

The Effect on Automated Technology of IoT Towards Mushroom Production in Agricultural Industry

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ABSTRACT

The demand for mushrooms is getting higher and the farmers are being pushed to increase their production to meet the demand. With the issue that is being faced by the farmers which is the poor quality of spawn, high labor cost, and lack of latest improved technology, the farmers are unable to produce more mushroom and meet the demand. The implementation of automation technology of internet of things (IoT) towards mushroom production is an important factor to make the production more effective. The development of technology such as IoT is one of the main things that should be implemented towards the mushroom production in order to make it more effective in terms of quality, cost and production. Therefore, this research focused on getting the scientific evidence and proof that the mushroom production would be more effective if there are implementation of automation technology of IoT towards the mushroom production. This research begins with the researcher doing a literature review to identify the relevant factors that are affecting the automation technology of IoT in mushroom production. Next, data collection is being conducted through giving out survey at the company. Thus, this quantitative study is continued by conducting a correlation analysis in order to find out the relationship between automation technology of IoT and mushroom production. To complete the research, a regression analysis generated out from the correlation analysis is determined to measure the IoT implication on automation technology of IoT before and after the implementation in mushroom production. The outcome that is reached in the research are that the automation technology of IoT have a strong and positive relationship with the mushroom production. This means that, the implementation of automation technology of IoT such as light sensor, temperature sensor and humidity sensor will highly benefit the mushroom production. The researcher hope that this research can be a reference for mushroom farmers in Malaysia in order to decide to implement the IoT.

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1. Introduction

Nowadays, mushroom production has become an important sector in small and medium enterprise (SME). Mushroom cultivation can help reduce poverty and strengthen the family livelihood of farmers. One of the edible mushrooms which is the “pleurotus sp.” or most of people known as the oyster mushroom as one of the widely known edible mushroom type in Malaysia. IoT on the other hand, are defined as the network of real-world items that have sensors, software, and other technologies integrated into them with the intention of connecting to and sharing data with other systems and devices over the internet.

There are several real-world issues that can be resolved thanks to the prominent role of sensors and the Internet. Smart cities, smart healthcare systems, smart buildings, smart transportation, and smart environments are a few examples of such applications. Here we can see that the implementation of IoT has brought benefits in various industry. In this project, the IoT implementation on mushroom production has been implemented by several SME company in Malaysia. The implementation of IoT in mushroom production is in the area of monitoring and environment control for oyster mushroom indoor growing. Not only may labor costs be decreased by covering a larger area with an IoT-based remote monitoring system, but production of oyster mushrooms can also be increased by controlling the best environment for growth. Urban farming technology is growing in popularity and has emerged as one of the most promising solutions for safeguarding the food supply due to the need for food and the lack of available land or space for agro-economic activities. In addition, agricultural production is impacted by harsh weather changes and climates, which raises food costs and degrades crop quality. We can see that without the implementation of IoT in the mushroom production there can be many problems with the cultivation process. Mostly the problem is regarding the quality of the cultivation which is really important for mushroom to grow into an edible level. Without proper care of the temperature in while the mushroom is growing, the fungi which is needed before the mushroom to grow won't be high quality and can decrease the quality of mushroom that are growing from the fungi. The monitoring and environment control system has provided the farmers of mushroom to take proper care by providing information of the area where they are cultivating the mushroom.

2. Literature Review

Mushroom production has become something important in many countries. Mushroom production has the ability to turn trash into the healthiest meal possible with a high protein conversion rate [1]. In Malaysia, the mushroom production industry is also not excluded. About 50 tons per day of mushrooms are needed in Malaysia to meet demand, but only 24 tons per day are being produced at the moment [2]. There are many processes in mushroom production from start to finish.

There are six processes in mushroom production which is composting in phases I and II as well as spawning, casing, pinning, and cropping [3]. In this study, IoT and IR 4.0 have attracted a lot of attention in recent years and are anticipated to acquire speed when they are integrated into the main initiatives of various governments [4]. Due to the presence of several potent chemicals, the oyster mushroom (pleurotus sp.) is one of the most significant edible and medicinal mushrooms [5]. With the presence of the potent chemical that are considered as nutritional for human body, the oyster mushroom has been eaten widely around the world, not only for daily food but also as medicinal herbs. Oyster mushroom became important as it is rich in antioxidants and angiotensin-converting enzyme [6]. The IoT is a part of changes that happens during the IR 4.0. The implementation towards

the various industry has changed on how the many things operate on a daily basis. With the help of IR 4.0, machines will become more intelligent and provide producers with hitherto unattainable insights. In the manufacturing industry, automation processes are employed in factories for production. Smart factories employ automation in their operations.

Due to multinational firms' ability to reduce production and operating costs as a consequence of IR 4.0, the cost of the goods and services that will be offered may be reduced, which might increase the competitiveness of Malaysian products. The reason on why these happen is because the IR 4.0 has made it easier to operate something. IR 4.0 enables the manufacturing industry to practically digitize the in-built sensor components, goods, and equipment found in every production process. IoT is a new high-tech technology that connect between physical objects that are installed with internet, sensors, software, and other technological advancements for the aim of interacting and exchanging data with other systems and devices.

Smart devices and the internet are used by IoT to offer creative solutions to a range of problems and difficulties affecting various economic, governmental, and public or private sectors worldwide [7]. The implementation of IoT is really crucial in the agricultural industry. The agriculture sector is more data-driven, accurate, and intelligent than ever [8]. In mushroom production real-time data collection for various applications is made possible by the integration of several sensors [9]. In order to continuously enhance agricultural techniques and boost production, smart farming is defined as the use of current technology to farming processes. The climate control is prepared by the monitoring system that comes from the IoT. If the temperature and humidity aren't right then oyster mushrooms would not grow, the ensuing fungus dries up, slows down, or even stops growing [10]. Without the monitoring system to monitor and control the temperature and humidity of the cultivation area, the mushroom would not grow. There are several factors of automation technology in IoT that are affecting the mushroom production. These factors are considered as the independent variables that can influence the dependent variable which is the mushroom production. The factors are light sensor, heat sensor, humidity sensor and display [11].

3. Research Methodology

In this third chapter, the researchers will explain about the methodology for the research. An overview of the research techniques used in the study is also provided along with the design of the research flow. The information about the company that are going to be researched will be stated in this chapter which is the overview on the company, criteria of the data collected and how will the data be used. The research instrument will also be introduced which is the data collection instrument, analysis instrument and the software that is used for the analysis. Lastly, the conceptual framework mapping will be shown in this chapter which explain the independent variables and the dependent variables of the research.

3.1 Research Design

The objective of this study is to measure the implication in automation technology of IoT before and after the implementation in mushroom production. The measurement will be used as a scientific proof that the implementation of automation technology of IoT has affected mushroom production. Quantitative analysis and data collection was implemented in this research to get statistical result at the end of the research. In this study, the first step is literature review will be done to get the relevant factors of automation technology of IoT towards mushroom production. Then, the data that is collected from the survey towards the company will be compiled and calculate using the correlation

and regression analysis using the excel software to get the measurement of the data. Fig.1 explains that there are four phases of the research which represent the flow of the research.

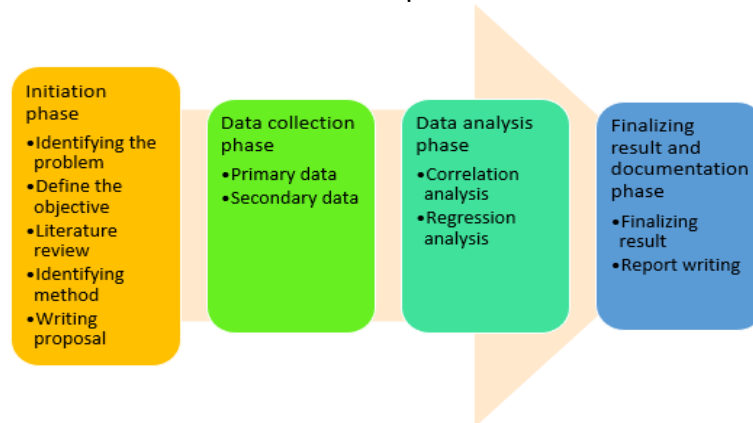


Fig. 1. Research flows design

A statistical technique called correlation analysis is used to determine whether or if there is a link between two variables or datasets and how strong that relationship could be. Correlation analysis is mostly used to identify patterns in datasets. While a negative correlation suggests that when one variable drops, the other increases, a positive correlation means that both variables increase in respect to one another. The data that has been collected in the data collection phase will be insert in the correlation analysis and a correlation graph will be projected as a result from the analysis. The result from the graph may vary from positive relationship, negative relationship and no correlation.

The data that will be inserted are the data about the primary data about the relevant factor of automation technology in IoT which is heat sensor, temperature sensor, humidity sensor and the display towards the factor such as quality of the mushroom, labor cost and the rate of production to find the relationship with mushroom production. A collection of statistical techniques known as regression analysis is used to estimate the relationship between a dependent variable and one or more independent variables. The estimation is done using the equation to express the connection which is generated by the correlation analysis. The equation has several indicators that is needed to calculate the equation. The formula and the indicator are stated as in:

$$Y = bX + a \quad (1)$$

Where:

Y – Dependent variable

X – Independent (explanatory) variable

a – Intercept

b – Slope

This equation will be generated after the correlation graph has been generated. In this research, the equation will be used to calculate the implication of automation technology in IoT before and after implementation of technology as researcher predicted. The equation being the baseline for the prediction and measurement.

3.2 Conceptual framework

A conceptual framework organizes the primary ideas and concepts from theories, important research findings, policy declarations, and other professional information for a research endeavor.

The conceptual framework organizes the study's primary concepts to demonstrate what the research is about and where it is headed as shown as in Fig. 2. The research will concentrate on the independent and dependent variables. The light sensor, temperature sensor, heat sensor, and display are the four factors of automation technology in IoT that make up the independent variables. These four variables have the potential to affect the dependent variable, which is efficient mushroom production. These four criteria were discernible to the researcher from the literature review.

4. Result and Discussion

In data collection and analysis level, are using a quantitative method which is distributing a survey to collect data from the case study. This company is chosen by the researcher because it is one of the companies in Malaysia that has implemented the automation technology of IoT towards their mushroom production. The researcher will use the correlation and regression analysis based on the data collected from the survey. Based on the results of the correlation and regression analysis the researcher will conclude on the effect that the automation technology of IoT has brought onto the mushroom production. Number of respondents have been chosen to answer the survey.

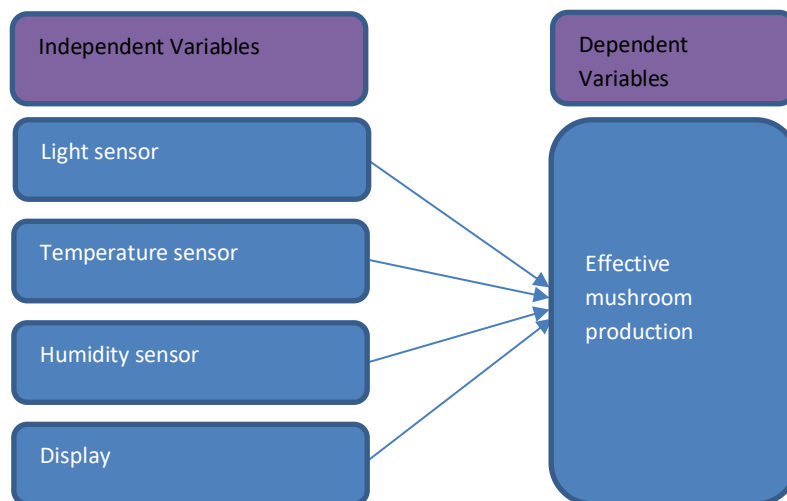


Fig. 2. Factors of effectiveness for IoT-based mushroom production

Thus, this section will present the results in a new perspective and understanding after the research take the findings into consideration and shows the effect of automation technology in IoT on mushroom production in agriculture industry. The survey consists multiple choice, Likert-scale and open question. This survey consists of a set of question which the respondent will be easy to understand and can answer shortly and consists of five sections. Section A is about the demographic of the respondent. Section B is a question based on usage of automation technology in mushroom production. Section C is a question based on perception of automation technology in mushroom production. Section 4 is based on the relationship between variables which consist of both the independent and dependent variables of the research. Section 5 is based on any additional comment that the respondent wants to add.

Table 1
List of Survey

Question 1
The use of light sensor technology give a positive effect to mushroom growth conditions.
Question 2
The use of temperature sensor technology give a positive effect to the stability of temperature in mushroom production.
Question 3
The use of humidity sensor technology give a positive effect to the optimal humidity levels for mushroom cultivation.
Question 4
The use of display technology eases the monitoring and adjusting environmental conditions in mushroom production.
Question 5
A good mushroom growth condition will improve the quality of the mushroom.
Question 6
A stable temperature will increase the yield of the mushroom.
Question 7
An optimal humidity levels will give a better control over environment during the production process.
Question 8
An easy monitoring and adjusting environmental condition will reduce the labor requirements.

The percentage of position of the respondent of the survey regarding The Effect of Automation Technology in IoT on Mushroom Production in Agriculture Industry. This figure shows that the respondent are 9 farmers with the highest percentage (60%), this is because they are more farmers working at the case study compared to supervisor, owner and other position that are being the respondent. Supervisor position (20%) with 3 respondents, owner position (13%) with 2 respondents and other position (7%) with 1 respondent.

For correlation analysis, 8 Likert-scale questions given to the respondents to rate from strongly agree, agree, neutral, disagree and strongly disagree as in Table I. After getting the result as in Table II and Fig. 3, the researcher will take the result and insert the data into excel software where the researcher will do a correlation analysis to find the relationship between independent and dependent variables. after that the regression analysis is done to get the significant value of the automation technology in mushroom production.

Table 2
Frequency of survey

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
Strongly agree	27	33	60	53	33	47	53	60
Agree	73	67	40	47	60	53	47	40
Neutral	0	0	0	0	7	0	0	0
Disagree	0	0	0	0	0	0	0	0
Strongly disagree	0	0	0	0	0	0	0	0

Note: All data is in percentage (%)

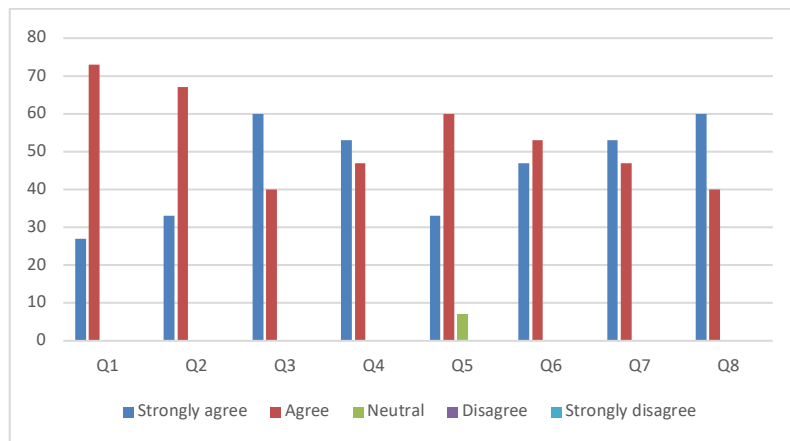


Fig. 3. Chart of frequency responds on 8 Likert-scale survey

After getting the result from the survey the researcher starts to analyze the data by doing correlation analysis. The researcher used question 1 and question 5 for the first correlation and regression analysis. It is to find the relationship between light sensor and improve quality of mushroom production. The formula to determine the correlation is also stated. Fig. 4-6 illustrates the correspond value for the dependent and independent variable is set as set in Table 3 as follows.

Table 3
Factors of IOT implementation relationship

Factor	X-axis	Y-axis	Linear regression remark	Predicted formula	
				Y	R ²
1	Light Sensor	Improve Quality of Mushroom	Relationship between light sensor and improve quality of mushroom	$y=0.8043x+0.0391$	0.96
2	Temperature Sensor	Increase Yield	Relationship between temperature sensor and increase yield	$y=0.875x + 0.025$	0.9007
3	Humidity sensor	Better Control Over Environment	Relationship between humidity sensor and better control over environment	$y=0.9583x + 0.0083$	0.9724
4	Display System	Reduce labor requirements	Relationship between display system and reduce labor requirements	$y = 1.0147x + 0.0029$	0.9724

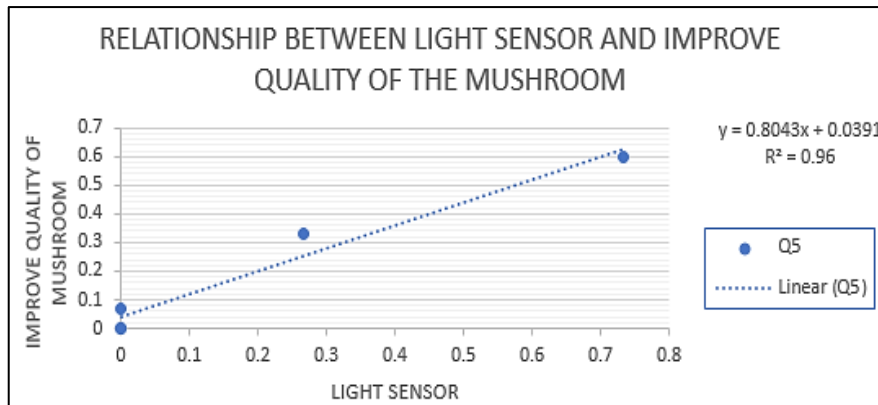


Fig. 4. Relationship factor 1st: light sensor - improve quality of mushroom

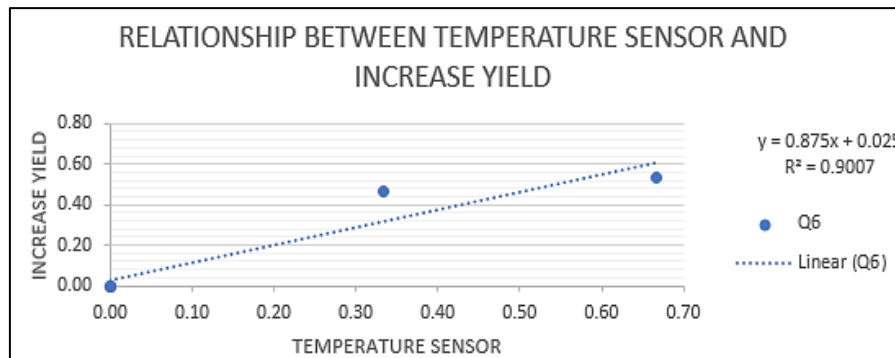


Fig. 5. Relationship factor 2nd: temperature sensor – increase yield

As the result extract from the correlation and regression generated between light sensor and improve quality of mushroom, showing that 0.804 light sensor and improve quality of mushroom as a positive relationship with each other. The intercept between light sensor and improved quality of mushroom is at 0.039. We can also see the “r” in the table which represent the correlation between light sensor and improve quality of mushroom which is 0.98. The researcher can conclude that the light sensor is giving a good effect towards the improve quality of mushroom.

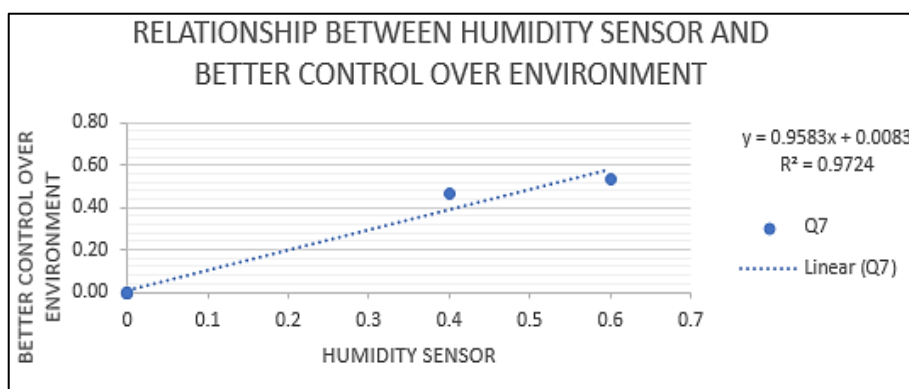


Fig. 6. Relationship factor 3rd: humidity sensor –control over environment

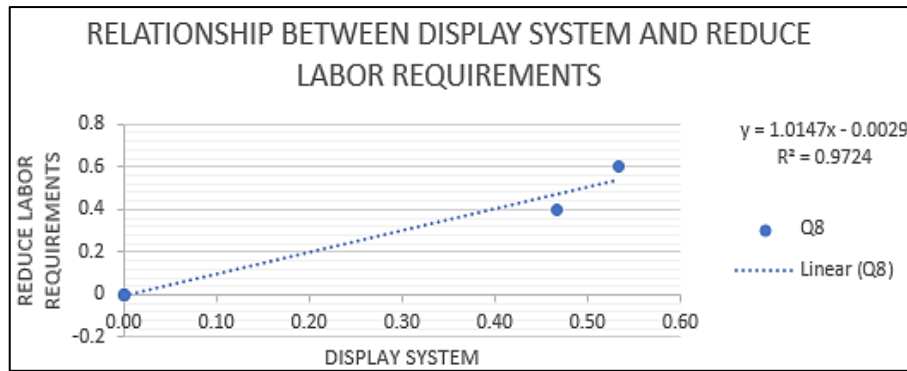


Fig. 7. Relationship facto 4th: display – reduce labour requirements

The second factor for correlation and regression analysis are between temperature sensor and increase yield. The researcher used question 2 and question 6 for the second correlation and regression analysis. It is to find the relationship between temperature sensor and increase yield. The formula to determine the correlation is also stated. The regression between temperature sensor and increase yield is 0.88 which means temperature sensor and increase yield have a positive relationship with each other. The intercept between light sensor and improved quality of mushroom is at 0.03. We can also see the “r” in the table which represent the correlation between light sensor and improve quality of mushroom which is 0.95. The researcher can conclude that the temperature sensor strongly affected the increase yield in mushroom production.

The third correlation and regression analysis are between humidity sensor and better control over environment. The researcher used question 3 and question 7 for the second correlation and regression analysis. It is to find the relationship between humidity sensor and better control over environment. The formula to determine the correlation is also stated. The regression between humidity sensor and better control over environment is 0.88 which means humidity sensor and better control over environment have a positive relationship with each other. The intercept between humidity sensor and better control over environment is at 0.0083. We can also see the “r” in the table which represent the correlation between humidity sensor and better control over environment which is 0.95. The researcher can conclude for a better control over environment in the mushroom production the humidity plays an important role for a better control.

The fourth correlation and regression analysis are between display system and reduce labor requirements. The researcher used question 4 and question 8 for the second correlation and regression analysis. It is to find the relationship between display system and reduce labor requirements. The formula to determine the correlation is also stated. The regression between display system and reduce labor requirements is 1.015 which means display system and reduce labor requirements have a positive relationship with each other. The intercept between display system and reduce labor requirement is -0.0029. We can also see the “r” in the table which represent the correlation between display system and reduce labor requirements which is 0.986. The researcher can conclude that with the display system the farmers can easily monitor and adjust the environmental condition which can lead to a reduce in labor requirements.

Based on the findings on correlation and regression analysis, the researcher found that all the relevant factor on automation technology of IoT has a strong relationship with mushroom production. All the relevant factor has a significant value in mushroom production and would bring a benefit to the mushroom production. Overall, the data collected from the respondents is really important as it allows the researcher to do the analysis and find the relationship between the independent and dependent variables. the analysis suggest that the automation technology is a good thing to implement in mushroom production. This analysis can contribute to giving recommendations

to improve the mushroom production process, which ultimately can lead to benefits such as increase yield, improve quality, reduce labor requirements and better control over the environment

5. Conclusions

Recent research has determined that there are four relevant factors that affected the mushroom production in agricultural industry. These factors include light sensor, temperature sensor, humidity sensor and display system. After analyzing the data, the researcher found that the relationship between is light sensor and quality of the mushroom, temperature sensor and increase yield, humidity sensor and better control over environment, and display technology and reduce labor requirements are all strongly positive. The light sensor and quality of mushroom which has the regression of 0.804, the intercept at 0.039, and the correlation is 0.98. Next is the relationship between temperature sensor and increase yield which has the regression of 0.88, intercept at 0.03, and correlation of 0.95. Other than that, the relationship between humidity sensor and better control over environment which has the regression of 0.96, intercept at 0.0083, and correlation of 0.99. last but not least, the relationship between display system and reduce labor requirement which has the regression of 1.015, intercept at -0.0029, and the correlation of 0.986.

In conclusion, the researcher found that the automation technology brings a significant effect towards mushroom production in agricultural industry. By analyzing the data collected from the survey given, the researcher is able to do an analysis towards those data. The researcher can conclude that the automation technology of IoT can give benefit to the mushroom production in agricultural industry.

This research focuses on relevant factors on automation technology of IoT that give effect towards mushroom production in agricultural industry. The study identifies four relevant factors that affect mushroom production which is light sensor, temperature sensor, humidity sensor and display system. By emphasizing these elements, the research adds to the body of current information and offers a foundation for more in-depth academic investigation and comprehension of automation technology of IoT in mushroom production.

The research examined the relationship between the independent variables and mushroom production whether it has a positive relationship in the mushroom production. According to the study, all of the relationship between relevant factors on automation technology and mushroom production is strongly positive. Therefore, it is crucial for any agricultural company to invest in implementing the automation technology of IoT in their production process. This finding also suggests the implementation would bring significant benefits to their production process as it would help in many ways. The implementation of light sensor, temperature sensor, humidity sensor and display system are only the essential technology that their company would need to implement. In the near future there can be a lot more automation technology that would help the improving the agricultural industry. Moreover, it is important for the agricultural industry to keep up with the technology nowadays which we are already at IR4.0. It is because the technology will keep on improving the industry by making the process easier to be done. These recommendations can help the agricultural industry to obtain the benefits of implementing the automation technology including increase yield, improved quality, reduced labor requirements and better control over environment. These are the most important thing when it comes to improving the agricultural industry. The research provides valuable data regarding the automation technology of IoT that the industry can use to make strategies on what they want to improve in the industry.

The study offers valuable data towards the community that can be used if they want to enter the agricultural industry including the benefits of mushroom production, step of mushroom production

process, what technology that they can implement to the production process and many more. The researcher hope that the community can use these valuable data to make their businesses more improved. For the agricultural industry to improved, the implementation of automation technology of IoT in the industry is crucial. The researcher has provided recommendations to improve the agricultural industry achieve this goal. The first recommendation is to implement the automation technology such as light sensor, temperature sensor, humidity sensor and display system. This automation technology would help the industry to improve significantly. By investing in the automation technology, the agricultural industry can enjoy benefits such as increased yield, improved quality, reduce labor requirements and better control over environmental factors.

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