued by Loukas Konstantinou, an 8th-semester student of the Department of Communication and Internet Studies at the Cyprus University of Technology, under the supervision of Dr. Labros Labrinos and was completed in May, 2018. This research belongs to the field of Information and Communication Technologies but takes on a cross-disciplinary approach, since it engages the field of agriculture and specifically the farming sector. The purpose of this study is to develop an effective Decision Support System that gathers weather based and agricultural data, formulates them and displays the most prominent results, prompting the user to take the appropriate action. By achieving this goal, this research also contributes to Precision Agriculture and sustainable food production. The overall Decision Support System comprises hardware and software elements and it is broken down into a pair of activities. Each activity consists of two smaller parts for better management. The methodology that was adopted for the purposes of the current study is quantitative, while the method is the experiment. For accomplishing this experiment, particular equipment was employed for gathering the data, a platform was utilized for storing the information and an Android application was developed for formulating and presenting the most crucial results back to the user. Additionally, as far as the outcomes are concerned, the Decision Support System has been fully developed and formed, according to the comprehensive and detailed system design, composition and arrangement of the various components. A complete testing of the system in actual farmlands and with farmers or farming consultants was not possible due to time constraints. Nevertheless, the proposed Decision Support System is available for deployment and usage.

**Synthesis**

The reviewed and presented literature and research findings have significant bearings on the current research. The study also provided the researcher with very relevant and essential insights.

The researchers found different studies there is DSS for pig farming, farming in general, agriculture, and a study about pigs. Which all of the foreign and local studies will in the development of the current study, in building a DSS for pig farming. The article entitled “Smart Decision-Support System for Pig Farming” is quite similar to the current study, both want to increase productivity and reduce risks. The difference is that the current study is not using camera to identify every each one of the pigs, the current study uses only the app to help decision the owner or user.

A review of the study entitled “A review of visualizations in agricultural decision support systems: An HCI perspective” this study reviews DSSs visualization, the study concludes that DSSs utilize maps, together with satellite imagery, as the central visualization. The current study aims to create DSS for pig farm, the study will help the researchers to give an idea for the design of the app.

The study entitled “Pig Farming in the Philippines: How to Raise Fattening Pigs” it talks about how to raise fattening pigs the similarity to current study is that it both discuss information about pigs, the difference is that “Pig Farming in the Philippines: How to Raise Fattening Pigs” does not have DSS aspect like the current study.

The study entitled “Decision support system for richdess poultry and egg farm” by Mark Edmund I Legaspi and “A Decision Support System for Urban Agriculture Using Digital Twin: A Case Study With Aquaponics” by Adam Ghandar, A. Ahmed, is quite like the current study. Both want to have a Farm Management Information Systems that can provide decision support to achieve sustainability, optimum efficiency, and effectivity.