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Design of an IoT-Based Automatic Weighing System for Catfish Farming to Support Smart Aquaculture

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ABSTRACT (10 PT)

Improving efficiency and accuracy in the catfish weighing process at farms is crucial for farmers who distribute their yields to retailers and wholesalers. Fast and informative operations also contribute to enhancing these two variables. Therefore, this study aims to design and implement an IoT-based automatic catfish weighing tool that can measure catfish weight automatically and in real-time. The research methods include mechanical, electrical, and software design. The catfish weight is measured using a load cell sensor that converts the data into weight in kilograms. The load cell sensor integrates with an ESP32 microcontroller equipped with a WiFi module for wireless data communication. The load cell sensor connects to the ESP32's analog pins. Data processing and monitoring are designed for a web-based platform with an interactive display to ensure easy reading and operation for all farmers. The power source for this automatic weighing system utilizes solar energy, applying renewable energy systems. This tool is designed to assist farmers in monitoring production. It is tested at catfish farms to evaluate its accuracy and efficiency under real conditions. The planned discussion covers the analysis of test results, evaluation of system performance under various operational conditions, and comparison with manual weighing methods. The outcomes of this research are expected to provide an effective solution to increase productivity and operational efficiency at catfish farms and to make a significant contribution to the development of smart aquaculture technology.

Keywords: Automatic Weighing System ; Catfish Farms; ESP32; Internet of Things; Renewable Energy Systems

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1. INTRODUCTION

In the digitalization era, efficiency and automation in the livestock sector are crucial to enhancing productivity and reducing operational costs. In the context of catfish farming, manual fish weighing is often time-consuming, inaccurate, and stressful for the fish, which can negatively impact their health and growth. However, IoT-based automatic weighing systems are still rarely implemented in this industry, despite the technology's potential to improve accuracy, efficiency, and real-time monitoring. Therefore, this research focuses on the design and evaluation of an IoT-based automatic weighing system that can be applied in catfish farming to support the concept of smart aquaculture. Through the development of this system, it is expected to provide a significant and practical solution to these challenges and support digital transformation in the aquaculture sector.

Several studies and developments serve as literature for this research. The first study was conducted by Abdul Muis, titled 'The Use of Load Cell Sensors in Automatic Weighing for Aquaculture,' published in Natural Journal in 2021. This study used the theory of weight measurement with load cell sensors and automation concepts using Arduino. The experimental method involved integrating a load cell sensor with a microcontroller, with data analysis using specialized software. The results showed a weighing accuracy with an average error of 0.66 grams, and the weighing process time was significantly reduced compared to the manual method. The researcher concluded that load cell sensors are effective in automatic weighing systems in aquaculture. Further development focused on IoT integration to improve efficiency and real-time monitoring.

The second study, conducted by M. Dande and titled 'A Simple Robust IoT Sensor-Based Weighing System,' was published in the International Journal of Pure and Applied Mathematics in 2018. This research explored the theory of IoT in monitoring systems using wireless network concepts for data transmission. The methods, analysis, and approach involved hardware and software development, resulting in IoT implementation that enables real-time fish weight monitoring with high data accuracy. The third study, conducted by Aries Boedi in 2024, was titled 'Application of Solar Power for Aerators in Catfish Farming.' This study used a case study and experimental approach to examine the use of solar panels to increase energy efficiency through the aerator system in catfish ponds.

This research involves the implementation and evaluation of an IoT-based automatic weighing system powered by solar energy, measuring its impact on the efficiency and accuracy of catfish weighing at farms. The goal is to provide a more efficient and accurate tool for catfish farmers to conduct weighing, ultimately enhancing productivity and profitability. Academically, this research adds to the literature and scientific knowledge in catfish farming, particularly in applying IoT and renewable energy technology in farm operations. By utilizing solar energy as the power source, this study also contributes to reducing fossil fuel usage, supporting renewable energy initiatives, and offering a more environmentally friendly solution.

2. RESEARCH METHOD

This research adopts a quantitative paradigm to systematically measure the performance of an IoT-based automatic catfish weighing device supported by renewable energy, specifically solar energy. The approach used is experimental with a case study conducted at several catfish farms in a specific region. This experimental approach allows for direct testing of the automatic weighing device's implementation in the field. A case study was chosen to gain an in-depth understanding of the device's use in the practical context of catfish farming. This study uses a case study and experimental approach to evaluate the effectiveness and efficiency of an IoT-based automatic weighing system powered by solar energy in catfish farming. The case study is conducted to understand the specific context and field conditions at catfish farms. This approach involves in-depth interviews with farmers and direct observation to gather qualitative data on their experiences and perceptions of the new system. The experiment tests and compares the efficiency and accuracy of the automatic weighing system with the manual weighing method. Quantitative data will be collected through direct weight measurements of the catfish using both methods.

This research is planned to take place over three months, covering the preparation stage, field survey, implementation, data analysis, and reporting of research results. The research will be conducted at an individual catfish farm located in Sukodadi Village, Paiton District, Probolinggo Regency. The location was chosen based on accessibility and cooperation with the farmer. The data sources include quantitative data on the weight of the catfish measured using both automatic and manual weighing systems, as well as the time required for each method. The primary data sources are the catfish farmers, as well as the devices and equipment used in the automatic weighing system. This research follows a series of systematic stages to ensure effective and accurate data collection, processing, and analysis. The following outlines the scenario and stages of this research

Figure 1. Stages of Reasearch

The design of smart weighing device includes mechanical, electrical, and software aspects, using an ESP32 as the microcontroller to compute data read by the load cell. The load cell needs to be calibrated to obtain an accurate reference value, ensuring precise weighing results. When an object is placed on the scale, data is sent to the ESP32 for processing. Through the WiFi module, the ESP32 sends the information to the Blynk application on a smartphone or PC connected with the appropriate network and token. The mechanism of the device's operation is illustrated in the following flowchart:

Figure 2. Smart Weighing System Flowchart

3. RESULTS AND DISCUSSION

3.1. Design of System

After concluding the problem analysis, the researcher proceeded to the system design stage. This system design includes planning the hardware and software required to develop an IoT-based automatic catfish weighing tool powered by renewable energy. The components used in the design of this tool are listed in Table 1 below:

Table 1. Table Supporting Hardware

Hardware Component	Component function
Modul Load Cell	Alat pendeteksi Berat
Modul ESP32	*Controller* sistem
Solar Cell	Sebagai penerima sumber energi
Modul SCC	Sebagai *controller solar cell*
Kabel Jumper	Pengkabelan antara sensor dengan *controller*
Box Panel	Tempat menyimpan seluruh komponen elektrik
Baterai	Sebagai penyimpanan energi
Handphone	Sebagai tampilan hasil monitoring berat lele

3.2. Page Size

The page size is A4 (210 mm x 297 mm). Page margins are 25 mm top-bottom, left-right.

3.3. Manuscript Layout

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4. CONCLUSION (10 PT)

In the conclusion, there should be no references. The conclusion contains the facts obtained. It is sufficient to answer the research questions or objectives (no further discussion); State possible applications, implications, and speculations accordingly. If necessary, provide suggestions for further research.

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