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The Development of Egg Hatching and Storage Machines Equipped with Cooling and Heating Systems and IoT

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Abstract: The development of egg hatching and storage machines equipped with cooling and heating systems and IoT was for helping chicken breeders to address the issue of chicken production shortages. To produce large numbers of poultry production, eggs hatching is one of the major step that needs to pay attention to. There are several reasons why egg hatching process fails, such as lack of care by hen, eaten by rooster, and unsuitable hatching environment and temperature. In addition, if the eggs are not incubated within 1 week, the eggs will be damaged having producing a hatching machine and egg storage can help the chicken breeders to produce a better amount of chicken production. Internet of Things (IoT) elements such as the Arduino and Blynk are also used to make this egg hatching and storage machine attractive and to meet the needs and requirements of users. The objectives of this study were to design, develop and evaluate the functionality of egg hatching and storage machines in combination with cooling and heating systems along with IoT. Methodology is a technique and method that incorporates methods and approaches used to achieve the objectives and objectives of the study. The model used is the ADDIE model which consists of 5 phases namely Analysis, Design, Development, Implementation, and Evaluation. This product has received expert confirmation in terms of design and functionality. The results show that the egg hatching and storage machine is well developed and can attract users when using this hatching and storage machine.

Keywords: Egg Hatching and Storage Machine, Internet of Things (IoT), Poultry Farmers, ADDIE

1. Introduction

The livestock industry has been around since long ago (Ariffin, 2014). The livestock industry was created to produce food for the people. According to Ali (2013), Malaysians have the highest average

consumption of chicken in the world. Livestock activities need to be undertaken to avoid the scarcity of local food sources and to depend on imports from abroad. Breeding process need high commitment in order to produce good production. Chicken eggs that are not cared for by the hen, will become damaged.

Current process of egg production is too complicated as users have to constantly move to the chicken coop or egg hatchery to check the condition of the egg, threats from other animal and the time spent for user to look after the eggs. IoT is a sophisticated human creation, with the use of IoT, everyday life will be simple and easy in many aspects (Kale & Mente, 2019). Thus, with the combination of Internet of Things (IoT) in egg hatching machine, user will not have problem with chicken productions.

In general, the breeders still use old hatchery machines in markets where there is no use of Internet of Things (IoT). The level of production is still satisfactory but not as easy as combination of Internet of Things (IoT). This study aims to discuss the development of egg hatching and storage machines in combination with cooling and heating systems along with the IoT.

Therefore the development of this machine was carried out to facilitate the process of hatching eggs with temperature and humidity as well as the use of Internet of Things (IoT). If the project was to be carefully designed, it would reduce the risk of raising poultry for workers in the livestock industry and ensure good work management, so that the time taken for an egg hatching process could be expected and reduce workloads.

2.   Research Background

There are various types of incubator chambers available in the market. In the market, manual and automatic incubator chambers can be selected according to the suitability and comfort of the user. The method of survey done to see the product that has been produced is important as an improvement to the product to be produced. Therefore, previous studies related to egg hatching machine products should be referred to as guidelines for implementing these products.

One of the machines that exists is a manual hatching machine. This manual hatching machine is often used by local operators because in terms of price it is cheap and easily available. This manual hatching machine uses hands to rotate the eggs. Next, this machine uses the bulb as heat to obtain the temperature. This machine uses a thermostat to obtain the desired temperature. Water containers should be placed in the egg hatching chamber to obtain the appropriate humidity.

In addition, there are also automatic hatching machines. This automatic hatching machine is fully controlled by the machine. This machine uses an egg machine that is automatically controlled by the machine, it has to set how many rounds of eggs it wants to do in a day. the heater for this automatic egg hatching machine is the heating coil. Inside this machine there is also a fan to remove excess heat when the heating coil is turned on.

Finally, there is also the agrowindo hatching machine. This agrowindo hatching machine uses a rotating rack that allows it to rotate the eggs on its own. The concept of agrowindo hatching machine is almost the same as automatic hatching machine but the difference is that this machine is equipped with good security features where if the electricity supply is cut off, this machine is still used.

However, based on these three products, there is room for improvement in ensuring that the hatching process can take place more effectively.

Egg hatching can be done in two ways: conventional and artificial or better known as homemade. According to Nafiu, Rusdin & Aku (2014), the use of egg hatching machines is more effective in maintaining embryonic breeding. The Internet of Things (IoT) is a system that allows users to connect to a wide range of electronic, mechanical, digital or human devices provided a unique and powerful way to transfer data and collect data without the need for human-computer interaction.

Design is the decision to decide whether to put it down or to drop it (Lawson & Dorst, 2013). In developing this product, the ADDIE model is used by researcher. This ADDIE model consists of five phases namely analysis, design, development, implementation and evaluation.

The objectives and goals of a design are achieved when the design decisions of the design developed provide a positive result in which the product works well, is safe to operate, usable and the problems that arise can be resolved.
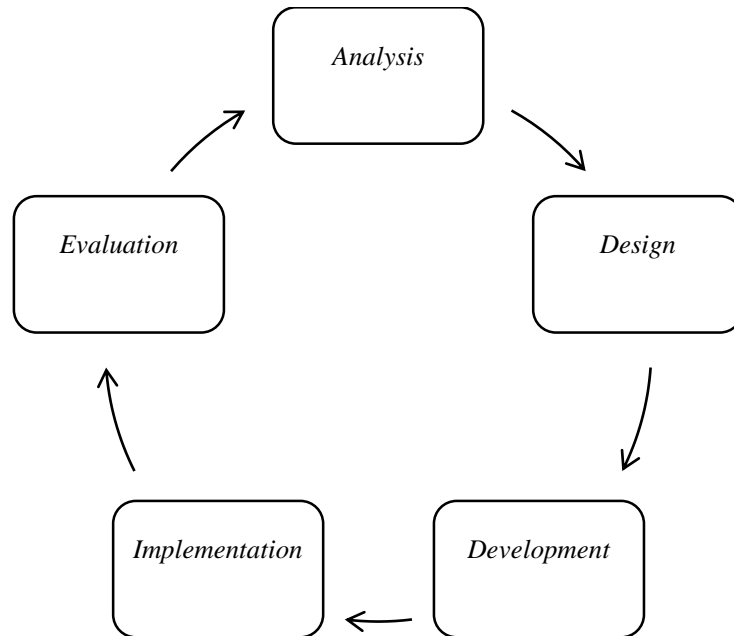
Figure 1: ADDIE model

In the market, both manual and automatic incubator can be selected according to the user's comfort and convenience. The method of surveying to see which products have been produced is as important as the improvements to the products to be produced. Improving the egg hatching machine by adding the Internet of Things (IoT) element would help the breeders. NodeMcu ESP 8266 is a development module for IoT platforms. To use the NodeMcu ESP 8266 circuit board (Figure 2), you first need to program it using Software Arduino (IDE). The DHT 11 sensor is capable of measuring two different parameters, namely the temperature and humidity parameters of the current environment
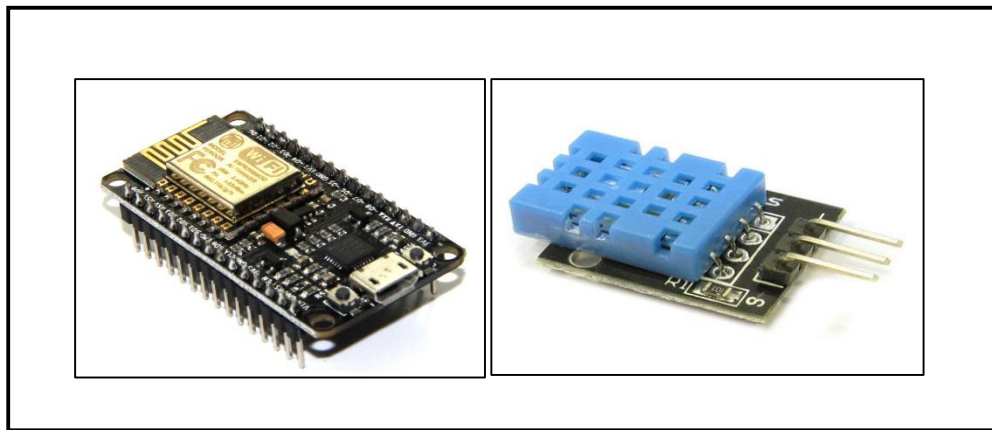
Figure 2: NodeMcu ESP 8266 and DHT 11 Sensor

2.1   Research Objectives

There are 3 research objectives;

- To design the egg hatching and storage machines for use in poultry breeders.
- To developed egg hatching and storage machines for use in poultry breeders.
- To test the functionality of egg hatching machine and storage with the combination of cooling and heating systems with this IoT can be remotely controlled, controlling temperature and humidity.

3.   Methodology

Methodology is a technique and method that often to be used to achieve the objectives and objectives of the study. The design of this study is product development using ADDIE model as development guidelines. The development process of this product is based on 5 phases outlined through the ADDIE Model.

3.1 Analyse

In this phase is to identify the problem researcher want to solve. Researchers used the preliminary survey method by conducting informal interviews with poultry farmers around Kampung Batas Ubi, Yan, Kedah to gather information on the problems encountered.

In addition, researchers collect information through reading materials, surfing the internet and existing products. Researchers have found information on problems with existing products in two ways: by interviewing with a producer of chicken eggs and also by reading. The findings show the need to improve existing products by involving innovations using the latest technology.

3.2 Design

This phase is a phase where egg hatching and storage machine are created based on the analysis that has been performed by the researcher. Based on the findings at the analyse phase, in this phase, the researcher emphasizes the aspects of machine layout, humidity sensing, temperature sensing and the application of the Internet of Things into the product. It aims to avoid any mistakes in the development phase. Researchers care about is important factors such as safety, functionality and development that the researcher can implement are emphasized. This phase is done by drawing three design drawings as a design proposal to be developed and given to expertise. The result of the discussion on the design proposal with the expert involved resulting a complete sketch of the product with complete design as shown on Figure 3, 4 and 5.
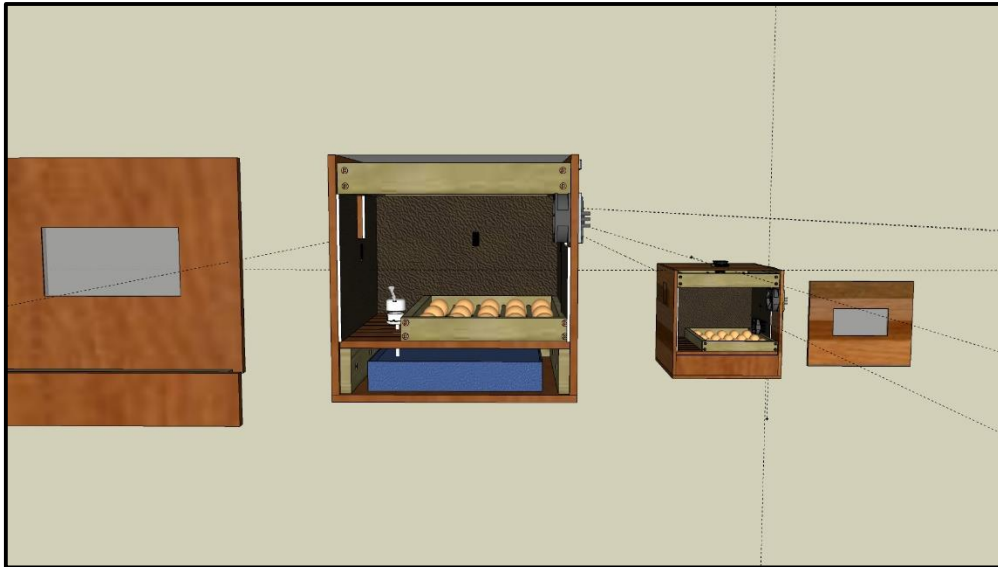
Figure 3: Final design of egg hatching and storage machines in combination with cooling and heating systems along with the IoT
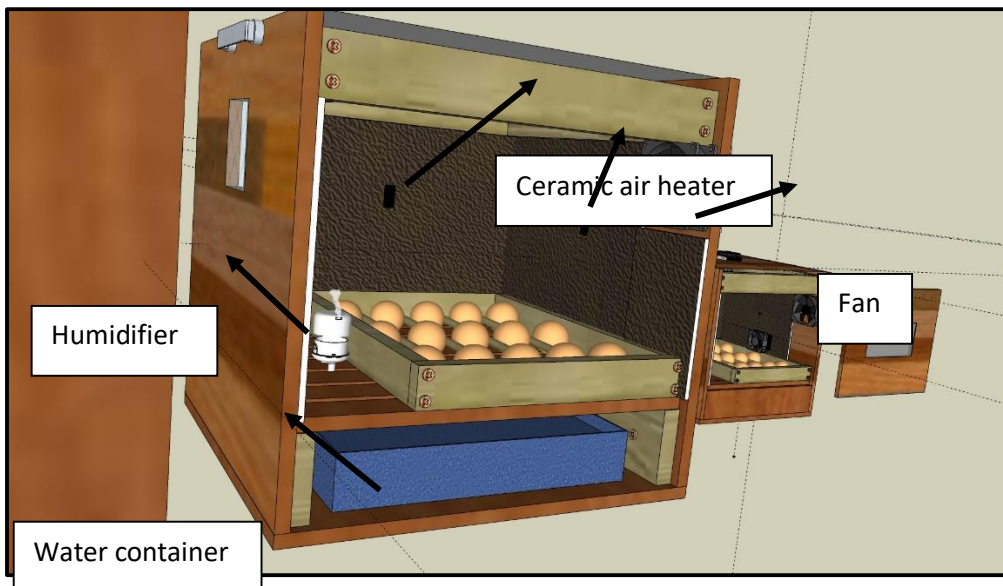
Figure 4: Egg hatching machine
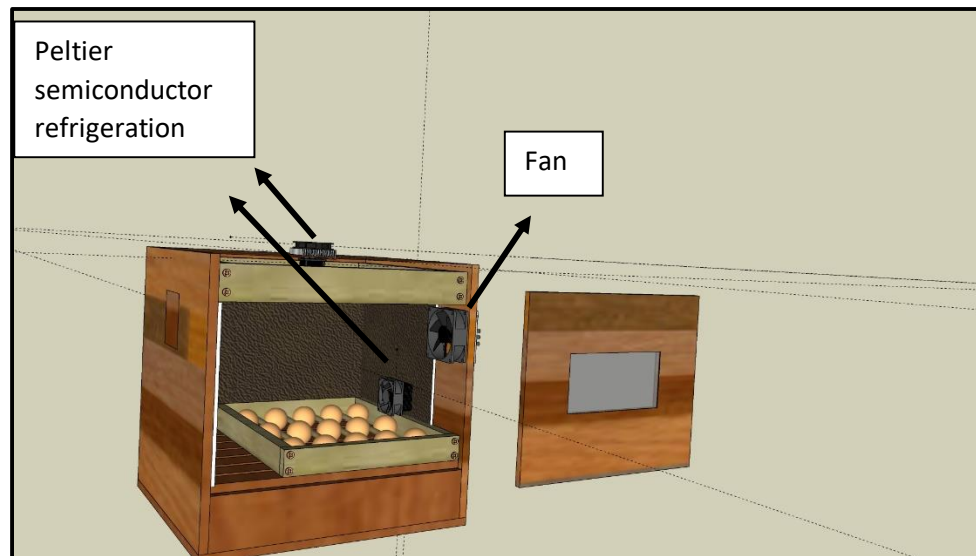
Figure 5: Egg storage machine

This product is equipped with internet access to transmit temperature and pressure displays. Temperature and humidity sensors are placed beside of the machine. Once the temperature and humidity readings are detected by the sensors, they are processed by an Arduino board located beside of the machine box and sent to the cloud so they can be connected to an internet. It enabled smartphone to access the server and display the temperature and humidity readings on the Blynk application.
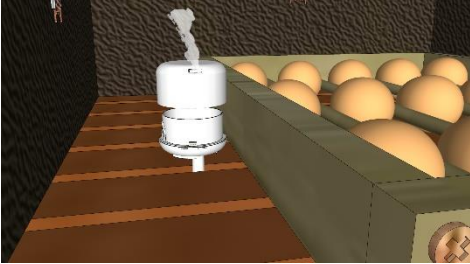
3.3 Development

In this phase researchers dividing the development of mechanical, electrical and IoT parts for the Egg hatching and storage machine. In the mechanical section, the researcher installs components such as ceramic air heater, air humidifier, Peltier semiconductor refrigeration, and fan. For the sensor installation is also included in the development mechanical parts. After the mechanical part, the IoT programming section was developed by using the Arduino Ide for coding on sensors and Arduino boards. After the installation have been done, the circuit was connected to complete the product.

3.4 Implementation

For implementation phase, is to test the product in aspect of design and functionality of the product. Researchers tested the product to get the same specifications as planned in the design phase such as the temperature and humidity control by using Blynk application. Functionality testing of this product is tested in terms of controlling the temperature and humidity in the egg hatching and storage machine by using internet access through Arduino board and display it on the smartphone screen. Detail for the product implementations shown in Table 1.

Table 1: Product Implementation

No	Diagram	Work Operation
1		Testing is done by turning on an egg hatching machine and egg storage
2		Performs the temperature and humidity settings that the user wants
3		When the humidity is less than <70%, the air humidity device becomes actived until the desired humidity level reached, the humidity device deactivated
4		When the temperature is less than <37 ℃, the air heater will be activated until the desired temperature level reached, the air heater deactivated
5		Finally, Temperature and pressure will be recorded and displayed on the smartphone.

3.5 Evaluation

In the evaluation phase of this product, researcher use a quantitative form which is a questionnaire distributed to 2 experts in the field of Chicken breeding and 1 expert in mechanical component. The distribution of the questionnaire was given in Google form and distribute to a technician of University Tun Hussein Onn Malaysia and chicken breeder in Kedah. In the questionnaire, it has aspects of demographics, design, functionality and product improvement recommendations. Comments and suggestions provided by experts will be used to make improvements to Egg hatching and storage machine.

4   Results

Analysis was done after an evaluation process conducted by an expert on the development of egg hatching and storage machines in combination with cooling and heating systems along with the IoT.The content evaluation form has four(4) sections, Part A is the demographic section of the respondents which contains details of educational status, work experience, employment, and specialization. Part B deals with content design containing eight (8) items. Whereas part C is a Functional Aspect containing six (6) items. Part D that is the comments section is for comments and suggestions.

Table 2: Expert demographic

Detail	Expert One	Expert Two	Expert Three
Education Status	Degree	SPM	Diploma
Work Experience	4 Years	36 Years	24 Years
Employment	Operation executive	Plan designer	Laboratory supervisor
Rating Category	Product design and functionality product	Product design and functionality product	Product design and functionality product

The purpose of the analysis is to identify whether the evaluation item for content design meets the expectation have been done by the researcher. The expertise has provided a good feedback on the item being submitted. The result is shown on Table 3.

Table 3: Expert analysis of design

No	Item	Frequency		Notes
		Yes	No	
1	The design of this egg hatching machine is creative and exciting	3	-	-
2	Does the egg hatchery design relevant?	3	-	-
3	Does the egg hatchery design suitable for use?	3	-	-
4	Does the egg hatchery design safe to use when the testing process is in progress?	3	-	-
5	Does parts of each model easy to see?	3	-	-
6	The size of the design of this model fits the intended use.	3	-	-
7	Does this design model suitable for home use?	3	-	-
8	Does the design of this model guarantee the satisfaction and confidence of the user when using this machine?	3	-	-
9	Does the design of this egg hatching machine user-friendly?	3		
10	Does using blynk application on this machine make it easier for users?	3		

Next evaluation is aspects of functionality. Experts agree that the temperature and humidity level can be controlled by using Blynk application. Experts agrees that all component works well and received a 100% acceptance rate. Experts agrees by using the heating device will increase the temperature level. Next, expert agrees that by using Blynk application is user-friendly. Table 4 is the result of the analysis of the functionality of product that have been performed.

Table 4: Expert analysis of functionality

No	Item	Yes	No	fFrequency
1	Does this egg hatching machine suitable for hatching purposes?	3	0	100%
2	Does this model reach the desired temperature (35 ℃ - 40 ℃)?	3	0	100%
3	Does this model achieve the desired air humidity (70% -80%)?	3	0	100%
4	Does every component used well?	3	0	100%
5	Does the heater part suitable for the desired temperature increase?	3	0	100%
6	Does Blynk application development easy to use?	3	0	100%

Finally, in the comments and suggestions section, experts have given positive comments and suggestions for improvements to the product. Researcher have made improvements based on the suggestions provided. Among them is by using the pre insulated aluminum for this project to make it more heat resistant. Table 5 contains comments and suggestions from experts.

Table 5: Expert comments and suggestions

Expert		Comments and suggestions
Expert 1	i.	Appropriate ideas according to market demand
	ii.	Research on the percent efficiency of egg hatching machines to reach up to 100%.
Expert 2	i.	This egg hatching machine is the best. Does not burden the breeder, saving time and can be marketed.
	ii.	Hopefully this egg hatching machine will be in the local and international markets one day.
Expert 3	i.	Interesting ideas and designs.
	ii.	Can use pre insulated aluminum for this project to be more heat resistant.

The implication of this product to the breeder is safety of the egg will be guarantee. Breeder would not need to always spectating their temperature in the egg hatching machine. By using Blynk application, breeders can spectate the temperature by only watching through smartphone screen. Breeders can also set their desired temperature and humidity level by using Blynk application. In fact, the comments and suggestions provided by the experts indirectly streamlined the application development process.

5. Discussion

The discussion can be carried out on this study is by follows three things namely design, functionality and suggestions for improvement. Researchers emphasize these three things because the objectives of the study and the research questions are based on them.

In developing this product, Researchers have used the ADDIE model as a reference to develop this egg hatching machine. The ADDIE model is an ideal model because there are five phases in which the

first phases are Analyze, Design, Develop, Development, Implementation and Evaluation. The goals and objectives of a design are achieved when they meet all the design flaws that are designed to deliver a product that is seamless, user-friendly, safe and user-friendly. The findings show that the design aspects of the product developed are high and this indicates that the design of this egg hatching machine is suitable for use at home and user-friendly.

From a functional aspect, the researcher ensures that the product can detect temperature and humidity level in the incubating space to be processed and displayed on the smartphone screen. Therefore, researchers connect DHT 11 sensors to a control box beside the machine that has an Arduino Board. Next, researchers use a Blynk application that stores processed temperature and humidity readings.

For the product improvement aspect, the researcher has provided a questionnaire to experts. There are two experts give suggestion for the production and that is installing pre insulated aluminium and doing a research on how to increase the efficiency of egg hatching to 100%. Lastly. researchers also take expert views to improve the egg hatching and storage machine to obtain readings more accurate and installing another component to make the product more effectively.

6. Conclusion

The development of egg hatching and egg storage machines in combination with cooling and heating systems along with IoT can be implemented to help breeders improve their production quality. In addition, with the Blynk application, it can help ease the burden of breeders to control the temperature and humidity in the hatching room. In addition, it can also attract users as it has a simple and intuitive interface. Overall, researchers can successfully develop this egg hatching machine. In fact, comments and suggestions provided by experts indirectly furthered the process of developing this egg hatching machine.The results and discussion section presents data and analysis of the study. This section can be organized based on the stated objectives, the chronological timeline, different case groupings, different experimental configurations, or any logical order as deemed appropriate.

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