Design of an automatic cost-effective cracker dryer as an effort to increase the production of squid crackers at Banyuwangi Regency

Brian Raafi'u[1*], Fitri Adi Iskandarianto[1], Joko Susilo[2], Erna Septyaningrum[3], Rakmad Amrinsyah[1], Badrul Alam[1], Tedy Agasta[1]

[1] Department of Instrumentation Engineering, Institut Teknologi Sepuluh Nopember, Surabaya, 60111, Indonesia.
[2] Department of Electrical Automation Engineering, Institut Teknologi Sepuluh Nopember, Surabaya, 60111, Indonesia.
[3] Department of Engineering Physics, Institut Teknologi Sepuluh Nopember, Surabaya, 60111, Indonesia.

Email of corresponding: brian@its.ac.id

Present Address:
Instrumentation Engineering Building, Jl Raya ITS, Surabaya 60111, Indonesia

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Abstract—Banyuwangi is a regency with a coastline length of about 175.8 km with 10 islands. The east coast of Banyuwangi (Bali Strait) is one of the largest fish producers in East Java. Banyuwangi is the second largest producer of fishery commodities in Indonesia. One of the villages in Banyuwangi Regency, Mojopanggung Village, has the potential for a thriving squid cracker business. The management of crackers in this village has not changed significantly from year to year, 90% of the management of the ponds is done traditionally, starting from the process of making raw materials for crackers, drying crackers to the marketing process. The most common problem faced by cracker business owners is the loss caused by the rainy season. Almost 50% to 75% of the crackers are not produced in a period of 1 to 4 months due to limited sunlight as a medium for drying crackers. This is evident from the decreasing amount of production. The most influential factor is the heating medium that changes based on natural conditions. Meanwhile, the demand for all types of crackers continues to grow. In its management, one of the dynamic elements that need to be considered is the temperature of the cracker dryer. Some of the physical variables that affect the quality of the drying process are temperature, humidity, and automatic scheduling, and to support the success of the cracker drying process, these parameters really need to be known by SME cracker business owners in Banyuwangi Regency. So the need for a cheap and energy-efficient technology for the drying process of crackers, which can produce good quality crackers, so that cracker-producing SMEs can significantly increase their production without any restrictions on natural conditions.

Keywords—Frugal Cracker Dryer, Temperature, Humidity, Scheduling, Fuzzy Control System.

1. INTRODUCTION

Banyuwangi is a regency with a coastline length of approximately 175.8 km with 10 islands [1]. The east coast of Banyuwangi (Bali Strait) is one of the largest fish producers in East Java [2]. One of the sub-districts in Banyuwangi district located on the east coast of Banyuwangi is Muncar sub-district. Seen in Figure 1, Muncar sub-district, Banyuwangi regency, has huge fisheries potential since 1995 until now. Most residents of Wringinputih Village earn income from the potential of the pond. One of the seafood commodities utilised as a livelihood for the local community is squid cracker production. The traditional processing of cracker production has been known for a long time among the community in general. One of the traditional processes

of making fish or squid crackers is the drying process with the help of nature, namely solar heat.

Figure 1 Map of Banyuwangi Regency and Muncar Fisheries Producing Area [1]

Sun drying has long been practised and is one of the oldest methods of making crackers in Indonesia [3]. According to the owner of a Fish Crackers (squid) SME in Muncar sub-district, Banyuwangi Regency, the biggest problem is during the drying process. This process is very vulnerable to changes in the sun as a source of heat, a problem that is often faced by SME Crackers is the loss caused by the dynamically changing rainy season. This is evident from the fact that turnover is reduced by up to 75% from the amount produced during the dry season. The most influential factor is the dependence of the SMEs on natural conditions for the drying process. This is because the sun in Indonesia is very dynamic. It can be seen in Figure 2 that the squid cracker SMEs in this village are still dependent on natural conditions for the drying process.

Figure 2 Drying Process of Crackers SMEs in Banyuwangi Regency

The dynamic nature is caused by weather changes, seasonal changes and so on. In the drying process, one of the dynamic elements that need to be considered is temperature and humidity as a process to reduce the moisture content in crackers [4]. Some physical variables that affect the quality of the cracker drying process include temperature, humidity, and drying time [5], and to support the success of the cracker drying process, these parameters need to be known by the Squid Cracker SMEs in Banyuwangi Regency. The need for an automated technology for the cracker drying process, which can be used at any time without depending on natural conditions, so that squid cracker SMEs can significantly increase squid cracker production. Because it is proven that the need for crackers, especially crackers made from seafood (squid and sea fish) has enormous market potential in Indonesia.

2. METHOD

2.1. Novelty of Cost-Effective Dryer Design

This research seeks to reduce losses from the drying process of squid crackers and increase the profit of Squid Crackers SMEs in Banyuwangi Regency. The strategy to be used in this research is the manufacture of appropriate technology for an automatic cracker dryer at an affordable cost, so that Squid Crackers SMEs increase the productivity of quality crackers. This research activity method consists of making appropriate technology tools, testing appropriate technology, and socialising the dryer as an appropriate technology product. The automatic cracker dryer that will be made in the research is shown in the design of Figure 3 to Figure 6 and has the following specifications of tools and components:

1. Machine dimensions
    a. Length: 60 cm
    b. Width: 50 cm
    c. Height: 50 cm
2. Weight: 4kg
3. Material: Wood and acrylic
4. Sensor: DHT11, Real Time Clock (RTC), Soil

5. Processor: AT-Mega 16
6. Actuators: Light bulb, DC fan, hot peltier
7. Display: 20X2 LCD
8. Working voltage
    a. Microcontroller: 5VDC
    b. Actuators: Light bulb (220Volt AC), DC fan (12Volt DC), Peltier (12 Volt DC)
9. Power source: 220 Volts AC 1 Phase

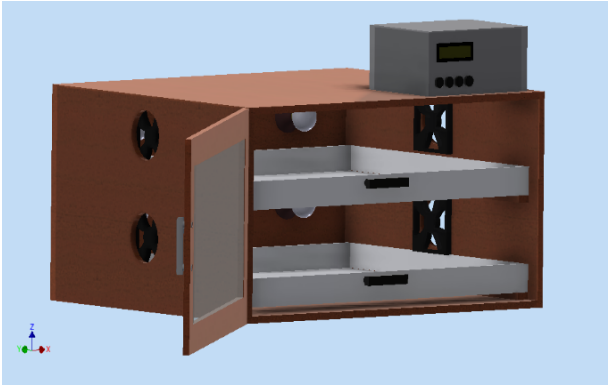

Figure 3 Design of Automatic Dryer

The block diagram of the Automatic Cracker Dryer prototype uses several supporting components in the form of sensor components, electronic controller components, and actuator devices as shown in Figure 4. Some inputs in the tool block diagram consist of a DHT11 sensor to determine the current temperature conditions of the drying room, a soil moisture sensor to determine the level of dryness of crackers, and a Real Time Clock (RTC) module to determine the time during the drying process. There are 4 buttons to adjust the parameter settings on the machine. The main controller used is a microcontroller with embedded software using the main complier application programme as the main regulator of the cracker drying process in the form of temperature control settings through light bulbs, hot air circulation control through fans.

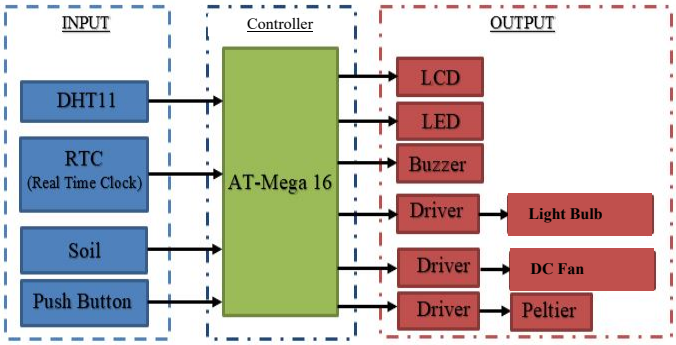

Figure 4 Hardware Schematic of Cost-Effective Automatic Dryer appropriate technology

The output on the machine consists of display and notification outputs in the form of a 20x2 LCD, DC buzzer and led indicators which include a display of temperature and humidity values. in the drying process, and the drying process time. Another output is in the form of AC voltage settings on the lamp bulb to determine the temperature in the drying room in accordance with the setpoint on fuzzy logic control, as well as setting the fan rotation speed combined with a hot peltier to determine the humidity and stability of air circulation in the drying room. The control block diagram of the cracker dryer uses a fuzzy logic control system. Fuzzy parameter settings use reference references in literature studies and several previous studies, especially in temperature parameters adjusting to the reference needed in the drying process, namely 40-50˚C [6]. In accordance with the references obtained in the literature study for temperature control with this value, the fuzzy logic control output on the Cracker Dryer tool is in the form of a duty cycle (PWM) value connected to the AC light bulb driver to regulate the heat level (temperature) in the drying room to keep adjusting the temperature reference set point value automatically [7].

Figure 5 Front View of Dryer Design

Figure 5 shows the design of an automatic cracker dryer with the main material of wood with a combination of acrylic materials for the drying chamber. As for the cracker container, a heat-conducting material in the form of aluminium is used. The control box of the dryer will be placed at the top with the main material of the controller case using a panel box.

Figure 6 Design of Automatic Cracker Dryer Front Side View

The working principle of this automatic cracker dryer is to regulate the temperature conditions in the drying chamber in accordance with the temperature reference which ranges from 40-50˚C and regulate air circulation in the drying chamber which is more stable and regular than the conventional way. Determination of temperature and humidity setpoints and basic rules of fuzzy logic control methods in the drying process greatly determines the performance and response of temperature regulation and air circulation speed in the drying room [8].

3. RESULT AND DISCUSSION

3.1. Cracker Dryer

This research resulted in the application of appropriate technology that is useful for reducing losses from the failure of the squid cracker production process due to changes in solar heat conditions. The strategy implemented in this research is the manufacture of appropriate technology for automatic squid cracker dryers at affordable costs, so that cracker MSMEs can increase the productivity of squid crackers. The Automatic Squid Cracker Dryer made in this research has several significant effects on squid cracker MSMEs in Banyuwangi, including the following:

- Dependence on natural conditions, namely sunlight and heat for the drying process of squid crackers.
- The level of public awareness of the application of technologies that can easily be made by themselves.
- Changing the old habit of drying squid crackers in open areas with new habits through a cost-effective automatic cracker dryer.

Figure 7 Appropriate Technology for Cracker Dryer Inner Front View

The implementation of the results of making appropriate technology 'cost-effective squid cracker dryer' results in the effectiveness of squid cracker MSMEs in producing more hygienic products. This drying process can be done at night and during the day without depending on natural conditions. Figures 7-9 are the realisation of the results of the Cost-Effective Squid Cracker Dryer which is instant and simple in its manufacturing process. The weather from August to December in Banyuwangi Regency is characterised by fluctuating sunlight or heat. In August, the average ambient temperature is 290C, and sunlight is often covered with cloudy clouds. So that the drying process needed by MSMEs in the squid cracker production process is not optimal. In the dedication [9] Fish dryers use materials and mechanical systems that are relatively expensive, because they require service fees from workshop fabrication, and this dryer system still requires dependence on sunlight as a drying medium. What can be taken from this fish dryer is a design that makes solar heat more optimal in the drying process. The Appropriate Technology that was built in 2020 utilises leftover materials, namely wood or shelves on the base of crackers. The estimated total mechanical cost spent when MSMEs want to make this appropriate technology is Rp. 250,000.

Figure 8 Dryer Control Panel

There are two main buttons, namely automatic and manual, when the automatic button is pressed, the controller system will directly activate fuzzy control to regulate the bright or dim work of the light bulb and hot peltier as a temperature setting in the drying room that continues to adjust the pre-set setpoint. When the temperature reading with the DHT11 sensor has a value above the temperature setpoint, the fuzzy control will directly reduce the duty cycle value (PWM) connected to the AC driver on the light bulb to reduce the heat / temperature in the drying room, another condition if the temperature is below the setpoint then the duty cycle value (PWM) will be increased to regulate the heat of the light bulb and hot peltier higher.

Figure 9 Pengujian Sensor ZMPT201B

The temperature setpoint used in this cracker drying process is 45℃. The test was conducted for 48 hours non-stop. Figure 10 presents the stability level of this cost-effective cracker dryer in maintaining the temperature.

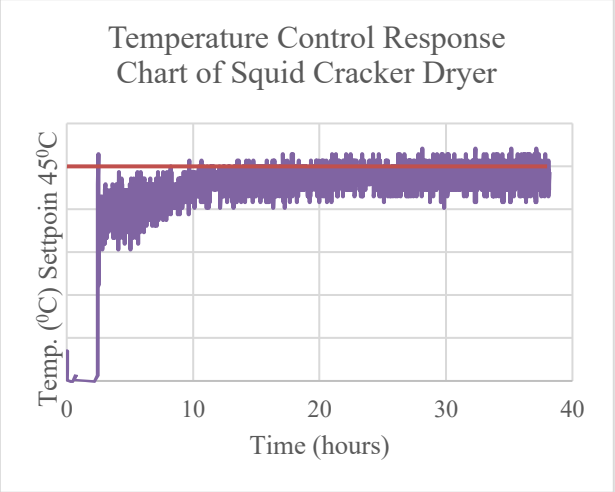

Figure 10 Temperature Control Response of Appropriate Technology for Automatic Cracker Dryer Tool

The fuzzy logic control system will be stopped if the manual button is pressed on the dryer. The output on the LCD display is the length of the drying process and the level of maturity of the tape, the temperature and humidity values in the drying room.

Figure 11 Implementation Results, Monitor the Quality of Drying Results with Appropriate Technology for Drying Equipment

Figure 12 Drying Test of Squid Crackers

Figure 13 Realisation of a cost-effective squid cracker dryer

The temperature change in this TTG is influenced by the actuators used, namely a 5W light bulb, and peltier + fan. This system is considered to be able to be used for a full day with a power consumption of 50watt/hours. The testing of the Squid Cracker Dryer went through two stages. The first stage is laboratory-scale testing with wet raw materials of squid crackers. The second stage after the first stage is in accordance with the class III quality standard [10] is tested directly at the location of the Squid Cracker UMKM with variable time and

variable number of squid crackers. After the two stages are carried out and in accordance with class III quality standards, the next process is to make mass media publications, and submit patents / IPR. Figure 13 is the mechanical output of the cost-effective automatic squid cracker dryer and Figure 9 is the output of the electrical module of the cost-effective automatic squid cracker dryer that will be proposed as a patent.

4. CONCLUSION

Based on the problems and results of the research on the design of an automatic squid cracker dryer, it can be concluded that a cost-effective cracker dryer has been designed using instrument components with small electrical energy consumption. The results of this dryer can stabilise the temperature of 45˚C for 40 hours based on experimental test data.

- The DHT11 sensor as a temperature and humidity sensor has an average error reading of 0.01 at 45˚C.
- The DC Fan Actuator, Peltier, and 5W Bulb Lamp produce heat energy with the fastest time to reach the 45˚C setpoint is 30 hours and stabilizes within 40 hours.

REFERENCES

[1] 'Peta Banyuwangi', 2019.
[2] B. P. P. D. Kabupaten Banyuwangi and P. I. B. dan L. M. Universitas Brawijaya, 'Masterplan Percepatan dan Perluasan Pembangunan Ekonomi Daerah (MP3ED) Kabupaten Banyuwangi', 2019.
[3] H. Wibowo and E. Purnomo, 'Pembuatan alat pengering kerupuk untuk industri kecil pedesaan', *INOTEKS: Jurnal Inovasi Ilmu Pengetahuan, Teknologi, dan Seni*, vol. 8, no. 2, 2004.
[4] Badan Standardisasi Nasional, 'SNI Kerupuk ikan - Bagian 2: Persyaratan bahan baku', 2009.
[5] Badan Standardisasi Nasional, 'SNI Kerupuk ikan - Bagian 3: Penanganan dan pengolahan', 2009.
[6] Z. Alex, M. Ali, and R. Brian, 'Speed control of single phase ac motor on cocoa beans fermentation process using pid controller', in *Proceedings of the 8th Annual Basic Science International Conference, Malang, Indonesia*, 2018, pp. 6–7.
[7] B. Raafiu and P. A. Darwito, 'Smart Monitoring of Solar Panel System in Saving of the Electrical Power with Internet of Things', *Proceedings Book*, 2018.
[8] P. A. Darwito *et al.*, 'Design and development of fuzzy-pid controller for four-wheeled mobile robotic stability: a case study on the uphill road', *IPTEK The Journal of Engineering*, vol. 6, no. 1, pp. 6–11, 2020.
[9] R. Hantoro, G. Nugroho, and E. Al., 'Photovoltaic sebagai Penyuplai Kebutuhan Energi Listrik Alat Pengering Ikan Warga Desa Nambangan Perak Kenjeran.', 2017.
[10] Kementerian Lingkungan Hidup, 'Baku Mutu Kelas III Peraturan Republik Indonesia No. 82', 2001.