# โมเดลการยอมรับเทคโนโลยี: หลักฐานการใช้เทคโนโลยี NodeMCU ในการควบคุมโรงเพาะเห็ดในประเทศไทย

# Technology Acceptance Model: The Evidence of NodeMCU's Mushroom House Control System in Thailand

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## บทคัดย่อ

งานวิจัยนี้มีวัตถุประสงค์เพื่อ (1) พัฒนาเทคโนโลยี NodeMCU ในการควบคุมโรงเพาะเห็ดโดยระบบควบคุมอัตโนมัติและควบคุมโดยมนุษย์ (2) สร้างแอพพิเคชั่น (หรือเครื่องมือที่เกี่ยวกับออนไลน์) ที่สามารถปรับอุณภูมิและความชื้นให้เหมาะสมสำหรับทุก ๆ การเจริญเติบโตของเห็ดในแต่ละช่วงเวลาในโรงเห็ดได้ (3) ค้นหาความจริงในการรับรู้การใช้งานเทคโนโลยี NodeMCU ของเกษตรกรโดยใช้โมเดลการยอมรับเทคโนโลยีโดยใช้ฟาร์มเห็ด "สองพี่น้อง" เป็นกรณีศึกษาสำหรับงานวิจัยนี้ หลังจากที่ติดตั้งเทคโนโลยี NodeMCU ในการควบคุมโรงเพาะเห็ดและพัฒนาแอพพิเคชั่นในสมาร์ทโฟนสำหรับเกษตรกรแล้ว เทคโนโลยีนี้สามารถรักษาอุณภูมิและความชื้นที่เหมาะสม ให้กับโรงเพาะเห็ดได้โดยอัตโนมัติหรือควบคุมโดยเกษตรกรผ่านแอพพิเคชั่นในสมาร์โฟน งานวิจัยนี้จึงเป็นการประยุกต์ใช้เทคโนโลยี NodeMCU ในการควบคุมโรงเพาะเห็ดในอนาคตได้โดยการประยุกต์ใช้โมเดลการยอมรับเทคโนโลยีได้อย่างมีประสิทธิภาพ

**คำสำคัญ**: โมเดลการยอมรับเทคโนโลยี อินเทอร์เน็ตของสรรพสิ่ง โรงเพาะเห็ด และฟาร์มอัจฉริยะ

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## Abstract

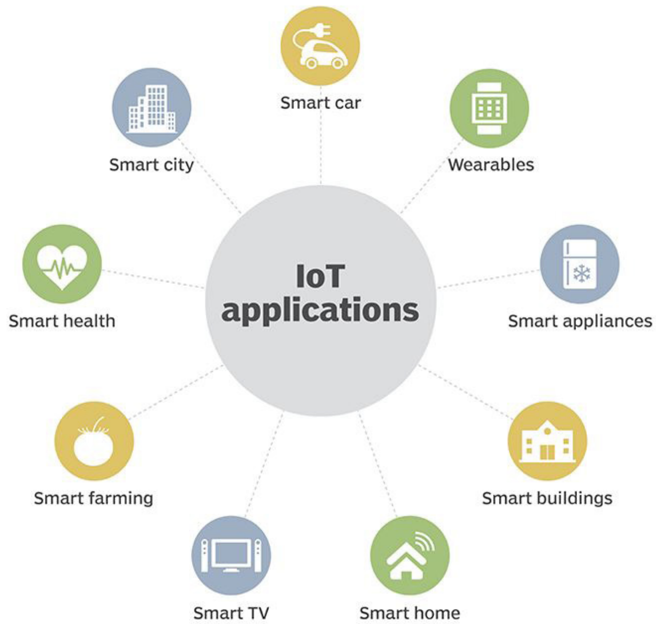
The purpose of this study is to (1) To develop the NodeMCU's mushroom house control system that be able to control by both automatic system and manual system (2) To generate the application (or related online tool) that be able to adjust the suitable humidity and appropriate temperature for each growth stages of mushroom in the mushroom house (3) To determine the perception of the NodeMCU's users by applying TAM model. "Song Pee Nong" mushroom farm was chosen as a case study to implement the NodeMCU's system in this study. After installed the NodeMCU's mushroom house control system and developed the mobile application for the users, the system was able to sustain the most appropriate temperature and humidity in mushroom house by set up the system automatically or by control manually from the users via mobile application. This study also applied technology acceptance model (TAM) to explain the famer's intention to use the NodeMCU's mushroom house control system in the future.

**Keywords:** Technology Acceptance Model, Internet of Things, Mushroom House, Smart Farm

## 1. Introduction

The term "the Internet of things" (IoT) was first coined by Kevin Ashton of Procter & Gamble in 1999. It can be referred as everything is connected with the Internet which allows the Internet users to control equipment and tools through the Internet (Ashton, 2009). According to Babin (2017), the IoT allows objects to be sensed or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention. When IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart car, smart appliances, smart home, smart buildings, smart TV, smart farming, intelligent transportation, smart city, and smart health as shown in Figure 1.

Figure 1 Example of IoT applications (Rouse et al., 2019)




In farming businesses, the IoT contributes significantly towards innovating farming methods. Farming challenges caused by population growth and climate change have made it one of the first industries to utilize the IoT. The integration of wireless sensors with agricultural mobile apps and cloud platforms helps in collecting vital information pertaining to the environmental conditions – temperature, rainfall, humidity, wind speed, pest infestation, soil humus content or nutrients, besides others – linked with a farmland, can be used to improve and automate farming techniques, take informed decisions to improve quality and quantity, and minimize risks and wastes (Rouse & Bernstein, 2019). Currently, people are willing to spend more money on healthy products. Mushroom is one of the best options for healthy food. The benefits of mushroom consumption are not only for food but also for medical reasons. Therefore, the consumption of mushroom are increasing which is helping the national economic growth. In 2016, Thailand produced 120,000 tons of overall mushroom to consume both domestically and internationally (Department of Agricultural Extension, Ministry of Agriculture and Cooperatives, 2019). However, the IoT contributions in farming businesses in Thailand, especially in mushroom houses, were rarely utilized.

The mushroom houses in Thailand were increased steadily because various kinds of mushrooms are suitable to grow up due to the weather conditions and environments. Moreover, most of the mushroom houses in Thailand are made from re-usable materials that help the farmers to reduce the cost of mushroom houses. However, during the growth stages of mushroom, farmers always face with the problems about unappropriated humidity and unsuitable temperature which cause mushroom's deceases and eventually affect the productivity of the mushroom. As a result, due to the varies of weather conditions in Thailand nowadays, famers need to spend a lot of time to take care of their mushroom houses in order to reduce the chance of mushroom deceases.

As a result, this research aims to fulfill this gap by developing the NodeMCU's mushroom house control system via the Internet in order to reduce the chance of mushroom deceases and reduce the farmers' time spending on taking care of the mushroom. NodeMCU is the CPU to process the evaluated data system that contains with the board ESP8266. Once connected NodeMCU with other tools and sensors via the Internet, NodeMCU is acted as the monitor to adjust the weather and other related environments to the user's setting point. In this, NodeMCU could be perceived as the tool on IoT. Consequently, the purpose of this study was shown as follows:

1. To develop the NodeMCU's mushroom house control system that be able to control by both automatic system and manual system.

2. To generate the application (or related online tool) that be able to adjust the suitable humidity and appropriate temperature for each growth stages of mushroom in the mushroom house.

3. To determine the perception of the NodeMCU's users by applying TAM model.

## 2. Theoretical Foundation and Literature Review

### 2.1 Smart Farming

According to Rouse and Bernstein (2019), Smart farming is a management concept emphasized on providing the agricultural industry with the infrastructure to leverage advanced technology such as big data, the cloud and the internet of things (IoT) in order to track, monitor, automate and analyze agricultural operations. It is software-managed and sensor-monitored system which includes technology such as sensors, telecommunications, advanced networking, GPS, satellites, data analytics tools for decision making and predictions, and the suitable hardware and software for specialized applications that create the IoT-based solutions, robotics and automation. By making farming more connected and intelligent, smart farming is able to reduce overall costs, improve the quality of product, increase the quantity of products, develop the sustainability of agriculture and enhance the new experiences for the consumers. With these smart devices, multiple processes can be activated at the same time. With these automated services, it will enhance product quality and volume by better controlling production processes. In this, IoT technology creates better control agricultural processes to reduce production risks and enhances the ability to foresee production results, which leads to better cost management and waste reduction.

### 2.2 NodeMCU

NodeMCU is the CPU to process the evaluated data system that contains with the board ESP8266. It is smaller than Arduino but has larger capacity. The mainboard ESP8266 12E has 4MB RAM and 40 MHz ARM which portable with WIFI system. NodeMCU was the key component in this research. Other specialized tools were installed in this study included DTH22, 8 channel relay, DTH22 is the temperature and humidity sensor which usually implements in food industries, warehouse, cold room, computer lab, operating lab, or baking room. Relay is an electrically operated switch. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. 8 channel relay module was implemented in this study because it is able to receive 10 A with 5 V and contains of 8 displayed LED. Water pump and sprayer were also employed in this study. A water pump is used to control the humidity and water in the mushroom house. Sprayer was connected to the water pump and hooked up on the ceiling of the mushroom house to spray the water in the way as the smog at 20 – 30 micron. This sprayer was able to reduce the temperature and increase the humidity of mushroom house. Table 1 illustrates all the tools used in this study.

**Table 1** Tools implemented in this study

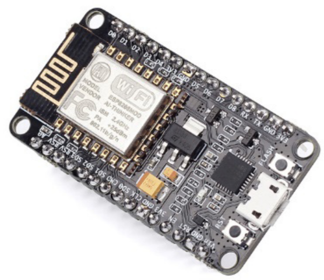
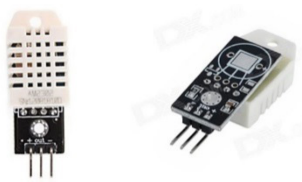
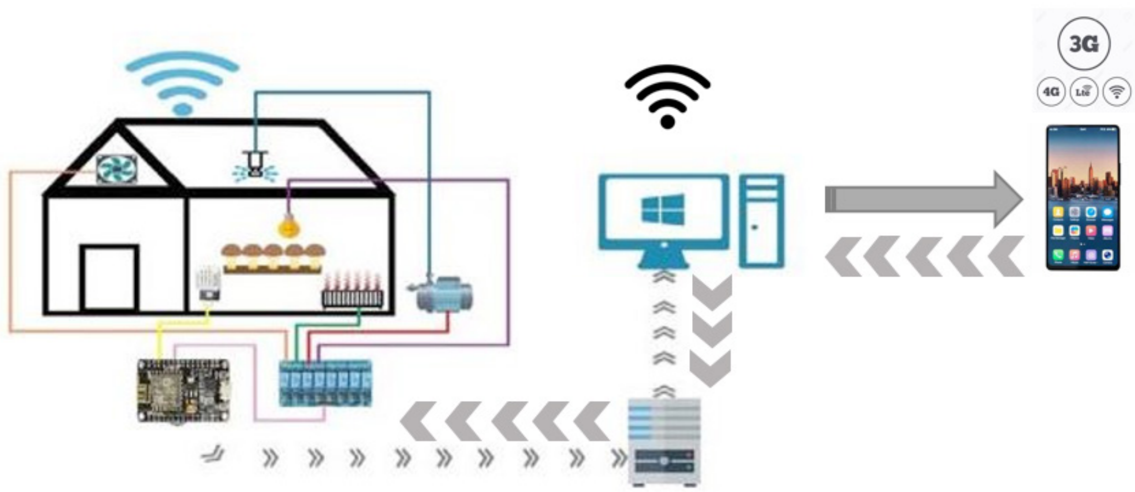
| Description | Figure |
|---|---|
| NodeMCU |  |
| DTH22 |  |
| 8 Channel Relay Module |  |
| Sprayer |  |

**Table 1** Tools implemented in this study (Continue)

| Description | Figure |
|---|---|
| Water Pump |  |
| electric box with display monitor |  |

NETPIE is the Apache web server program that provides the spaces for any Internet users. This study developed script and program via NETPIE. By installing some materials in mushroom house and applying all controlling systems in the electric box, the purposed framework for this research was developed as presented in figure 2. The NodeMCU's control system was designed to monitor temperature and humidity of the mushroom house 24 hours a day and transmitted all data to the developed program and mobile application via NETPIE. The owner of mushroom farm is able to see all data by either computer or mobile application on mobile phone. Once the temperature is too high or the humidity is too low, the owner of mushroom farm is able to order water spraying via computer or mobile application without visiting mushroom house in person.

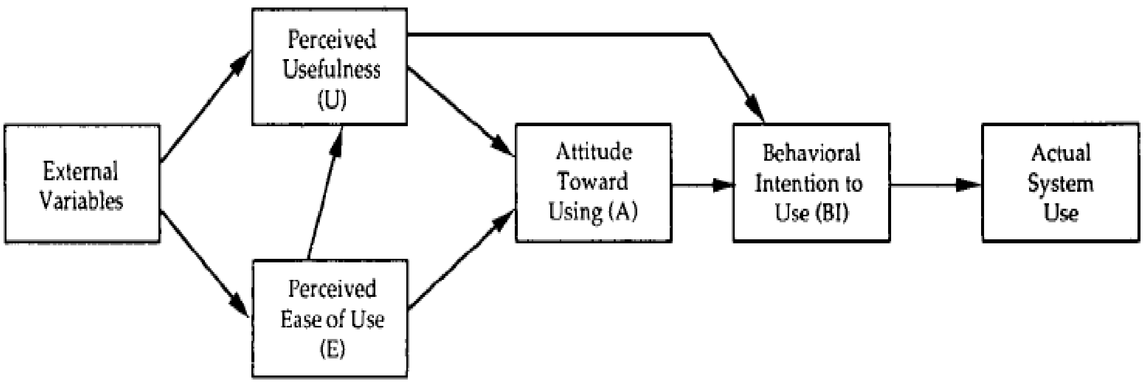
**Figure 2** The purposed NodeMCU's mushroom house control system



### 2.3 Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) was first developed by Davis (1989). The main purpose of the TAM is to explain computer-usage behaviors. This model would be well-suited for modelling acceptance and usage of any product and service that involve computer technology (Bosnjak et al, 2006). TAM assumes that technology adoption, intention to use and actual use are depended on perceived usefulness and perceived ease of use of technology as shown in Figure 3.

**Figure 3** Technology Acceptance Model (Davis el al., 1989)




According to the model (Davis et al., 1989), it predicts user acceptance and intentions based on the influence of two variables which are perceived usefulness and perceived ease of use. These two variables determine behavior on attitude toward using and then behavioral intentions to use, which behavioral intentions to use finally determines the actual system use. In addition, Davis et al. (1989) also propose a direct relationship between perceived usefulness and behavioral intentions to use. Davis et al. (1989) gave definition for two determinants as follows. “Perceived usefulness (U)” is referred as the degree to which an individual believes that using a particular system will enhance his/her performance. “Perceived ease of use (EOU)” is defined as the degree to which an individual believes that using a particular system will be free from effort.

TAM has been utilized in various studies which include the adoption of instant messaging by Shih and Fan (2013), mobile commerce by Zhou and Lu (2011), mobile shopping by Aldas-Manzano et al. (2009); mobile ticketing by Mallat et al. (2009), digital multimedia broadcasting by Shin (2009), mobile TV by Jung et al. (2009), 3G services by Kuo and Yen (2009), and mobile gaming by Ha et al. (2007). TAM is relevant to this study because this study highly associates with new technology system as well as it involves with networking technology. As a result, this model is able to help the researcher to understand the driven mechanism of farmer’s behavior as well as facilitate the researcher on generating the effective mechanism system in product and application designs in order to create a suitable NodeMCU prototype system for mushroom farm.

## 3. Research Methods

The purpose of the study was to develop a thorough understanding of what factors influence mushroom farmers and what barriers hinder them from the applying smart farm technology such as NodeM-CU. This study employed the qualitative method, using in-depth interviews to explore the mushroom farmer's behavior intention by applying TAM. According to Mariampolski (2001), the qualitative method allows the researchers to generate rich data and have more flexibility to probe into areas of specific behavior that helps to develop a comprehensive understanding of all the influences shaping that specific behavior. In this, qualitative approach provides a necessary and complementary perspective on human behavior

### 3.1 Sample Selection

The study was conducted in Thailand and the participants were Thai mushroom famers who have experienced on mushroom farming for more than a year. Moreover, participants in this study had to allow the researchers to install all equipment and tools for NodeMCU's mushroom house control system at least 6 months in order to investigate farmer's behaviors as well as develop this smart farm technology. After contacting several mushroom farms in the North-east region of Thailand, "Song Pee Nong" mushroom farm was chosen due to several reasons. Firstly, the owners of "Song Pee Nong" mushroom farm would like to test the NodeMCU's on all four mushroom houses and allowed the researchers to collect data without restrictions. Secondly, "Song Pee Nong" mushroom farm has started mushroom business since 2015. Thirdly, "Song Pee Nong" mushroom farm meets all requirements for mushroom house. It has own spawn production line through sterilization process, provides mushroom incubation room for spawn run, stocks and sells packages of sprouting mushrooms, and collects fresh mushrooms from mushroom house. Lastly, "Song Pee Nong" mushroom farm is located on Ban Tam-Yay, Na-Sri-Nuan sub-district, Kantarawichai district, Mahasarakham which takes around twenty minutes from Mahasarakham University by car. This location was appropriate for this research because the NodeMCU's mushroom house control system was on the development prototype phase. Therefore, the researchers needed to be ready for analyzing and solving any problematical issues related to this smart farm technology on time in order to eliminate any unexpected consequences.

### 3.2 Data Collection Procedures

Semi-structured in-depth interviews with Thai mushroom farmers were used to gather the data; this technique was particularly suitable to understanding the farmers' intention behavior toward NodeMCU's mushroom house control system. In-depth interviews allowed a more comprehensive insight into the farmers' thoughts, feelings, and experiences. Additionally, the flexible nature of in-depth questioning enabled the interviewer to return to a topic several times during an interview if needed. An interview guide was developed to ensure that the interviews did not get lost in topics that were of no relevance to the study's objectives. All nine main questions were derived from Davis el al. (1989), Venkatesh & Bala (2008) and Behrend et al. (2011). These questions motivated the interviewees to express their feelings, thoughts, and experiences freely. The ordering of questions was flexible and was mainly dictated by the 4 interviewee's responses. The interviews were audio-taped and transcribed for analysis and interpretation.

## 4. Results

### 4.1 Prior the installation of NodeMCU's mushroom house control system

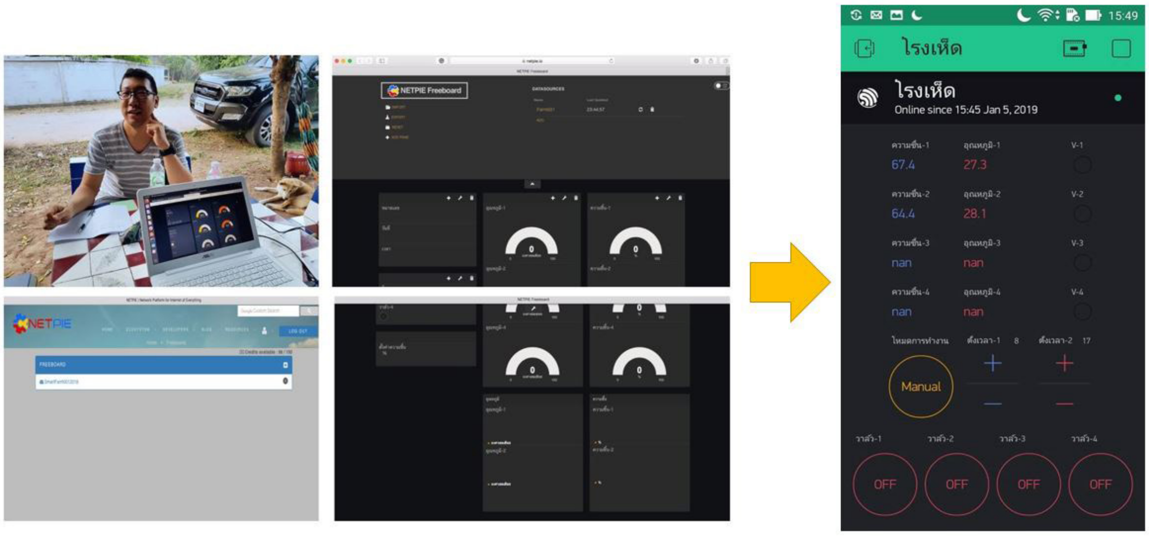
"Song Pee Nong" mushroom farm had two full-time workers and two part-time workers. There were four mushroom houses and each mushroom house was able to produce around 10 kg of fresh mushroom per day. There were around 4,000 mushroom bags on each mushroom house. The farmers always collect fresh mushroom twice a day (in the morning at 6 am and in the afternoon at 4:30 pm). They sprayed water on mushroom bags directly at least twice a day (generally, in the morning at 6:30 am and in the afternoon at 5:00 pm). Each worker spent time on water spraying about 10-20 minutes per one mushroom house and it took around 218 litters of water for each time. However, on some days, the weather is too hot and makes the temperature of the mushroom house too high. The farmers needs to spray water at lunch time around 10 minutes which used about 109 litters of water in order to reduce the temperature and increase the humidity of mushroom house. The materials used for setting up the mushroom houses were mostly reused and recycled material which include steel structure tubing, bamboo woven, shade cloth thatching and roof vents. Each mushroom house costs about ฿10,000. The appropriate temperature inside the mushroom house was around 20-25 degree Celsius with the humidity above 80%. The contamination of fresh mushroom in "Song Pee Nong" mushroom farm included green mold and black mold which normally affected around 10 percent of the collected products.

### 4.2 After the installation of NodeMCU's mushroom house control system

NodeMCU's mushroom house control system was first introduced to "Song Pee Nong" mushroom farm in September 2018 and explained in details on how to applied and utilized the system. After "Song Pee Nong" mushroom farm agreed with all given conditions, NodeMCU was installed in early October 2018. The researchers had also developed the application to control NodeMCU via NETPIE. NodeMCU was set automatically to do the water spaying for 5 minutes if the mushroom house's temperature reached 30 degree Celsius or the humidity went lower than 70%. At the beginning, NodeMCU could only be controlled manually with the control box due to the limitation of the internet networking from the local internet provider. However, after solved the problem with internet networking, NodeMCU was able to be controlled via computer or mobile application developed by the researchers as shown in the figure 4. Both controlled systems on computer and mobile application were not only set to present all important data of the mushroom house 24 hours a day but also were able to control the water spraying by simply click on spraying button. "Song Pee Nong" mushroom farm could set or change the time for water spraying by using this technology without visiting farm in person.

For security and privacy issues, NodeMCU control system was set to require a password or finger print (mobile application version) to log-in prior system access. It was also set to limit the number of users by system administrators and automatically log-out after inactivated program for 10 minutes. In different levels of users, the system limits some data access and some functions in order to secure the data and control system.

**Figure 4** NodeMCU's control system on computer program version and mobile application




Due to the set up at the beginning (if farm temperature reached 30 degree Celsius or the humidity went lower than 70% – NodeMCU would order water spraying for 5 mins), the farmers said that their mushrooms were rotten because water sprayed frequently. Therefore, NodeMCU control system was reset to a new set-up by automatically spraying water only 3 times a day (6:00-6:05 am, 12:00-12:05 pm and 18:00-18:05 pm). In this, if the weather was too high during other times of the day, the NodeMCU's system was set for the users to see the data about temperature and humidity in mushroom house and made the decision on whether to turn on water or not by users via mobile application and computer program. The farmers was easily able to control the temperature and humidity in mushroom farm under the best condition 24 hours a day. As a result, the products of "Song Pee Nong" mushroom farm increased around 15% compare with the amount of products produced prior install NodeMCU. Moreover, NodeMCU also helped "Song Pee Nong" mushroom farm on decreasing the energy usage for the water pump as well as reducing the water usage because the water spraying system. All farmers of "Song Pee Nong" mushroom farm agreed that they had got more time to do other things because they did not need to spray the water in person. The application of NodeMCU was easy to use and it was very useful for them on taking care of mushroom houses.

### 4.3 Results related with TAM

Since the core components of TAM consist of four constructs: Perceived Usefulness (PU), Perceived Ease of Use (PEOU), and Behavioral Intention (BI) as shown in figure 3. At the beginning, only the owner of "Song Pee Nong" mushroom farm believed that the NodeMCU's mushroom house control system would create a lot of benefits for her farm. The other farmers were still not sure about the results. Moreover, due to the system required internet connection with mobile application, "Song Pee Nong" mushroom farm needed to install internet broadband from Thai-internet provider as well as provided smart phones for the workers in order to install and utilize the NodeMCU's application. The first version of NodeMCU's mobile application and computer program was set up the display as analogue gauge. So, it was hard to read the correct number of the temperature and humidity. As a result, the researchers needed to develop the second version by adjusting all displays into digital gauge. In this, the farmers' perceived ease of use (PEOU) of the NodeMCU's application and asked the researchers to develop a better friendly reading version. After adjusting the display, all users were able to read the gauge easily and took action immediately. After using the NodeMCU for about one month, every workers agreed that this system was useful for them similarly as shown in TAM's perceived usefulness (PU) and they used the NodeMCU mobile application every day because it was very efficient, effective and usefulness. Then, the researchers showed them the overall costs of installing and developing the mobile application for the NodeMCU's mushroom house control system and asked them about the intention to use this system (behavior intention to use in TAM) if they needed to invest by themselves. All of them would love to invest the NodeMCU's mushroom house control system in every mushroom farms that they had because they believed that this system is useful for them in many aspects and it was very easy to use.

## 5. Conclusion and Limitations

In conclusion, this study had fulfilled the objectives on developing the NodeMCU's mushroom house control system for mushroom farm as well as developing both computer program and mobile application to control the NodeMCU's system. The famers were able to set the program automatically or control the system manually at their own wills. The NodeMCU's control system was able to eliminate the problems about high temperature or low humidity in the mushroom house by adjust the suitable humidity and appropriate temperature for each growth stages of mushroom in the mushroom house.

This study applied technology acceptance model (TAM) to explain the famer's intention to use the NodeMCU's mushroom house control system in the future. The results confirmed that after the famers perceived the usefulness (PU) of the NodeMCU's system (on saving time, water, energy, workers and other expenses as well as increasing their final products by 15%) and PEOU of this system (receive all data and control the system via mobile phone application), all of them agreed that the NodeMCU's mushroom house control system was helpful and would like to purchase the system in the future. In addition, the NodeMCU's system had made "Song Pee Nong" mushroom farm to become an example of smart mushroom farm in the future and "Song Pee Nong" mushroom farm was broadcasted by Thai-TV national channel 7 as presented in Figure 5.

**Figure 5** "Song Pee Nong" mushroom farm broadcasting by Thai-TV national channel 7


There were several limitations in this study. Firstly, due to the limited budget, this study was able to test the NodeMCU's mushroom house control system with only one farm. Including other mushroom farms in future research could obtain more quality feedbacks and data to develop the NodeMCU's system. Secondly, apply the NodeMCU's control system with other plants rather than mushroom could be a challenging result for this technology on smart farm industry. In this, set up the NodeMCU's system with fixed time automatically for vegetables such as lettuce or cabbage might create a good results because the vegetables were not get rotten easily by spraying water frequently. Lastly, install the NodeMCU's control system in other countries could produce the interesting results. Due to the different conditions on whether in different countries, it could help to develop a better version of the NodeMCU's control system in the future.

## References

Aldas-Manzano, J., Ruiz-Mafe, C., & Sanz-Blas, S. (2009). Exploring individual personality factors as drivers of M-shopping acceptance. *Industrial Management & Data Systems, 109* : 739–757. doi: 10.1108/02635570910968018.

Ashton, K. (2009, June 22). That 'Internet of Things' Thing. *RFID Journal.* Retrieved from https://www.rfidjournal.com/articles/view?4986

Babin, N. (2017). Internet of Things or connected objects. *The Internet of Things.* Retrieved from https://www.linkedin.com/pulse/internet-things-connected-objects-nicolas-babin-l-i-o-n-/

Behrend, T. S., Wiebe, E. N., London, J. E., & Johnson, E. C. (2011, March–April). Cloud computing adoption and usage in community colleges. *Behaviour & Information Technology,* 30(2) : 231–240.

Davis, F.D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterty,* 13(3) : 319-340.

Davis F.D., Bagozzi R.P., Warshaw P.R. (1989). User acceptance of computer technology: a comparison of two theoretical models. *Management Science,* 35(8) : 982-1003.

Department of Agricultural Extension. (2019). Agricultural Statistics Information, *Ministry of Agriculture and Cooperatives, Thailand*. Retrieved from https://www.doae.go.th/doae/km_list.php?Cat=SXpUV-VF0TGdXb0Y1SlRFOVNBdnhqUT09

Ha, I., Yoon, Y., & Choi, M. (2007). Determinants of adoption of mobile games under mobile broadband wireless access environment. *Information & Management,* 44(3) : 276–286.

Jung, Y., Perez-Mira, B., & Wiley-Patton, S. (2009). Consumer adoption of mobile TV: Examining psychological flow and media content. *Computers in Human Behavior,* 25(1) : 123–129.

Kuo, Y. F., & Yen, S. N. (2009). Towards an understanding of the behavioral intention to use 3G mobile value-added services. *Computers in Human Behavior,* 25(1) : 103–110.

Mallat, N., Rossi, M., Tuunainen, V. K., & Oorni, A. (2009). The impact of use context on mobile services acceptance: The case of mobile ticketing. *Information & Management,* 46(3) : 190–195.

Mariampolski, H. (2001). *Qualitative market research: A comprehensive guide*. Thousand Oaks, CA: Sage Publications.

Rouse, M. & Bernstein, C. (2019, June). Smart Farming. *TechTarget*. Retrieved from https://internetofthingsagenda.techtarget.com/definition/smart-farming

Rouse, M., Rosencrance, L., Shea, S. & Wigmore, I. (2019, March). Internet of Things (IoT). *TechTarget*. Retrieved from https://internetofthingsagenda.techtarget.com/definition/Internet-of-Things-IoT

Shih, Y. & Fan, S. (2013). Adoption of instant messaging by travel agency workers in Taiwan: Integrating technology readiness with the theory of planned behavior. *International Journal of Business and Information,* 8(1) : 120-136.

Shin, D. H. (2009). Understanding user acceptance of DMB in South Korea using the modified technology acceptance model. *International Journal of Human–Computer Interaction,* 25, 173–198.

Venkatesh, V., & Bala, H. (2008, May). Technology acceptance model 3 and a research agenda on interventions. *Decision Sciences,* 39(2) : 273-315.

Zhou, T. & Lu, Y. (2011). The effects of personality on user acceptance of mobile commerce. *International Journal of Human-Computer Interaction,* 27(6) : 545-561.