Temperature Characteristics of Post-Harvest Technology Equipment Based on Biomass Waste Energy Using the Internet of Things Telecontrol System

Juandi Muhammad\textsuperscript{1}, Joko Risanto\textsuperscript{2}, Gimin\textsuperscript{3}

\textsuperscript{1}Department of Physics, Universitas Riau
\textsuperscript{2}Computer Science, Universitas Riau
\textsuperscript{3}Economics Education, Universitas Riau
Jl. HR. Soebrantas, Km. 12.5, Pekanbaru, 28293, Indonesia
juandi@lecturer.unri.ac.id

Abstract. Technological innovations based on the internet of things have been designed, this technology is very suitable to deal with New Normal conditions (Covid 19). This internet of things-based technology tool has been tested on a laboratory scale to produce a prototype tool, which is ready to be implemented on an industrial scale. Biomass-based post-harvest technology innovation with the internet of things system, Stages of research methods to achieve goals. The first stage is to design a technological innovation design, to design an internet of things work system, to test the results of the tool design on a laboratory scale. The results of the characteristic test of this technological tool using coconut shell biomass waste with variations in the number of shells, 6, 8, 10 and 14. The results of the temperature characteristics in the drying chamber show that there is a linear relationship between the maximum temperature results produced and the number of coconut shells. Temperature results data can be viewed via an Android phone or based on the Internet of Things (IoT).

1. Introduction
Environmentally friendly technology and a sustainable economy are very important in line with the vision of the University of Riau, namely the Dignified Research University in the Field of Science and Technology in the Southeast Asia Region in 2035. The research strategic plan of the University of Riau in the management aspect of natural resource management is realized in the form of post-harvest technology that is environmentally sound. There have been many researches on post-harvest drying technology, including the study of desiccant technology based on coconut shell waste [1]. Drying apples, depending on the output voltage [2]. Transparent walled drying chamber design [3]. Furthermore, Juandi from 2015 to 2019 found the scientific concepts that underlie the development of research. Utilization of biomass-based drying technology to dry cracker raw materials [4], other product drying applications [5], the use of biomass stoves helps to make crackers [6]. Research innovation funded by DIPA UNRI biomass-based drying innovation with an alarm system [7]. Developed an innovative model of a biomass-based dryer with a microcontroller automation system.
The patent that Juandi has produced is the PATENT of Biomass Waste Energy-Based Dryer Technology. Registration: P00201901985 [9]. PATENT Development of Post-Harvest Technology of Biomass Energy-Based Dryer Simple Patent No. Registration: S00201909089 [10]. The development of previous researchers and the results of Juandi's research, it is necessary to innovate on technology, especially the current condition is New Normal (Covid 19). Juandi needs to do further research with the title Post-harvest technology innovation based on biomass waste energy using the internet of things telecontrol system.

The problems in this research are (1). There is no internet of things system. Post-harvest technology innovation based on biomass energy, (2). There is no laboratory scale trial to produce a prototype of a biomass-based post-harvest technological innovation implementation tool with the internet of things system.

2. Methodology

2.1 Tools and Materials

| Tools /Materials                  | Use for                                    |
|----------------------------------|--------------------------------------------|
| Internet of things system        | Implementation of circuits for data        |
|                                  | acquisition                                |
| Arduino                          | Microcontroller                            |
| Dryer Technology Tool            | Drying post-harvest products               |
| Corn cob and coconut shell       | fuel source of biomass                     |
| Fire drum                        | a place for burning the biomass            |
| Drying rack                      | a place for the crackers                   |
| Drying cabinet                   | drying process room                        |

2.2 Proposed IoT-based technology

The design of the Proposed IoT-based technology is consisted of a cabinet with 3 chambers, open fire drum, a couple armed window and IoT board as a controller as shown in Figure 1. The data obtained from drying using a tool will be observed via an android phone.

![Figure 1. Schematic design of Proposed IoT-based technology. (a) Top view and (b) side view.](image)

2.3. IoT board

The IoT board consisting of an Arduino, an LM35 sensor, and a buzzer. Arduino used as microcontroller (MC) to control the temperature sensor and open the window. Figure 1 shows schematic design of the board.

IoT will provide information about the temperature value in the drying chamber which can be observed through an android phone. IoT is a computer system that is connected via the internet, with...
the aim of for system control and data logging. In IoT, there are generally a mini computer connected to sensors with special functions. This mini computer is capable of sending and receiving data via a WiFi connection. This WiFi feature is what makes this mini computer very capable, because can be used for sending sensor data (also called data logging) or commands from user to a mini computer (control system), both processes can be done remotely (remote). In data logging, the computer will read the output from the sensor, this output will be sent to the server which located in a data center, such as Amazon Web Service or Google Cloud Platform. On the server, there are database that functions as a data store. Furthermore, the data that has been saved can be read using a programming language such as Python for further processing purposes.

2.4. Testing and data collection
The crackers are put into the dryer and each rack is installed temperature sensor to measure the temperature on each chamber. The data collection process was carried out for 2 to 3 hours with an interval of each 1 second.

3. Results and Discussion
The final look of our proposed technology using IoT is shown in Figure 3. Aluminum plate is covered the cabinet and fire drum is placed in the bottom. IoT board is place on the top of tools. This tool is developed to provide a near constant temperature around 30°C to 90°C. The proposed tool is modified design from our previous design for drying agricultural products [4].

![Figure 2. Schematic design of IoT board](image)
Figure 3. Realization of post-harvest drying technology (a). Installation of an IoT system on a biomass-based drying technology device, (b). Temperature data can be observed via Android phones.

Figure 4. Temperature characteristics inside the dryer, (a). 10 Coconut shells, (b). 14 Coconut Shell, (c). 6 Coconut Shell, (d). 8 Coconut Shells.

Based on Figure 4, it can be said that the minimum temperature produced in the dryer is around 30 degrees Celsius, while the maximum temperatures for 10, 14, 6 and 8 coconut shells are 66.3 degrees Celsius, 89.1 degrees Celsius, 61.4 degrees Celsius, and 75.9, respectively. degrees Celsius, while the temperature resistance in the drying chamber for 14 shells is for 3 hours, otherwise for 2 hours. Based on these temperature characteristics, it can be said that to dry products that are not too thick, or thin sizes can take 2 hours, drying can use 6 shells, but for thick products it takes 3 hours to dry, 14 shells are needed. The temperature characteristics in the drying chamber can be used to design the equipment for drying certain agricultural products, so that the dried material is not damaged.
Based on Figure 5, it can be seen that the maximum temperature model produced in the drying chamber meets the linear model with a correlation level of 0.7095, with a line gradient model parameter of 3.01 and a constant parameter of 44.58. The model obtained can be used to estimate the material requirements of food products with certain sizes which require high or low temperatures. Table 2 shows the value of the temperature characteristics in the dryer.

**Figure 5.** Maximum temperature model based on the number of coconut shells in the combustion chamber

| Coconut shell | Minimum temperature (°C) | Maximum temperature (°C) |
|---------------|--------------------------|--------------------------|
| 6             | 33.3                     | 61.4                     |
| 8             | 35.9                     | 75.9                     |
| 10            | 31.6                     | 66.3                     |
| 14            | 29.6                     | 89.1                     |

The temperature characteristics in the dryer can be seen approaching the graph of the Gaussian peak curve with four parameters [11].

\[ T(t) = T_0 + a \exp \left( -\frac{1}{2} \left( \frac{t - t_0}{b} \right)^2 \right) \]

**4. Conclusion**

The characteristics of the dryer have been successfully carried out using the IoT system, that from the results of the characteristics it turns out that the tool works very well with a minimum temperature value of around 30 degrees, and the maximum temperature depends on the number of shells used. Generally the temperature value in the tool works well for 2 hours using 6.8 and 10 coconut shells, while for 3 hours it is using 14 coconut shells. The maximum temperature characteristics produced from the tool based on the number of coconut shells can be approached with a liner model with a slope gradient of 3.01 and a correlation level of 0.7095.
References

[1] Azmir J, Hou Q and Yu A 2018 Discrete particle simulation of food grain drying in a fluidised bed Powder Technology 323 238-249

[2] Salli G S and Fat J 2015 Perancangan dan realisasi sistem pengering buah apel Jurnal Kajian Teknologi 11(1)

[3] Sukmawaty S, Priyati P, Guyup M D P, Diah A S and Sirajuddin H A 2019 Introduksi Alat Pengering Tipe Rak Berputar Sebagai Upaya Mempercepat Proses Pengeringan Hasil Petanian Jurnal Masyarakat Mandiri (JMM) 3(1)

[4] Juandi 2015 IbM Kelurahan Rejosari Untuk Meningkatkan Produksi Dan Kualitas Usaha Nita Kerupuk Opak Singkong Dan Usaha Renggilang Singkong Melalui Penerapan Teknologi Pengeringan Kolektor Tenaga Energi Biomassa Yang Ramah Lingkungan. Ristekdikti

[5] Juandi 2016 IbM Bina Mandiri Energi Kelompok usaha opak singkong (Mitra 1) dan Kelompok Usaha Rosa Rengilang Singkong (Mitra 2) Rejosari, Ristekdikti

[6] Juandi 2017 IbM Kecamatan Tampan Untuk meningkatkan produksi dan kualitas usaha kerupuk jangek (MITRA 1) dan usaha Kerupuk ikan bawal (MITRA 2) melalui penerapan teknologi pengeringan tenaga biomass yang ramah lingkungan. Ristekdikti.

[7] Juandi 2018 Rancang Bangun Teknologi Berbasis Energi Biomassa Untuk Pengeringan Bahan Olahan Kerupuk Ikan yang Ramah Lingkungan. DIPA UNRI

[8] Juandi and Usman M 2019 Pengembangan Teknologi Pasca Panen Pengering Berbasis Energi Biomassa, DIPA UNRI

[9] Juandi 2019 PATEN Teknologi Pengering Berbasis Energi Limbah Biomassa Paten No. Pendaftaran: P00201901985

[10] Juandi 2019 PATEN Pengembangan Teknologi Pasca Panen Pengering Berbasis Energi Biomassa Paten Sederhana No. Pendaftaran: S00201909089