Analysis of water, light sensors, and performance on rice drying machine

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**Abstract**. The rice drying system in Indonesia is still inefficient, especially for drying now using the old method using conventional drying. So it requires a large area in drying rice yields and requires a lot of energy. Therefore it is necessary to make appropriate technology for rice dryers with a combination of conventional drying systems by adding sensors. The method used in this research is the Quality Function Deployment method. The results of this study indicate that the analysis of the rain sensor functions optimally when the sensor is exposed to water splashes then sends a signal to Arduino Uno by closing the roof by moving the power window. The LDR sensor, as a light sensor works when the light intensity standard that is set is met and sends a signal to Arduino Uno to open the roof by moving the power windows. The roof cannot open if the two sensors are not free from several conditions, including wet conditions on the rain sensor and intensity standards that are not met or far from the set standards. It is hoped that with the right technology, this rice dryer can help farmers in drying rice yields.

1. Introduction

In the farmers opinion as the user of technology, only some farmers were able to and would apply postharvest technology due to different abilities, culture, habits, reluctant to adopt new technologies, and other social problems. Farmer institutions in West Sumatra were generally government facility oriented and the farmer business was not profit oriented [1]. Several rice post-harvest handling processes are needed to produce products ready for consumption, including: threshing process to separate the rice from the panicles, the rice drying process to reduce the moisture content in the rice, the sifting process (cleaning the rice from dirt), the packaging or storage process, and the milling process to separate the rice skins and rubbing them to produce white-coloured rice ready for consumption [2]. A rice drying process constitutes one part of the processes that determines the quality of rice due to its relation with the storage and milling processes. Drying is a process of reducing the moisture content of a material to a certain limit thermally [3]. The maximum water content value of rice according to SNI (Indonesian National Standard) standards and which is required by BULOG (Logistics Agency) in its purchase is 14% (Joint Decree of the Head of the Food Security Community Guidance Agency No. 04/SKB/BBKP/II/2002).

The rice drying process generally takes three days, but the time needed can reach one week if the rainfall is high. It can be concluded that rice drying takes up to 54 hours to reach a moisture content of 14.12% so alternative rice drying is necessary to shorten the drying time [4]. The manufacture of a vertical drying machine shows that the higher the drying air temperature used, the higher the drying rate and drying time are accelerated [5]. The drying machine for agricultural products uses three different energy sources, namely solar energy, biomass fuel energy, and coal fuel energy [6]. Thermostat controlled rotary dryer for agricultural produce which can be used for rice and sweet potatoes [7], and potato chips [8]. Drying machines using solar cells can dry agricultural products efficiently [9]. Solar dryers for agricultural and marine products [10]. The drying machine uses biomass energy combined with rotary dryer and biomass-heater for 180 minutes to reduce moisture content and drying rate [11]. This study analyzes water and light sensors on a rice dryer, so that if it rains the roof of the dryer can close automatically using a sensor. Because there has been no research on drying machines that use water sensors and light sensors.

A sensor is a device to detect/measure something, used to change mechanical, magnetic, heat, light and chemical variations into voltage and electric current. In the control system and robotics environment, sensor provides similarities resembling eyes, hearing, nose, tongue which will then be processed by the controller as the brain [12]. Input from an application providing command information is received by the control device system, in this case using the Arduino Uno microcontroller device, which is able to convert digital signals into mechanical movements in operating doors for open-closed movements [13].

Therefore, it is necessary to research water analysis, light sensors, and performance on rice drying machines using the Quality Function Deployment (QFD) method. QFD is an effective method of developing products with a structured approach that engages users [14]. The QFD method aims to convert customer needs into product designs [15,16]. The QFD method has four phases, namely the product planning stage, product design, process planning, and process control [2,17–20].

1. Method

The method used in this research is the Quality Function Deployment method, because the method is very suitable for use in product development by the expectations and desires of users [14,21,22]. The data collection technique starts with the identification of user needs, technical requirements, the value of the relationship between technical requirements and the attributes of user needs, and the relationship between technical requirements. Identification of customer needs is done by distributing questionnaires to 30 farmers to determine the attributes of user needs [23]. The attributes of customer requirements will be discussed with experts to determine technical requirements and the relationship between technical requirements. This technical requirement is the reference in designing a rice dryer using a water and a light sensor.

Researchers analyzed the performance of appropriate technology for the rice drying process, particularly in the use of water and light sensors against the weather conditions. The two sensors are used as input to the Atmega328 control system in case of dark and rainy conditions, which are then used as performance operations of the DC motor functioning as an open and closed roof regulator and an AC motor for the rice stirring process. The servo motor of the prototype system is able to move to open and close the clothesline at an angle of 0˚- 90˚ when the water and light sensors detect changes in the weather around the environment, and the system works in accordance with the design having been made [24]. Machine manufacturing and machine performance analysis are carried out to determine the effectiveness of machine performance.

## 2.1. Sensors (water sensor and light sensor)

## The water sensor is designed to detect water during raining as well as to be used to detect the water level. Rain sensor circuits can be made using a resistor component as the main component and an electrode as a water detector [25]. The light sensor is an electronic device/component that functions to convert light quantities into electrical quantities. LDR (Light Dependent Resistor) light sensor constitutes a type of resistor which is light sensitive [26].

## 2.2. Arduino uno microcontroller

ATmega 328. This board has 14 digital input/output pins, 6 pins of which can be used as PWM output and 6 analog input pins, 16 MHz crystal oscillator, USB connection, power jack, ICSP header, and reset button [23]. In supporting the microcontroller to be able to be used, just connect the Arduino Uno board to the computer using a USB cable or a voltage source which can be obtained from an AC-DC adapter or battery in its operation. The Arduino Uno is of a credit card in size. Despite its small size, the Arduino Uno board can make it easier for users to create various electronic projects [27].

## 2.3. Electric motor

An electrical motor is a machine that converts the electrical energy into mechanical energy. Motors are broadly classified into two types AC motors and DC motors. The AC motors operate on alternating current where as the DC motors operate on the direct current. The input to AC motor is alternating current/voltage and its output is in the form of torque, similar is the output of DC motor it differs from AC motors at its input side, i.e. the input of a DC motor is the direct current/voltage [28].

1. Result and discussions

Several attributes of consumer needs in designing post-harvest rice machines i.e; portable [29], cheap, multifunctional [2], lightweight, ergonomic [2], easy to maintain, and easy to find spare parts [2]. The design of a rice drying machine using a light sensor and a water sensor is shown in Figure 1.

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| D:\JuRNaL-Karya Ilmiah\Analisis Sensor Pengering padi\picture 2.png**Figure 1.** Construction of rice drying machine | **Figure 2.** Rice Drying Process |

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| **Table 1.** Weather Sensor Program Design |
| Weather Conditions | Water Sensor | Light Sensor |
| Hot | X | X |
| Cloudy  | X | A |
| Rainy and Cloudy  | A | A |
| Hot and Rainy  | A | X |

A = Functioning to close the roof

X = Not functioning

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| **Table 2.** Sensor Testing on DC Electric Motor |
|  | Light Sensor | Water Sensor | DC Motor  | Roof Conditions |
| Conditions | Bright | Wet | Counterclockwise | Closed |
| Bright | Dry | Clockwise | Open |
| Dark | Dry | Counterclockwise | Closed |
| Dark | Wet | Counterclockwise | Closed |

**Table 3.** Sensor Testing at AC Electric Motor

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Light Sensor | Water Sensor | AC Motor | Working Conditions |
| Conditions | Bright | Wet | Off | Stopped |
| Bright | Dry | On | Active |
| Dark | Dry | Off | Stopped |
| Dark | Wet | Off | Stopped |

Tables 1 and 2 explain that the condition of the two sensors must be free from interference either cloudy and / or rainy by activating a DC electric motor to open the roof [30]. Tables 1 and 3 explain that the two sensors must also be free from interference to activate the AC electric motor to rotate the mixer for the rice drying process [30,31].

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| **Table 4.**The ability of mixer rice using an AC Electric Motor ¼ HP and a gearbox with a final rotation of 31 rpm and drying time 11.00 - 15.00 WIB. |
| Types of mixer | early weight of rice (kg) | final weight of rice (kg) |
| single plate and double plate (sp & dp) | 6.5 | 6.1 |
| single plate and single plate (sp & sp) | 6.5 | 6.2 |
| single plate and double harrow (sp & dh) | 7 | 6.6 |
| double plate and single harrow (dp & sh) | 7 | 6.5 |
| double plate and double harrow (dp & dh) | 6.5 | 6.2 |
| double plate and single harrow (dp & sh) | 6.5 | 6.2 |

**Figure 3.** The Ability of Variation Mixer

Table 4 and Figure 3 show that the double plate and single harrow (dp & sh) types have greater drying ability than other types of mixers with a decrease in rice mass of 0.5 kg/day. The structural system of the composite shear wall with double steel plate grid-type walls with infilled concrete has good seismic performance [32]. The rain sensor functions optimally when the sensor is exposed to water splashes (rain) and the light sensor works on the intensity of sunlight in accordance with the setting, then the two sensors send a signal to the Arduino Uno microcontroller by activating the electricity supply to the DC Electric Motor to open the roof and the AC Electric Motor stirring the rice dryer. The roof and the performance of the rice mixer cannot be reopened if the two sensors are not free from the conditions that are allowed to function. For example, the water on the sensor and the intensity obtained which is still far from the set standards.

1. Conclusions

The results of this study indicate that the analysis of the rain sensor functions optimally when the sensor is exposed to water splashes then sends a signal to Arduino Uno by closing the roof by moving the power window. The LDR sensor, as a light sensor works when the light intensity standard that is set is met and sends a signal to Arduino Uno to open the roof by moving the power windows. The roof cannot open if the two sensors are not free from several conditions, including wet conditions on the rain sensor and intensity standards that are not met or far from the set standards. The type of mixer that was effectively used in the experiment was a double plate and single harrow with a decrease in rice mass of 0.5 kg/day. It is hoped that with the right technology, this rice dryer can help farmers in drying rice yields.

References

[1] Iswari K 2013 Kesiapan teknologi panen dan pascapanen padi dalam menekan kehilangan hasil dan meningkatkan mutu beras *J. Penelit. dan Pengemb. Pertan.* **31**

[2] Nurdin S, Ahlan A, Sugiarto S, Lestari M W, Hidayat K and Prasnowo M A 2018 Design of Ergonomic Paddy Harvesting Machine *Journal of Physics: Conference Series* vol 1114 p 12136

[3] Pakowski Z and Mujumdar A S 2006 Basic process calculations and simulations in drying *Handb. Ind. Dry.* **53**

[4] Wongpornchai S, Dumri K, Jongkaewwattana S and Siri B 2004 Effects of drying methods and storage time on the aroma and milling quality of rice (Oryza sativa L.) cv. Khao Dawk Mali 105 *Food Chem.* **87** 407–14

[5] Syahrul S, Nansah D F, Mulyanto A and Mirmanto M 2020 Effect of mass variation of material on continuous vertical type drying machines against drying time *Din. Tek. Mesin J. Keilmuan dan Terap. Tek. Mesin* **10** 152–8

[6] Yuwana Y, Silvia E and Sidebang B 2020 Observed performances of the hybrid solar-biomass dryer for fish drying *IOP Conference Series: Earth and Environmental Science* vol 583 (IOP Publishing) p 12032

[7] Adeodu A O, Akinola S O, Daniyan I A, Akinlosola D O, Oloyede O R and Alufa O O 2019 Development and Performance Evaluation of Thermostat Controlled Rotary Dryer for Agricultural Produce *Journal of Physics: Conference Series* vol 1378 (IOP Publishing) p 22028

[8] Prasnowo M A, Nurdin S and Ahlan A 2019 ANALISIS KELAYAKAN MESIN PENGERING KERIPIK KENTANG *AGROINTEK* **13** 10–3

[9] Ruiz‐Gutiérrez M G, Quintero‐Ramos A, Meléndez‐Pizarro C O, Talamás‐Abbud R, Barnard J, Márquez‐Meléndez R and Lardizábal‐Gutiérrez D 2012 Nixtamalization in two steps with different calcium salts and the relationship with chemical, texture and thermal properties in masa and tortilla *J. Food Process Eng.* **35** 772–83

[10] Fudholi A, Sopian K, Ruslan M H, Alghoul M A and Sulaiman M Y 2010 Review of solar dryers for agricultural and marine products *Renew. Sustain. energy Rev.* **14** 1–30

[11] Rindang A, Panggabean S, Sukoco A and Ayu P C 2019 Drying characteristic of unhulled rice in biomass energy and combination rotary dryer *IOP Conference Series: Earth and Environmental Science* vol 260 (IOP Publishing) p 12037

[12] Petruzella F D 1995 *Industrial electronics* (McGraw-Hill Science/Engineering/Math)

[13] Kusumawardhani A, Nurdin S and Sari M S A 2017 Teknologi Smartphone Android Dan Aplikasinya Sebagai Pengendali Pintu Air Daerah Aliran Sungai (DAS) *Tek. Eng. Sains J.* **1** 89–94

[14] Mendoza N, Ahuett H and Molina A 2003 Case Studies in the Integration of QFD, VE and DFMA during the Product Design Stage *Proceedings of the 9th International Conference on Concurrent Engineering*

[15] Ekawati Y and Bazarado M 2016 Designing Food Products Based on Carrots Using the Product Design Phase of Quality Function Deployment *ARPN J. Eng. Appl. Sci.* **11** 3109–16

[16] Hidayat K, Prasnowo M A, Nurmawati N, Lestari V N S and Abdullah D 2018 Adding Value of Crispy Peperek Product Using Quality Function Deployment and Value Added Engineering *Journal of Physics: Conference Series* vol 1114 p 12074

[17] Purohit S K and Sharma A K 2015 Database design for data mining driven forecasting software tool for quality function deployment *Int. J. Inf. Eng. Electron. Bus.* **7** 39

[18] Chougule A, Gupta A K and Patil S 2014 Application of value engineering technique to A residential Building–Case study *Int. J. Innov. Res. Adv. Eng.* **1** 2163–349

[19] Ginting R, Hidayati J and Siregar I 2018 Integrating Kano’s model into quality function deployment for product design: A comprehensive review

[20] Hidayat K, Asfan D F and Nursiyam U A 2020 Designing Instant Corn Rice Using the Product Design Phase of Quality Function Deployment *IOP Conference Series: Earth and Environmental Science* vol 515 (IOP Publishing) p 12068

[21] Cohen L 1995 *Quality function deployment: how to make QFD work for you* (Prentice Hall)

[22] Nurdin S, Kusumawardhani A, Lestari M W, Hidayat K and Prasnowo M A 2020 ERGONOMIC ANALYSIS ON REDESIGNING RICE HARVESTING MACHINES *Humanit. Soc. Sci. Rev.* **8** 165–70

[23] D’Ausilio A 2012 Arduino: A low-cost multipurpose lab equipment *Behav. Res. Methods* **44** 305–13

[24] Irwanto I, Permata E and Aribowo D 2019 Rancangan Prototype Alat Jemuran Otomatis Menggunakan Sensor Air Dan Sensor Cahaya Berbasis Mikrokontroller Arduino *JTEV (Jurnal Tek. Elektro dan Vokasional)* **5** 133–9

[25] Adha O P, Muid A and Brianorman Y 2015 Prototipe Sistem Buka Tutup Atap Jemuran Pakaian Menggunakan Mikrokontroler Atmega8 *Coding J. Komput. dan Apl.* **3**

[26] Yuniati A and Rifai R 2019 Study of simple spectrophotometer design using LDR sensors based on arduino uno microcontroller *Journal of Physics: Conference Series* vol 1153 (IOP Publishing) p 12099

[27] Laskar M R, Bhattacharjee R, Giri M S and Bhattacharya P 2016 Weather forecasting using Arduino based cube-sat *Procedia Comput. Sci* **89** 320–3

[28] Shrivastava K and Pawar P M D 2016 A review on types of DC motors and the necessity of starter for its speed regulation *Int. J. Adv. Res. Comput. Commun. Eng.* **5** 61–3

[29] Lorena B R G S 2020 Portable Farming *IOP Conference Series: Materials Science and Engineering* vol 879 (IOP Publishing) p 12099

[30] Fijalkowski B T and Tutaj J Integrated DC or AC motors with the mechanical split-ring flat and or macroelectronic commutator

[31] Fediakov V V, Zhuravleva L A and Kornienko M N 2019 Design of fast response electric drive of agricultural objects *IOP Conference Series: Earth and Environmental Science* vol 315 (IOP Publishing) p 32037

[32] Tao J, Jinbao L and Wenping X 2020 Static elastoplastic analysis of the composite shear wall of the grid-tube-type double steel plate wall with infilled concrete *IOP Conference Series: Earth and Environmental Science* vol 568 (IOP Publishing) p 12047.