

IoT-Based Mushroom Cultivation for Sustainable Farming

Jayrold G. Franco, Josephine B. Blanca, Reymond A. Paculanang, John Mark B. Balingcong, Paul Gene L. Empiales, Kristine T. Soberano

¹Central Philippines State University

Abstract:

Cultivation, Mushrooms, often categorized as vegetables, are biological fungi with significant nutritional and medicinal benefits, including reduced risks of obesity, diabetes, and heart disease. However, traditional cultivation methods often limit yields. To address this, a controlled environment for oyster mushroom growth has been developed in a greenhouse, integrating Internet of Things (IoT) technology. This system utilizes highly sensitive sensors to monitor temperature, humidity, and CO₂ levels, as well as a disease sensor to detect potential pathogens. Real-time data analysis enables the system to activate actuators, maintaining optimal growth conditions and resulting in high and consistent yields. IoT integration facilitates remote monitoring and control, allowing for iterative development based on feedback and testing. This approach also enables rapid prototyping and adaptation to dynamic changes in requirements. Furthermore, the system was evaluated against the ISO 25010 standard, assessing key dimensions such as functional suitability, performance efficiency, usability, reliability, security, compatibility, maintainability, and portability. The evaluation results confirmed the system's quality and effectiveness in optimizing mushroom farming, demonstrating significant success in both technological implementation and development.

Keywords: Environmental, Conditions, Disease, Prediction, Monitoring, Sustainable

Date of Submission: 12-10-2025

Date of acceptance: 26-10-2025

I. INTRODUCTION

In recent years, the agricultural sector has witnessed significant technological advancements, resulting in innovative solutions that enhance farming practices and increase productivity. One area that has received considerable attention is mushroom cultivation, which holds tremendous potential in terms of its nutritional value and medicinal properties (El-Rammady et al., 2022). With the growing demand for mushrooms in both domestic and international markets, optimizing the farming process is essential to ensure efficient production and high-quality yields. The oyster mushroom (*Pleurotus ostreatus*) is a widely cultivated culinary mushroom known for its rich nutritional profile and therapeutic bioactive compounds. Belonging to the class Basidiomycetes and the family Pleurotaceae, this macro fungus is considered one of the most important commercially cultivated mushrooms globally. However, mushroom growers often face challenges from mushroom diseases of bacterial and fungal origin. While the number of commercial mushroom farms is increasing, growers have encountered serious challenges caused by various viral infections due to contamination from human

intervention. Fungal viruses, known as mycoviruses, persistently infect fungal taxonomic groups, including plant pathogenic fungi and mushrooms.

Growing mushrooms in a controlled environment presents several challenges for producers. The costs associated with developing the necessary infrastructure, such as humidity control systems and air-conditioned rooms, can be a significant barrier, particularly for new and small-scale farmers. Additionally, the high energy consumption and associated costs incurred by constant monitoring and regulation of environmental conditions can impact profitability. Despite these challenges, there is a need for an artificial system to provide an optimal growing environment for mushroom cultivation (Rahman et al., 2022). Maintaining optimal environmental factors, such as temperature, humidity, light, and CO₂ concentration, is crucial for achieving a satisfactory rate of production. These factors require more precise control given the specific demands of various mushroom species. By optimizing environmental parameters, mushroom growers can enhance crop yields, quality, and consistency, ultimately boosting productivity and profitability (Jiazheng et al., 2022). An IoT-Based Mushroom Cultivation for Sustainable Farming is intended to address these challenges. This system will provide a completely controlled temperature and humidity environment, regardless of external conditions. Sustainable techniques combined with advanced technology will reduce labor costs for growers, increase yields, and reduce production costs. The system contributes to the success and sustainability of mushroom production by enhancing production capabilities.

II. OBJECTIVES OF THE STUDY

This study aims to develop an IoT-Based Mushroom Cultivation for Sustainable Farming.

Specifically it aims to:

Develop a system with the following features:

- 1.1 Design and Integrate sensors to detect temperature, humidity, CO2 levels, soil moisture, and light intensity, providing comprehensive data for optimal growing conditions.
- 1.2 Implement an IoT-based oyster mushroom cultivation system, utilizing a mobile application for disease detection alongside remote environmental monitoring and automated control, enabling optimized and sustainable growth and Predict the Harvest date for the sustainable farming.
2. Assess the system's efficiency in resource utilization (water and energy consumption), quantify the reduction in waste, and evaluate the decrease in manual labor at Brgy. Salvacion, Murcia.
3. Provide a solution that minimizes contamination and human intervention, reduces labor requirements, and establishes a controlled environment for oyster mushroom cultivation.
4. Evaluate the system using ISO 25010.
5. Determine the usability of the system using Computer System Usability Questionnaire (CSUQ).

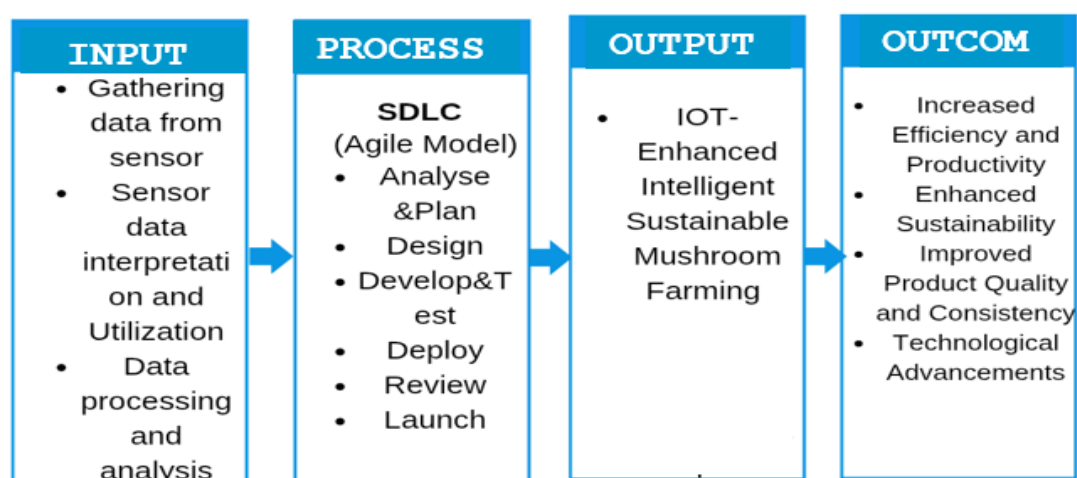


FIGURE 1. CONCEPTUAL FRAMEWORK

CONCEPTUAL FRAMEWORK OF THE STUDY

This conceptual framework for IoT-Based Mushroom Cultivation for sustainable farming aims to integrate cutting-edge technology to enhance productivity and reduce environmental impacts. This integration emphasizes closed-loop systems with low wastage footprints and low external resource input, focusing on resource efficiency. Predictive analyses of historical data lead to proactive interventions in disease management and yield forecasting, incorporating sustainability considerations throughout the process. Ultimately, the framework focuses on developing a self-tuning data ecosystem for mushroom growing, achieving ecological balance with economic viability.

III. MATERIALS AND METHODS

Research Design

This researcher used a Descriptive and Developmental research design in this study. It specifically intends to determine the effectiveness, feasibility and Usability of the proposed system which is IoT - Based Mushroom Cultivation for Sustainable Farming in Brgy. Svacion Murcia Negros Occidental.

This study focused on the transformation process of old manual mushroom cultivation into an IoT-Based Mushroom Cultivation for sustainable farming the main goal is to develop an IoT-Based and AI integrated platform that can optimize mushroom production through environmental parameters because this design would allow for a systematic exploration in the whole development process from conceptualization to implementation and evaluation.

The descriptive component of this study explore the modern mushroom farming and an identification of key obstacles with regard to efficiency, sustainability, and environmental control, key data for knowing just what much call for technological intervention; while the developmental portion concerned the building and improvement of an intelligent mushroom farming system. It would include the employing IoT devices in a real-time mode for the acquisition of temperature, humidity, CO2 levels, and disease indicators; the developing of data analyzing, for control of the environment, and for predictive modeling; and lastly the implementation and testing

of the system in a controlled environment to test the effectiveness of such system. This investigation was meant to establish that also advanced technology can allow sustainable, efficient production of mushrooms. By manipulated growing conditions, independent of outside environmental variations, such research sought to provide models for modernizing agricultural practices and promoting sustainable food production.

IV. RESEARCH DESIGN

A. DATA GATHERING PROCEDURE

The assessment of system quality by three IT professionals from two universities and industry, on the other hand, was conducted within the framework of the ISO 25010 Software Quality Model for evaluating its usability and maintainability in wider deployment. Evaluating the system against Quality in Use, purposive sampling was adapted by the researchers. Because the developed system was in the "Alpha" stage initial stage of development the researchers opted to limit the number of respondents to allow better control of the testing carried out. 30 mushroom growers in Barangay Salvacion, Murcia, were selected via purposive sampling. This technique was employed to target respondents possessing key characteristics pertinent to the research. The researchers ensured complete transparency by providing all participants with detailed information concerning the study's purpose, methods, benefits, privacy measures, and researcher identities.

DATA ANALYSIS

For the assessment of the Intelligent Sustainable Mushroom Farming system, the researchers applied quantitative methods using mainly the mean, which was used as a criterion for survey on vital software quality attributes. The evaluation process was carried out in accordance with Evaluation of the Quality of the System Based on ISO 25010 standard. Specified calculations of mean were for metrics correcting the accuracy aspect of the system in producing the right and expected output; reliability relates to consistency and steadiness of the system across time; efficiency reports on the performance of the system in terms of resource utilization and time responses; integrity delved into the aspects of the system in safeguarding the data against unauthorized access; usability measures ease- of-use and satisfaction of users with the system interface; and maintainability concerns how easily the system can be modified and repaired. Mean emerges as an understandable and clear measure of performance for the system across these essential quality attributes, making quantitative assessment of its effectiveness and conformance to the ISO 25010 standards possible.

RESPONDENT

To ensure that the Intelligent Sustainable Mushroom Farming system was evaluated thoroughly, a heterogeneous study sample was identified. Such respondents were classified into three different occupational groups: Experts, Mushroom Growers, and Students. Experts were specifically chosen due to their knowledge and experience in the field, offering such input on the technical aspects and possible impact of the system. Most importantly, Mushroom Growers provided feedback on the usability and effectiveness of the system and hence are seen as the practical users of such technologies in actual work environments. Being future potential stakeholders, Students gave their view on the issues of accessibility and educational value of the system. Following, the table summarizes the sample size for each respondent category, including the number of participants under each occupational group.

Table 1. Summary of Evaluators during the Initial Testing

Evaluators Classification	Number of Evaluators
Experts	3
Mushroom Growers	21
Student	9

SAMPLING TECHNIQUE

This research applied a stratified sampling design so as to represent and widely evaluate the Intelligent Sustainable Mushroom Farming system. The sampling method divided the 33 respondents into different occupation-based strata, namely: 3 Experts, 21 Mushroom Growers and 9 Students. Both stratification aimed to capture diverse perspectives and experiences related to the system development and deployment. The study sample included adequate representation from each occupational group, as contribution and perspectives are typically related within those representative samples. After stratification. Participants were selected from each stratum. With the intention of reflecting the proportion of those groups within the larger population.

RESEARCH INSTRUMENT

Prior to the onset of system development, it was necessary to design a survey questionnaire intended for the identification of tools and technologies suitable for community use. The rigorous examination of the system's quality against the ISO 25010 Software Quality Model examined various attributes of the system like Functional Suitability, Reliability, Performance Efficiency, Operability (i.e. Usability), Security, Compatibility, Maintainability, and Portability. The researchers attempted to evaluate user experience on the basis of five quality-in-use characteristics according to ISO 25010: Effectiveness, Efficiency, Satisfaction, Safety, and Usability. The merger of both was to evaluate both the technical quality of the system as well as the usability within the community.

Before the development of the system the researchers conducted a simple survey to determine the most common problems that need to address in mushroom production at Barangay Salvacion, Murcia.

Table 2. Reveals that Mushroom producers consider their biggest challenge contamination (38%), followed by environmental control (27%) and disease (22%). The other problems account for 13%. It therefore emphasizes the need for sanitation care, precision environmental management, and control of disease in mushroom cultivation.

Table 2. Summary of the Responses of the Respondents on the Initial Interview.

Statement	Contaminat ion	Environmental Control	Disease	Others
What is your biggest challenge in mushroom production.	38%	27%	22%	13%

Intelligent mushroom for sustainable farming was developed by the system really works in emerging technologies for environment monitoring and data management. the system has proved its efficiency in parsing and assembling data from sensors for important environmental factors such as temperature, humidity, CO2 levels, and light. With the algorithm developed by the researchers, the system is capable of analyzing sensor readings intelligently to provide near-real-time

information from the growing environment. It also allows end-users to store reported cases, and graphs can be generated to give decision support for growers. Moreover, it adopts a process of treating data that were uncategorized through keyword analysis and requesting human help for better classification to guarantee continuous learning and improvement. It closely monitors, analyzes, and presents environmental information to users and guides them on effective growing practices and sustainable mushroom farming.

D. SYSTEM DESIGN

A. SOFTWARE DEVELOPMENT LIFE CYCLE

To evaluate the system, the research utilizes a software engineering framework.

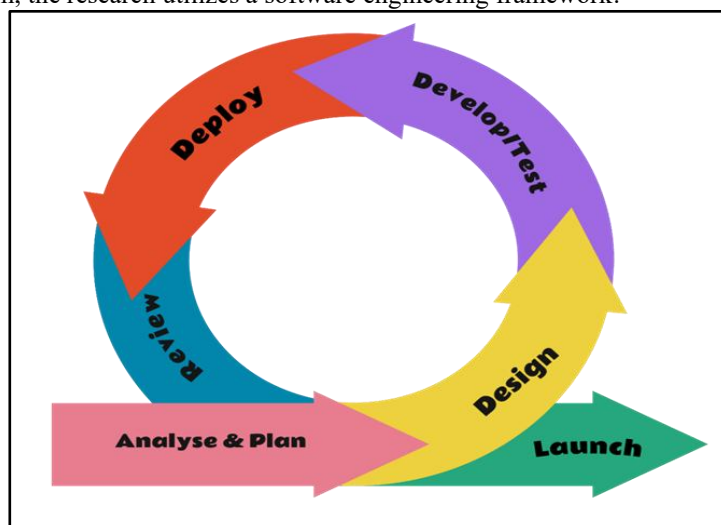


Figure 1. Software Development Life Cycle (SDLC)

The In the evaluate the system, the research utilized a software engineering framework. According to Gupta, Software Development Life Cycles (SDLCs) provide a structured approach for high-quality, cost-effective software development, recognizing that development is a complex process. Without a well-organized plan, development can be inefficient and unreliable. Definitions of activities and tasks are established to ensure a precise sequence of operations and act as a template for further modeling of development. Their merits and demerits are weighed for clear distinction and a comprehensive overview for efficient application. The SDLC undergoes repeated cycles of development, demonstration, and refinement until it aligns with the specified requirements. Thorough testing and deployment follow when those specifications are met. This study aimed to establish a baseline, which was conducted with researchers in Barangay Salvacion, Murcia, Negros Occidental. The gathered data correlated environmental parameters, such as temperature, humidity, CO₂ level, light intensity, soil moisture, disease prediction equations, and harvest prediction.

B. SOFTWARE DEVELOPMENT PHASES

1. PLAN

In the planning phase, the research team conducted a comprehensive requirement analysis to ensure the IoT-based mushroom cultivation system aligns with the specific needs of farmers in Brgy. Salvacion, Murcia. This involved direct consultations with local farmers, agricultural extension officers, and community leaders to understand their current cultivation practices, challenges, and desired outcomes. This analysis focused on identifying key environmental parameters crucial for optimal mushroom growth, such as temperature, humidity, light Intensity, and CO₂ concentration for Environment control for Harvest Prediction and for the disease detection mobile application.

To manage the project effectively, a Scrumban board was implemented. User stories, reflecting the farmers' needs and system functionalities, were created and added to the board. Prioritization was determined by urgency, importance, and dependency, facilitating a continuous flow of work.

2. DESIGN

The next activity after the requirements collection and analysis stage in the SDLC process is prototype design for every system that would be developed. At this stage, the intricate diagrams and interface prototypes are also created to specify that the system is well structured, easily used, and consistent with its designated purpose.

3. DEVELOP

The IoT-based mushroom cultivation system was built following the prototype and design specifications. The process was divided into modules for effective implementation, including sensor integration of DHT22 temperature and humidity sensor, MH-Z19 CO₂ sensor, and light intensity sensors with the ESP32 to monitor in real-time. A cloud-based database was established to store environmental data, farmer inputs, disease detection results, and historical reports for analysis and future reference. A user-friendly web interface was developed to allow farmers to interact with real-time data and prediction harvest for sustainable farming. The disease detection feature was developed as a mobile application using JavaScript in Android Studio. To detect diseases, farmers first capture an image of a mushroom using their smartphones. The application then analyzes the image, provides a diagnosis, and suggests appropriate solutions to address the detected issue.

4. TESTING

The reliability and functionality of the system components. Unit testing was performed on each module, including sensor integration, database connectivity, web application features, and the disease detection mobile app. Integration testing ensured seamless data flow and interaction between different system components, while system testing evaluated overall performance in a controlled environment. Finally, user acceptance testing (UAT) was conducted, where respondent in Brgy. Salvacion, Murcia, used the system and provided feedback on usability and effectiveness.

5. DEPLOY

The system was deployed. IoT sensors and devices were installed in mushroom farming locations, and the web application was made accessible to farmers through cloud hosting. The mobile application was deployed to Android devices for real-time disease detection.

6. LUNCH

The system was officially launched to respondent. A support framework was established for system maintenance, updates, and troubleshooting. Future improvements and potential expansions will be considered based on user feedback and system performance.

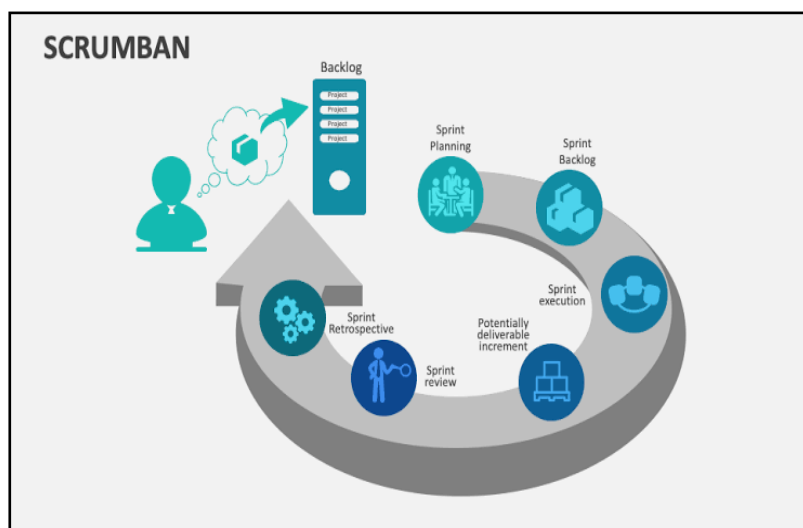


FIGURE 2. SCRUMBAN BOARD

The Scrumban board is a visual workflow management tool that brings clarity and efficiency to project execution. It fosters transparency by offering a shared, real-time view of tasks, enabling seamless team collaboration. Additionally, it cultivates a culture of continuous improvement, empowering teams to adapt and refine their workflows. Furthermore, it synchronizes physical and information flows, ensuring alignment and efficient task completion, particularly in complex environments 2(Bertolini et.,al 2024).

FIGURE 2: SAMPLE GRAPH PRODUCED BY THE SYSTEM AFTER PAPER SURVEY REPORT

The analytical aspects of the developed system were demonstrated within a controlled environment via a simulated scenario. A sample graph that spatially represents the system's outputs from analyzed data from paper surveys demonstrates the above assertions. It is worth noting that the present data are simulated and only for demonstration purposes and do not reflect actual human responses.

To preserve the integrity of the simulation and allow the investigators to trace results accurately, selected participants had to register in the system, providing their names, phone numbers, and addresses. The whole registration process was aimed at avoiding careless errors and helping identify survey respondents. Also, address information was collected so as to locate respondents in cases where actual location reporting was omitted in their simulated survey response.

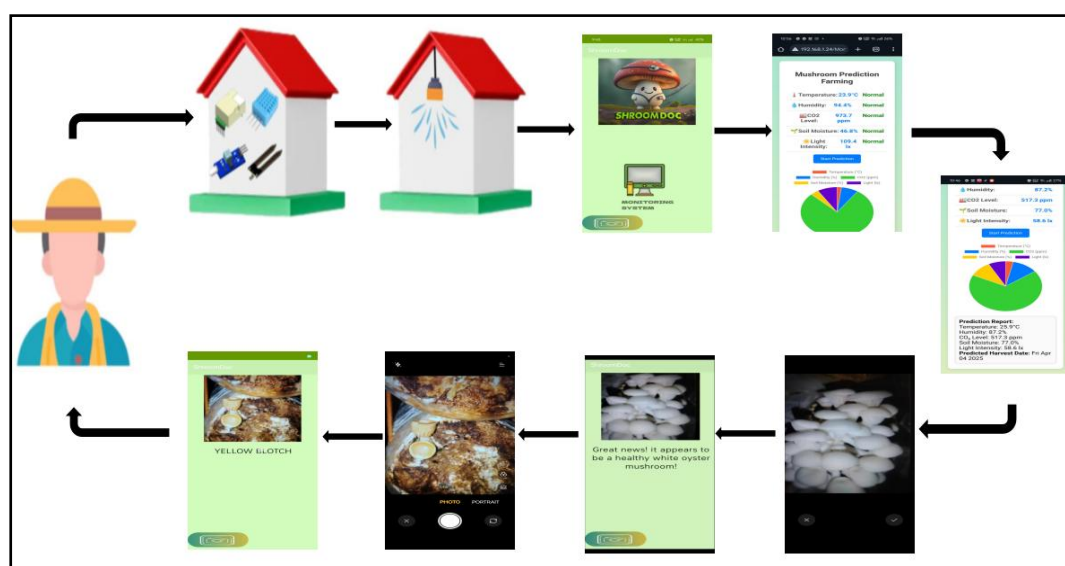
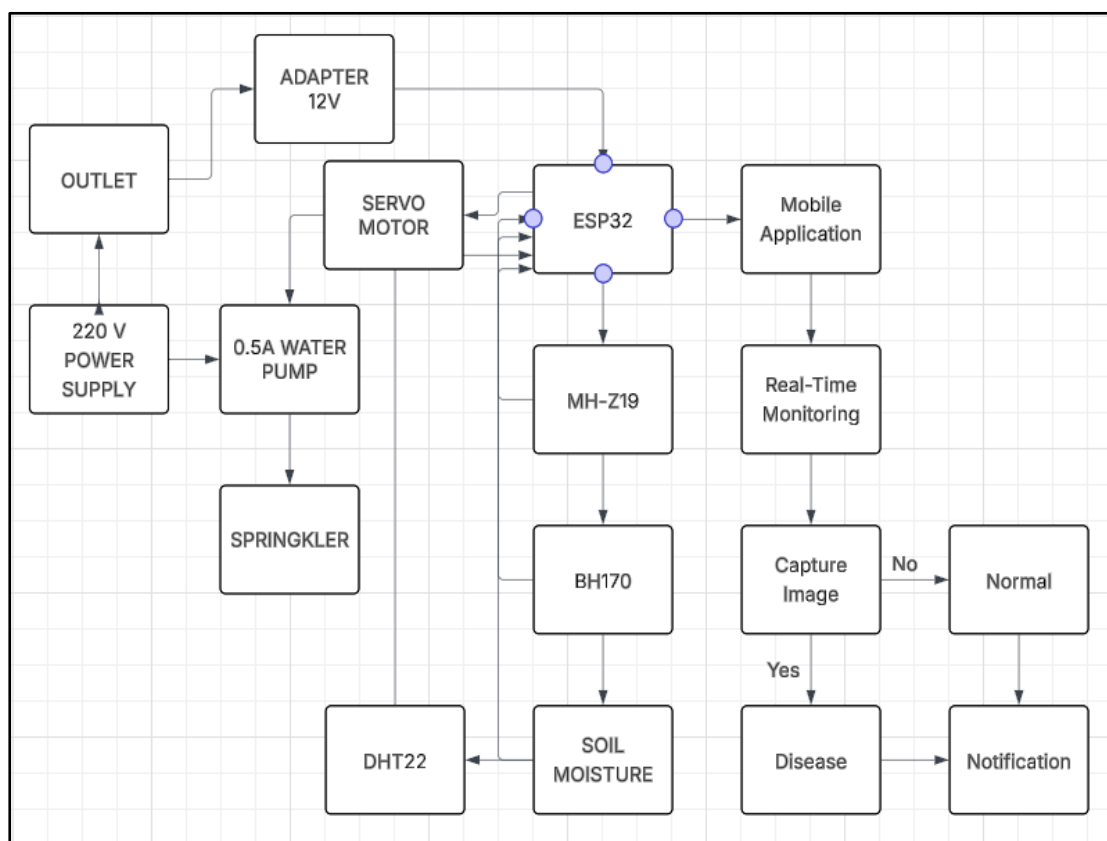


FIGURE 3: SYSTEM ARCHITECTURE OF INTELLIGENT MUSHROOM FOR SUSTAINABLE FARMING

The community was crucial in this project as its members participated actively in the Intelligent Mushroom for Sustainable Farming simulation. proved relevant for testing and demonstrating the system's functionality in a realistic but simulated environment. This participation allowed researchers the opportunity to collect significant project data and insights that ultimately assisted in improving and developing sustainable farming technologies. In participating in the simulation, community members contributed toward the well-being of the project while keeping an open door to experience another door for possible innovative agriculture sustainability.



3.1 SYSTEM DATA FLOW

The IoT-based mushroom for sustainable farming system integrates environmental monitoring, irrigation control, disease detection, and harvest date prediction into a centralized, automated platform. At its core, the system is powered by an ESP32 microcontroller supplied via a 12V adapter, while a separate 220V power supply operates a 0.5A water pump. This pump is controlled indirectly through a servo motor, which the ESP32 manipulates to physically switch the pump on or off, ensuring electrical isolation between high-voltage and low-voltage components. The pump delivers water through a sprinkler system to maintain optimal substrate moisture levels. The ESP32 continuously collects environmental data from a DHT22 sensor (temperature and humidity), a soil moisture sensor, an MH-Z19 CO₂ sensor, and a BH1750 light intensity sensor. This data is processed in real time to manage growing conditions and is also transmitted to a mobile application for live monitoring. When abnormal environmental readings are detected, the system prompts the user via the mobile app to capture an image of the mushroom using the phone's camera. This image is then analyzed within the app to detect signs of disease, and the environment is classified as either "Normal" or, if disease is detected, a notification is sent immediately to alert the user. Additionally, the system predicts the optimal farming or harvest date based on real-time environmental data, allowing the user to plan and optimize harvest cycles more effectively. This smart system enhances productivity, reduces resource waste, and promotes sustainable practices in mushroom farming.

2.2 BLOCK DIAGRAM

This system uses an ESP32 to automate mushroom growing. Sensors monitor the environment, and the ESP32 controls MH-Z19, light Intensity, humidity, Temperature and Predict the harvest date for sustainable farming. A mobile application takes pictures for disease detection. Data is sent to the Arduino cloud, allowing farmers to monitor and control the system remotely via their phones.

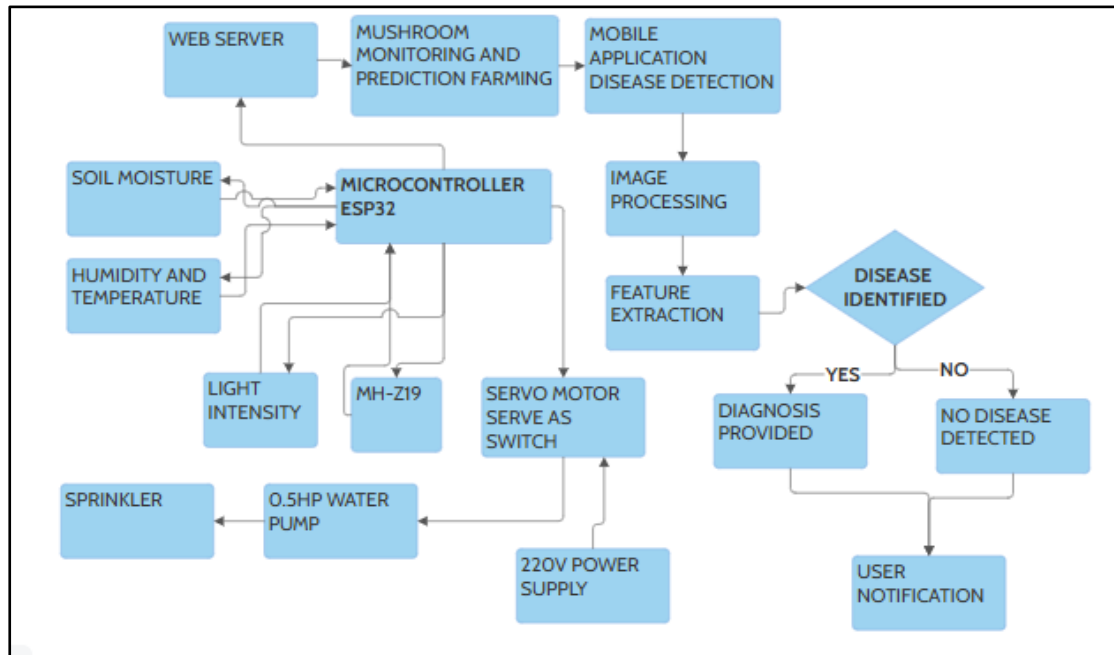
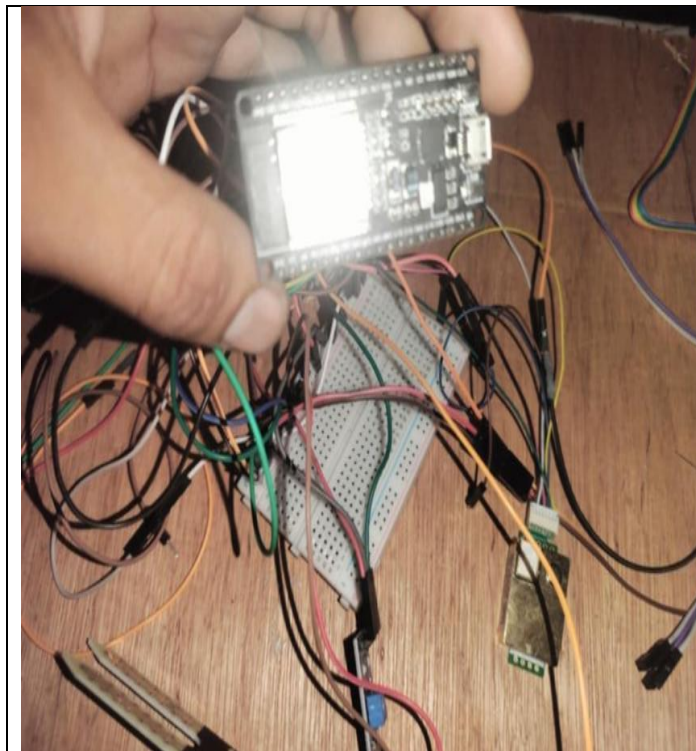


FIGURE 4. BLOCK DIAGRAM

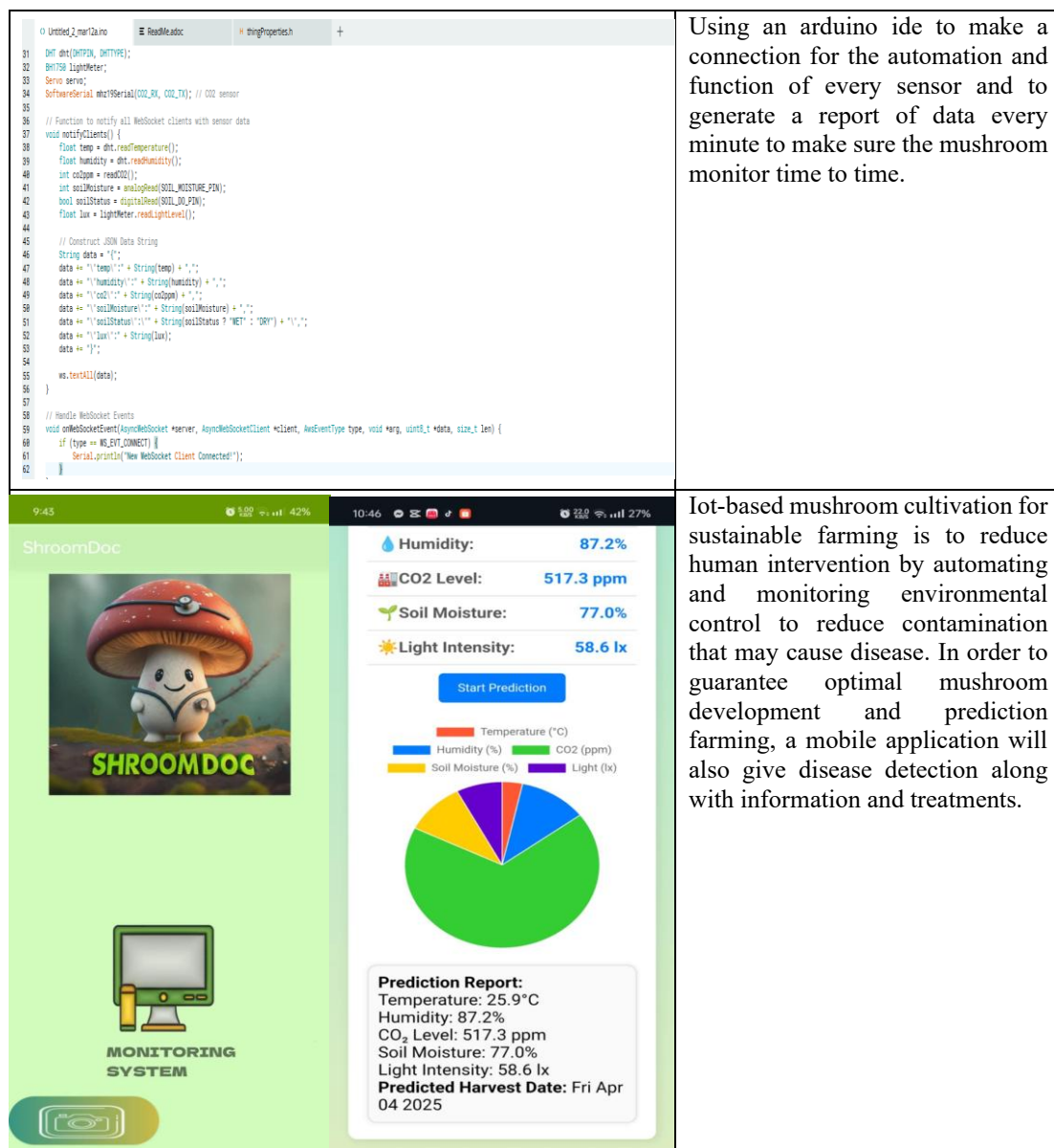
MONITORING AND PREDICTION FARMING MOBILE APPLICATION DISEASE DETECTION

2.3 DEVELOPMENTAL CONSTRUCTION

The developmental construction of an IoT-based mushroom cultivation system for sustainable farming involves a multi-faceted approach, integrating hardware, software, and data management to create a responsive and efficient growing environment.



Attached all wiring from esp32 wroom to co₂ gas sensor to monitor and regulate carbon dioxide (co₂) levels, dht11 to monitor temperature and humidity, bh1750fvi is a light intensity sensor that measures ambient light in lux (lx), soil moisture to maintain the correct water content in the substrate or growing.



MATERIALS

MH-Z19 is a non-dispersive infrared (NDIR) CO₂ sensor ideal for monitoring carbon dioxide levels in mushroom cultivation. Maintaining the right CO₂ concentration is crucial for optimal growth, preventing contamination, and triggering fresh air exchange when necessary.

BH1750 FVI is a digital light sensor that measures illuminance in lux (lx). While mushrooms do not rely heavily on light for growth like plants, light plays a crucial role in shaping mushroom morphology, and ensuring healthy development triggering fruiting.

Soil Moisture is crucial in Mushroom Farming to ensure the substrate remains adequately hydrated mycelial growth and fruiting. Too much or too little moisture can lead to yields, contamination, or stunted growth.

ESP32-WROOM is a powerful Wi-Fi and Bluetooth micro-controller ideal for automating and monitoring mushroom farming. It enable real-time data collection from sensors and allows remote monitoring via a web dashboard or mobile app.

DHT22 is a digital sensor that measures temperature and humidity, two crucial environmental factor for mushroom growth. Maintaining optimal conditions ensures health.

Servo motor is used to switch on/off the automation by controlling mechanisms such as valves, switches, or ventilation systems, ensuring precise and efficient operating in the mushroom cultivation process.

0.5A water pump is ideal for automated watering in mushroom farming, ensuring the substrate stays at the optimal moisture level while preventing over-watering and contamination.

Mobile phone is used for Monitoring all sensor in mushroom house to Predict the harvest date and for disease detection using an application to capture a disease.

2.4 USER INTERFACE DESIGN

The oyster mushroom app features a user-friendly dashboard offering growers a step-by-step guide, diagnostic image uploads, problem-solving assistance, environmental monitoring (temperature, humidity, CO₂, and soil moisture), and harvest date prediction.

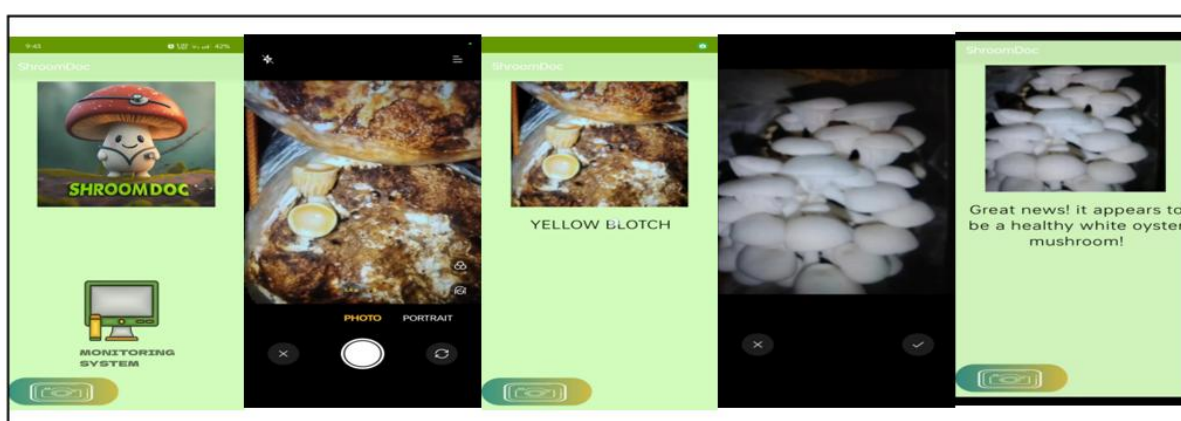


FIGURE 5. MOBILE APPLICATION DISEASE DETECTION

Is a visual guide for diagnosing oyster mushroom problems, showing pictures of healthy and unhealthy mushrooms, diseases, pests, and environmental issues to help users identify and address cultivation problems. Provides visual solutions to oyster mushroom problems, showing users how to fix issues like mold, pests, or environmental imbalances identified in the diagnosis stage.

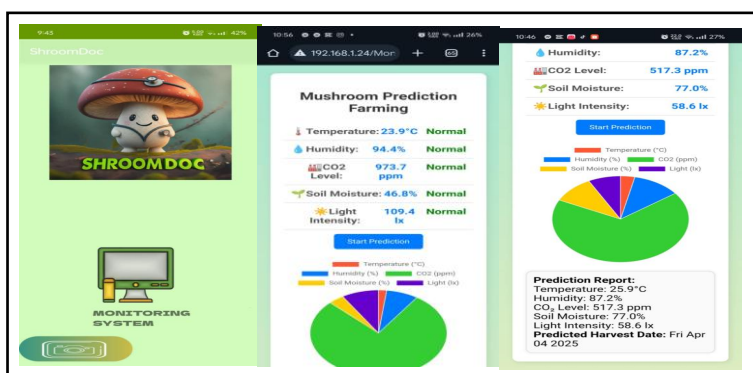


Figure 6. Mobile application Monitoring and prediction farming

Visual displays real-time environmental data such as temperature, humidity, CO₂ Level, Light Intensity of the mushroom growing area, enabling users to monitor conditions and see the harvest prediction Date.

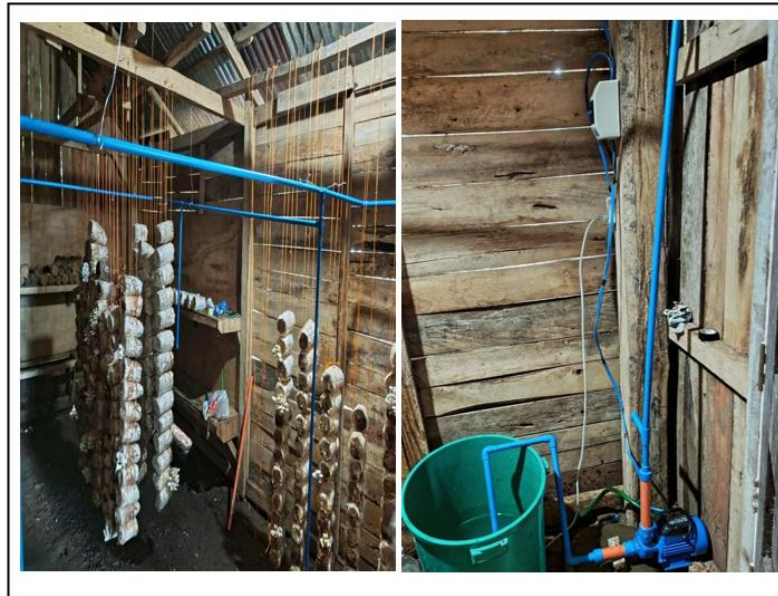


FIGURE 7. IMPLEMENTATION OF THE SYSTEM

V. RESULTS AND DISCUSSION

An IoT-based mushroom cultivation system for sustainable farming triggers automated responses when it detects a hot environment or predicts disease, utilizing sensors and machine learning to monitor and analyze environmental data. Upon detecting high temperatures, the system activates ventilation, adjusts humidity, and sends alerts, while disease prediction prompts environmental adjustments and grower notifications based on pattern recognition and historical data. By combining these functionalities, the system proactively manages environmental challenges and disease risks, ensuring optimal growing conditions and promoting sustainable mushroom production.

TABLE 3. FEATURES OF THE DEVELOPED SYSTEM

Criteria	Pre-Alpha Testing	Alpha Testing
System accurately parses and categorizes environmental sensor data (temp, humidity, CO ₂ , light)	95%	100%
System sends alerts to designated personnel regarding out-of-range environmental readings	90%	100%
System stores environmental data to generate decision support graphs/reports	70%	100%
System analyzes uncategorized environmental data trends and requests human input for refinement	85%	100%

It reveals that Mushroom producers consider their biggest challenge contamination (38%), followed by environmental control (27%) and disease (22%). The other problems account for 13%. It therefore emphasizes the need for sanitation care, precision environmental management, and control of disease in mushroom cultivation. An intelligent system for sustainable mushroom farming has been developed, leveraging emerging technologies for environment monitoring and data management. This system effectively parses and assembles data from sensors measuring critical environmental factors such as temperature, humidity, CO₂ levels, and light. Utilizing researcher-developed algorithms, the system intelligently analyzes sensor readings to provide near-real-time information about the growing environment. End-users can store reported cases, and the system generates graphs to provide decision support for growers. Furthermore, it incorporates a process of categorizing previously uncategorized data through keyword analysis and, when necessary, requesting human input for enhanced classification, ensuring continuous learning and improvement. By closely monitoring, analyzing, and presenting

environmental information, the system guides users towards effective growing practices and sustainable mushroom farming.

VI. CONCLUSION AND RECOMMENDATION

As per tests and assessments conducted to the system after modeling simulation, the system contains all the necessary functions mentioned with 92 percent ratings on all features during Alpha testing. Thus, this is a clear indication that the system is fully ready for Beta Testing, which will involve real testing of the developed system. From the analysis of the system after the simulation of the model, it has proved itself efficient in providing all functions required, with all features rated 92% in Alpha testing. This is quite an indication of the readiness of the system for Beta Testing, which will include actual use of the fully developed system. The evaluative result of the IT experts has given the verdict that the system is of Good Quality against the eight (8) parameters of ISO 25010 Software Quality Model. Further, the system was also estimated to be beneficial by these five characteristics of ISO 25010 Quality in Use. Thus, the conclusion of the researchers is that the stated objectives of this study were satisfied as it coincided to the requirements and needs of the intended users.

The main aim of this study is the promotion of mushroom growers in Brgy. Salvacion, Murcia, through an automated environmental control system for enhanced oyster mushroom cultivation. The system continuously measures temperature and humidity inside the mushroom house and triggers automated watering and humidification to sustain the optimum growing conditions. An important feature of the system allows it to prevent overwatering and higher moisture, which trigger fungal contamination, by deactivating the sprinkler when the temperature remains within the optimal range. Thus, with limited human intervention and a stable environment almost always guaranteed, mushroom cultivation under this automated system will be made more efficient for higher production and better-quality oyster mushrooms for the local growers. This feasible solution will boost production and profits of the community. The main contribution of this research consists of the development and implementation of an automated environmental control system specifically designed to suit oyster mushroom operations in the specific context of Brgy. Salvacion, Murcia. Through integrating continuous monitoring of temperature and humidity with automated water sprinkling and humidification, the

system provides a proportional and consistent environment, thus minimizing the risks of fungal contamination from optimized management of moisture. Also, with reduced human intervention, the system is able to improve efficiency and decrease labor cost concerns among local growers. In effect, this paper presented a practical, scalable solution that can enhance mushroom production, improve product quality, and increase the socioeconomic viability of oyster mushroom farming in the region, thereby giving much direct aid to the livelihood of the community.

With many advantages, this automated mushroom cultivation system will work wonders for the Barangay of Salvacion, Murcia. First, it sustains food security with a consistently produced nutritious food, oyster mushrooms. Second, this increase in production provides the local residents with sustainable economic opportunities, which can directly create new forms of income and enhancement of the local economy. Keeping in mind maximum few hours of labor and efficient resource usage, it further promotes a very efficient and eco-friendly kind of agriculture. Not to add, the constant ideal environment provided by the system reduces risks of crop losses due to environmental changes or fungal contamination, thus providing a much more reliable and predictable harvest. This high-tech system thus augments the success and development of local growers within the area and furthers the advancement of the entire Barangay resilience toward self-reliance and prosperity.

This study has opened new avenues for research due to its developmental-descriptive nature. For example, machine learning algorithms could optimize the system's operation by predicting and adjusting environmental conditions based on historical data and real-time sensor readings. This would allow more room for maneuver for the system under different climatic conditions and stages of growth of the mushrooms. An alternative area of research would be to incorporate other environmental parameters, such as CO₂ levels and light intensity, into the automated control system to improve the growing environment further. Another research idea could be to compare many varieties of mushrooms in the automated system to discover the setting of choice for maximum yield of different species. In addition, the larger economic magnitudes of the system could be further studied to analyze the viability of the system for the wider acceptance of this technology within the Barangay area and beyond. Finally, the research ideas could steer towards sustainability studies of the system in terms of the usage of renewable energy sources for its operation and closed-loop systems of water recycling for reducing damages to the environment.

REFERENCES

- [1]. N. (2023). Cultural studies on mycelia of *Pleurotus ostreatus* (Oyster mushroom). *Mushroom Research*, 32(1), 81-85. <https://doi.org/10.36036/mr.32.1.2023.126319>
- [2]. Bellettini, M. B., Bellettini, S., Fiorda, F. A., Pedro, A. C., Bach, F., Fabela-Morón, M. F., & Hoffmann-Ribani, R. (2018). Diseases and pests noxious to *Pleurotus* spp. mushroom crops. *Revista Argentina de Microbiología*, 50(2), 216-226. <https://doi.org/10.1016/j.ram.2017.08.007>
- [3]. C., G., & H., M. (2024). The economics of production and marketing of oyster mushroom (*Pleurotus ostreatus*) in Bukidnon, Philippines. *Asian Journal of Agricultural Extension, Economics & Sociology*, 42(11), 186-196. <https://doi.org/10.9734/ajaees/2024/v42i112604>
- [4]. Chen, L., Qian, L., Zhang, X., Li, J., Zhang, Z., & Chen, X. (2022). Research progress on indoor environment of mushroom factory. *International Journal of Agricultural and Biological Engineering*, 15(1), 25-32. <https://doi.org/10.25165/j.ijabe.20221501.6872>
- [5]. Effiong, M. E., Umeokwochi, C. P., Afolabi, I. S., & Chinedu, S. N. (2024). Assessing the nutritional quality of *Pleurotus ostreatus* (oyster mushroom). *Frontiers in Nutrition*, 10. <https://doi.org/10.3389/fnut.2023.1279208>
- [6]. Gupta, A. (2021). Comparative study of different SDLC models. *International Journal for Research in Applied Science and Engineering Technology*, 9(11), 73-80. <https://doi.org/10.22214/ijraset.2021.38736>
- [7]. Kadam, P. V., Giram, D. K., Shaikh, S. K., Yadav, K. N., Karanje, A. S., & Patil, M. J. (2023). Pharmacognostic, chemical characterization studies on oyster mushroom (*Pleurotus ostreatus*). *Pharmacognosy Research*, 15(3), 514-523. <https://doi.org/10.5530/pres.15.3.054>
- [8]. Rahman, H., Faruq, M. O., Abdul Hai, T. B., Rahman, W., Hossain, M. M., Hasan, M., Islam, S., Moinuddin, M., Islam, M. T., & Azad, M. M. (2022). IoT enabled mushroom farm automation with machine learning to classify toxic mushrooms in Bangladesh. *Journal of Agriculture and Food Research*, 7, 100267.