SMATIKA : STIKI Informatika Jurnal
Vol. 14, No. 1, Juni 2024 1~12
ISSN: 2087-0256, e-ISSN: 2580-6939

Implementation of the Elliptic Curve Digital Signature Algorithm for Smart Gerobak Sorongs in Monitoring Animal Feed

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Abstract

The Internet of Things (IoT) implementation in the livestock sector includes the use of sensors, software and internet-based platforms to monitor, manage and optimize in real-time. This research is intended to solve problems at PT. Indo Prima Beef noted that the use of animal feed is still based on estimates, resulting in the calculation of the selling price of cattle being inaccurate and potentially detrimental. Manual recording which is prone to errors and less efficient causes uncertainty in feed management and costs. Therefore, this research develops an IoT-based tool that is integrated in a wheelbarrow. This tool is capable of reading the results of weighing animal feed and storing the data in real-time in a database connected to web monitoring. Apart from that, the monitoring application can display recap results of cow feed weights, there are also features that support optimal use of the Smart Gerobak Sorong. The method used in this research is applying the Elliptic Curve Digital Signature Algorithm as a safeguard for data communication between IoT and the database. Based on the test results on a cow's feed weight of 10.6 kg, a difference value of 0.11 kg was obtained. This means that the average error value is 0.01%. So, it can be concluded that the loadcell sensor can read mass data for weighing cattle feed with the same load. With this tool, PT. Indo Prima Beef can increase the efficiency of feed use, optimize business income, and provide innovative and effective solutions in overall animal feed management.
Keywords: Cow feed; Elliptic Curve Digital Signature Algorithm; IoT; Smart Gerobak Sorong; Website

1. Introduction

Almost all areas in Lampung Province can become potential locations for livestock such as goats, buffalo and cattle because they are supported by land and green plants for feed. The Lampung Provincial Government, through the Lampung Province Animal Husbandry and Animal Health Service, also continues to maximize the cattle assistance provided by the Central Government. In order to support the Lampung Provincial Government's program to become a national livestock barn, PT Indo Prima Beef (IPB) continues to strive to develop its business in the field of raising imported cattle. PT IPB has been established since 2014, located in Adirejo Village, Terbanggi

Cite: Sulistiani, H., dkk. (2024). Implementation of the Elliptic Curve Digital Signature Algorithm for Smart Gerobak Sorongs in Monitoring Animal Feed. SMATIKA : STIKI Informatika Jurnal,14(1). doi: https://doi.org/10.32664/smatika.v14i01.1231

Besar District, Central Lampung Regency, Lampung Province. Problems at PT. IPB in recording the use of cattle feed is still based on estimates, resulting in inaccurate and potentially detrimental calculations of the selling price of cattle. Manual recording which is prone to errors and less efficient has caused uncertainty in feed management and costs.

Along with the development of technology that continues to grow, today's technology is utilized to the best of its ability, making all human tasks more efficient, encouraging human activities in the industrial field, leaving the agricultural world behind. [1], [2], [3]. A farm is a business or place where farm animals, such as cows, goats, sheep, or chickens, are kept and raised. The purpose of animal husbandry can vary, ranging from the production of meat, milk and eggs [4]. Many people can use animal husbandry as their source of employment and livelihood. In a modern context, livestock farming often uses technology, such as Internet of Things (IoT) systems, to improve productivity and efficiency. [2], [5], [6], [7].

To solve an existing problem, the Smart Cart Sorong Web-Based Monitoring application is a solution tailored to the needs of PT Indo Prima Beef (IPB) to manage cattle feed more efficiently [4]. This application allows users to monitor the total feed weight of cows at each feeding, as well as providing detailed information about the weight of each type of feed at each feeding process. [1], [8], [9]. In addition, this application also facilitates accurate calculation of cattle feed weight by providing detailed data [10], [11]. The presence of an IoT device that can measure the weight of cow feed based on its type is one of the app's top features [2], [8], [12], [13], [14]. This ensures that the recorded feed weight data is accurate and reliable. Users can also use weighing during feed delivery to obtain accurate and timely cattle feed data. This application also presents information in the form of periodic feed weighing summary data. [15].

The data obtained facilitates the management in understanding the cattle feed reports issued over a certain period, thereby simplifying evaluation and future planning. Thus, the Web-Based Smart Gerobak Sorong Monitoring application provides an efficient and effective solution for cattle feed management at PT IPB, helping to overcome challenges in calculating feed weight during each feeding and simplifying the recording of used feed. [4]. This research also utilizes advancements in cryptographic technology, particularly in IoT applications. The Elliptic Curve Digital Signature Algorithm (ECDSA) is popular because it can secure data with smaller keys and requires less operational space. [12], [16]. This research seeks alternatives to meet the needs of IoT that can support the secure storage of data.

From previous research, there is a similarity in the development of digital weighing devices, differing only in function. This study discusses the development of an IoT-based oil palm fruit weighing scale as a solution to facilitate landowners in remotely monitoring the weight of oil palm fruits. This device uses the ESP32 microcontroller from TTGO T.Call to control the system and a load cell sensor to detect the weight of the oil palm fruits. [14].

This research focuses on highlighting the importance of calibration techniques and error analysis for load cell sensors in industrial weighing systems. It makes a valuable contribution to the development of weight or load measurement techniques in industrial weighing systems. By applying proper calibration methods, the measurement accuracy of load cell sensors can be significantly improved. [17].

Previous research also discussed monitoring conducted using dynamic weighing sensors to oversee vehicle loads and enforcement at toll gates. This study focuses on the Trans Sumatra toll road owned by PT. Hutama Karya (Persero). The aim of this research is to assist toll road management in handling vehicles that exceed load limits (overload), which often cause road damage. C# is used for both backend and frontend programming, MySQL is the DBMS, and the software development method is Prototype. Microsoft Visual Studio 2019 IDE was used to build the program. The discussion results show that the authors have successfully developed software that can quickly and accurately monitor vehicle data. [1].

This research also shares similarities in the implementation of IoT technology for monitoring livestock production using animal weight sensors. The results indicate that the implementation of IoT technology in animal weight monitoring has great potential to improve efficiency and animal welfare, as well as enhance overall livestock production management. By using animal weight sensors connected to the IoT network, farmers can monitor animal weight in real-time, collect useful data, and apply statistical techniques and data modeling to identify patterns and trends related to animal growth and health [10].

Previous research also applied the performance of the ECDSA algorithm on JSON Web Tokens in the authentication mechanism of RESTful web services. The research methods used include research clarification, descriptive study, perspective study, research tools and materials, and research instruments. The findings and discussion of this research include an overview of the test application, implications, and recommendations. This research benefits in enhancing the security of web service applications [18].

From previous research, we can also compare that the Smart Gerobak Sorong technology has cutting-edge technological advantages. The Smart Gerobak Sorong leverages advanced AI technology, namely IoT, to provide ease for cattle farmers in recording feed usage reports by type and daily. In addition to the availability of real-time data, the Smart Gerobak Sorong provides real-time data that can be accessed by cattle farmers and owners to precisely know the amount of feed dispensed each day. This research also features high data accuracy in the Smart Gerobak Sorong's automated database system, ensuring that all feed-related data, such as type and quantity, is recorded accurately. This ensures that the cattle receive the correct food intake, reducing the possibility of human error. Furthermore, this research includes efficient stock management; the system helps in better feed stock management. Data automation allows for better planning, avoiding shortages or wastage of feed. Lastly, another advantage is the ease of integration; the system can be easily integrated with existing livestock management systems, enabling farmers to have a comprehensive system that connects various aspects of farm operations.

2. Research Method

This research aims to develop a new, better, and more effective product through development and testing research. Development research usually involves the product development process, conducting analysis, providing explanations of the results, and then re-evaluating to improve and verify the product. The research process begins with a literature review and references, studying and analyzing problems related to the research subject. After that, the next step is to review the literature and assess how many journals are relevant to the research. The research begins with reading literature on the research subject. Collecting data for the research process is also the next important step. A clearer research diagram can be seen in Figure 1.

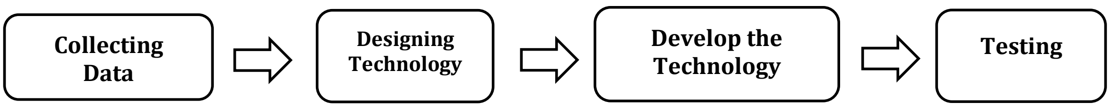

Figure 1. *Diagram of the Smart Gerobak Sorong Research Points*

The research diagram consists of several steps, as shown in Figure 1 above:

1. Conduct data collection for research purposes.
2. Design the technology for both hardware and software so that the devices can be used and interconnected.

3. Develop existing technology into an updated version and repurpose the product created by this research.
4. Test the assembled technology and then implement it in the case study location.

Research Flow

This research aims to solve PT IPB's issues by increasing cattle productivity and business revenue. The recording of feed usage by type, which is still based on estimates by the feed department, causes inaccuracies in the cattle selling price calculation process and potentially leads to losses. The conducted research has produced two output products: a web-based application for monitoring cattle feed weight and the Smart Gerobak Sorong by implementing IoT.

Collecting Data

Data collection in cattle feed types is a critical initial step in producing accurate and relevant feed weight calculations. This process involves comprehensively gathering information related to all types of cattle feed associated with feed production, such as feed weight and types of feed used. This data can be obtained from cattle feed management sources. With well-collected data, the cattle feed monitoring system can generate accurate and relevant calculations, helping farm managers make better decisions, manage costs more efficiently, and increase cattle farming business profitability.

Data collection in Smart Gerobak Sorong technology for cattle feed weighing devices and automatic weighing is an essential step in ensuring optimal performance. Based on the results of observations and interviews at PT. Indo Prima Beef received information that this process involved the acquisition and analysis of various information related to the operation of the Smart Gerobak Sorong equipment, including data on feed types, the amount of feed transported, and the load history. This data is collected through various sensors installed on the Smart Gerobak Sorong, which continuously monitor and record cattle feed weight information. Additionally, this data can be integrated with the web-based cattle feed management monitoring system for monitoring and analysis. The results of this data collection provide valuable insights for farmers, enabling them to optimize feed usage, ensure livestock health, and improve farm operational efficiency. With accurate and up-to-date data, Smart Gerobak Sorong technology enhances productivity and sustainability in cattle feed management.

Develop the Technology

This process involves identifying livestock feeding, with the system design considering how this data will be collected, processed, and integrated into the system. Additionally, the system designs the calculation methods and formulas to be used for calculating the total feed used and will display graphs. The accuracy and reliability of this system are crucial, as the calculation results will assist farmers in making strategic decisions, including determining the daily feed amounts.

The design of the Smart Gerobak Sorong includes selecting and placing appropriate sensors on the transport equipment and weighing system to measure the feed weight accurately and precisely. Furthermore, this technology enables real-time data communication between the transport equipment and the weighing system.

The following components are used to create the Smart Stroller:

a. Hx711

   The HX711 is a weighing module used to connect loadcells (load cells) to microcontrollers such as the ESP32. The HX711 allows reading the weight value measured by the loadcell with high precision and sending it to the microcontroller through a digital communication interface such as SPI [13], [19], [20].

b. Loadcell

A loadcell is a specialized sensor used to measure weight or load. In cattle feed weighing, the loadcell will be mounted on the platform or container supporting the feed, and the change in load on the loadcell will be used to measure the weight of the feed. [14].

c. Push Button
The push button may be used to control or configure the weighing device, it can be used to start or end the weighing process, specify the measurement mode, or send data to the mysql database.
d. BMS 3S (Battery Management System 3S)
e. BMS is a system used to manage and protect 3S (three-cell) lithium-ion batteries such as 18650 batteries. The BMS monitors the voltage of the battery cells, avoids overcharge and overdischarge, and keeps the battery cells safe [21].
f. Battery 18650
18650 batteries are a type of lithium-ion battery that is often used in portable applications. They provide power for the device, and the BMS is used to manage the power of these batteries [22], [23], [24].
g. Stepdown LM2596
The LM2596 Stepdown voltage drop module is used to convert high voltages. For example, from an 18650 battery which may have a voltage of more than 3.3V) to a voltage suitable for operating the ESP32 and other components that require a voltage of 3.3V or 5V [25].
h. MySQL
MySQL is a database management system used to store, manage and administer data, and access the data collected by the ESP32 when weighing cattle feed weights. Weight data and other related information can be stored in a MySQL database for further analysis or long-term monitoring. [26], [27].

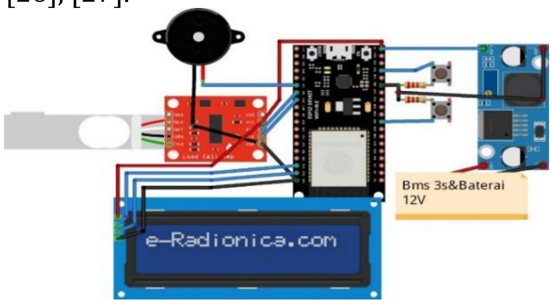

Figure 2. *Schematic of the Smart Gerobak Sorong's circuitry and components*

The cattle feed weight weighing system uses various key components for its operation. First, the ESP32 acts as the main brain that controls the entire system. The ESP32 communicates with the HX711 sensor, which connects a loadcell to measure the feed weight. This loadcell is a specialized sensor that responds to changes in load and produces a corresponding change in voltage, which is then converted into weight data by the HX711. In addition, buttons or push buttons are used as input elements that allow the user to control the operation of the device. The button can be used to initiate or stop the weighing process, switch the measurement mode, or set other parameters on the ESP32.

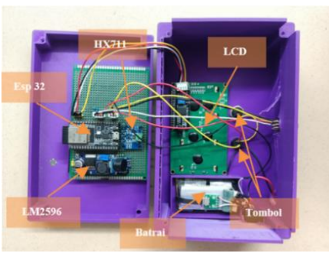

Figure 3. *Components used in Smart Gerobak Sorong*

To maintain the smooth operation of the device, BMS 3S (Battery Management System 3S) is used which supervises and protects the 18650 battery, the main power source of the system. BMS 3S ensures that the battery works within safe limits by preventing overcharge and overdischarge. In addition, the LM2596 voltage drop module is used to convert the high voltage from the battery (e.g., from 12V DC) into a voltage suitable for operating the ESP32 and other components, maintaining power stability. Thus, this system provides an efficient and accurate solution for weighing cattle feed, integrating these various components into a harmoniously functioning circuit scheme. All these components work together to measure and record feed weight with precision, while keeping battery power under control through the BMS 3S and LM2596 voltage drop module.

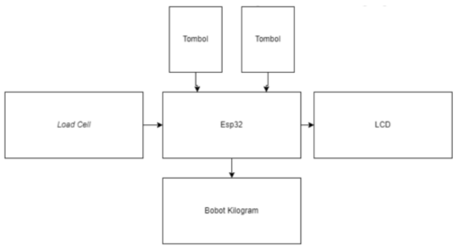

Figure 4. *Block diagram of Smart Gerobak Sorong design*

The process begins with the "Start," stage which marks the initiation of the workflow. Next, at the "Loadcell Input" stage, weight data is obtained from the loadcell as the first step in weight measurement. The ESP32 plays an important role in the next stage, "Weight Measurement Process Using ESP32," where it accurately measures the weight and generates the corresponding results. The next stage, "Button to Change the Type of Cattle Feed Being Measured," provides the flexibility to customize the type of feed being measured, ensuring measurement accuracy according to the characteristics of each type of feed. The "Upload Button" provides the option to upload the measurement results to the database, enabling efficient monitoring and data management. Finally, the flowchart reaches the "Finish" stage, signaling the completion of the entire process. Thus, the flowchart creates a structured and effective workflow, enabling accurate weight measurement and efficient data management for cattle feed.

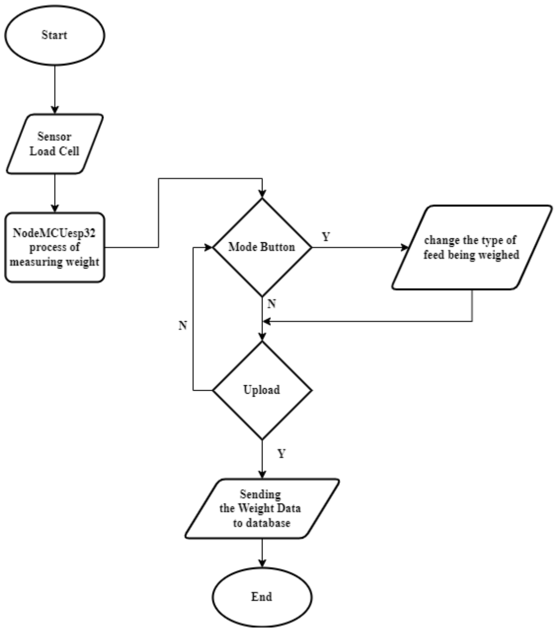

Figure 5. *The Flowchart of Smart Gerobak Sorong*

Developing the New Technology

At this stage, the development of a website-based cattle feed monitoring system application is carried out. Technology development in the cattle feed calculation system is an important step in supporting growth and efficiency in the cattle farming industry. With the adoption of advanced technology, farmers can more easily and accurately calculate the costs involved in cattle production, namely feed costs. The system can also integrate data from various aspects of production, such as stock management, feed efficiency, and a graph, to provide a complete picture of cattle feed. Thus, this technology helps farmers make better decisions in managing cattle feeding, increasing profitability and maintaining animal welfare.

The cattle feed monitoring application is used by PT IPB to import data on cattle feed distribution. The application developed is not one hundred percent successful and further development is needed. Currently, the application has only been developed up to the stage of inputting cow feed data and importing cow feed data. The display of the developed cattle feed monitoring application is shown in Figures 6 and 7.

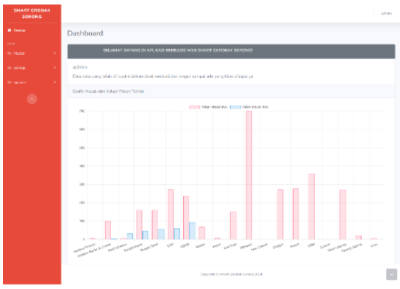

Figure 6. *Visualization of the total weighted values*

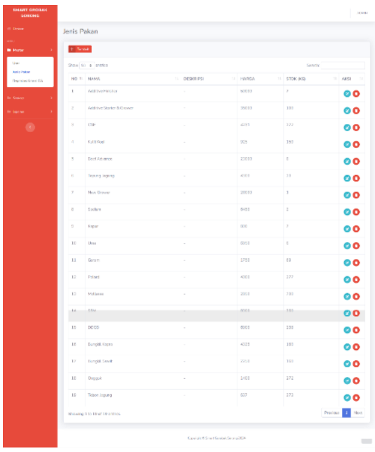

Figure 7. *Inputting the Cattle Feed Type*

The second research result is in the form of Smart Gerobak Sorong which is a carrier and weighs cow feed automatically that applies IoT technology. In addition, Smart Gerobak Sorong can also store data on the results of weighing per type of cow feed every day. This technology allows farm managers to better control the feed supply, ensuring that the cows are getting the food intake that suits their needs. In addition, the integrated automatic weighing system helps to measure feed precisely, reduce potential waste and improve operational efficiency. The development of Smart Gerobak Sorong technology for cattle feed conveyance and automatic weighing helps farmers increase productivity, reduce costs and overall improve livestock welfare and operational efficiency in the cattle farming business.

3. Result

After the IoT device and web monitoring have been assembled or made, the tool that has been formed will be tested and used. This will include hardware implementation testing, connectivity testing, and others. calibration of the wheelbarrow tool, recap data report on the results of weighing cattle feed and implementation of the tool to PT IPB.

Product testing of Smart Gerak Sorong is an important stage in testing and validating the latest technology that integrates aspects of artificial intelligence in cattle feed transportation tools. The Smart Gerobak Sorong is a technology developed in this research that aims to streamline the performance of the feed warehouse section in reporting data on the amount of feed usage before mixing. The purpose of testing Smart Gerobak Sorong is:

a. Ensuring the Quality
   Product testing aims to identify and eliminate potential defects or problems in the product so that it can meet or even exceed customer expectations in terms of quality.
b. Security
   Product testing aims to ensure that products are safe for use by users. This includes physical, electrical, or software safety testing that may threaten the safety of the user.
c. Performance
   The purpose of testing is to evaluate the performance of the product under various situations and conditions. This helps ensure that the product works properly and delivers the expected performance.
d. Design Validation
   Product testing helps validate the product design before it is mass-produced. It helps identify design issues that may need to be corrected before the product reaches the market.
e. Improving the Product
   Results from product testing are often used to refine and improve products. Information from testing can be used to identify areas where the product can be improved.

4. Discussion

The technology that has been developed has been subjected to early stage testing to ensure the accuracy and reliability of the device. This process involved a series of trials and evaluations to check the extent to which the system could accurately recapitulate cattle feed. The tests involved entering feed type data and then comparing the results with existing manual calculations. During the tests, the system's ability to integrate data from different aspects of production and provide clear and accurate reports was also evaluated. The results of these tests not only ensure that the system can provide useful information to farm managers, but also help in identifying and correcting potential defects or shortcomings in the technology. Documentation of the application testing process can be seen in Figures 8 and 9.

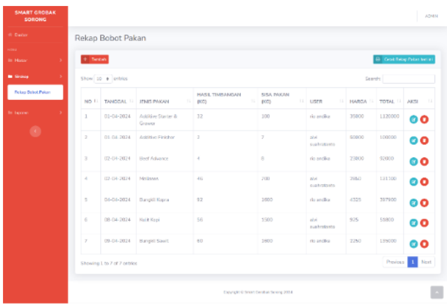

Figure 8. *Testing the monitoring application in the recap section of the cow feed weight report*

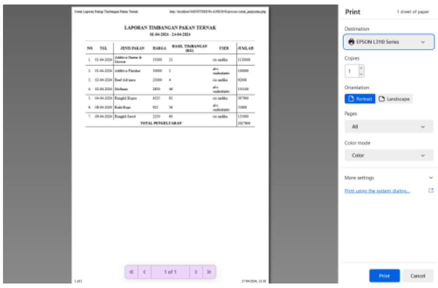

Figure 9. *Testing the monitoring application in the print section of the cow feed weight recap report*

The hardware that will be applied has been developed and designed with the aim of applying the Smart Cart tool will be implemented directly to add information from the tool. This tool is designed to make it easier to save the weighing results that will be stored in the database, so that it will minimize errors in recording the results of weighing animal feed. This tool is equipped with a weight detection sensor that is loadcell and uses a loadcell amplifier module. Load calibration testing is carried out by weighing cattle feed using the same load and by using various types of loads. This cow weight test aims to determine the difference value, error value, and accuracy of the data reading of the weighing period. cattle feed using a load1call sensor installed on a Smart Gerobak Sorong which can be seen in the test results in Table 1. [14].

Table 1. *Test sensor accuracy, difference, and error on the same load*

N	Yn (Kg)	Xn (kg)	Difference (kg)	Error (%)	Accuracy (%)
1	10,6	10,4	0,2	0,02	99,98
2	10,6	10,75	0,15	0,01	99,99
3	10,6	10,5	0,1	0,01	99,99
4	10,6	10,65	0,05	0,00	100,00
5	10,6	10,45	0,15	0,01	99,99
6	10,6	10,67	0,07	0,01	99,99
7	10,6	10,46	0,14	0,01	99,99
8	10,6	10,76	0,16	0,02	99,98
9	10,6	10,66	0,06	0,01	99,99
10	10,6	10,62	0,02	0,00	100,00

Description :
N: Testing Number
Yn: Measurement of weight data with comparison devices
Xn: Weight data measurement with Loadcell sensor
This equation can be used to calculate the difference, error, and accuracy values at the same load:

$$\text{Difference} = |Yn - Xn| \tag{1}$$

$$\text{Difference} = |10.6 - 11.4| = 0.2 \text{ kg}$$

To get the average difference value, use the following equation:

$$\text{Difference Avg.} = \left|\frac{\text{Difference Value}}{\text{Testing Number}}\right| \tag{2}$$

$$\text{Difference Avg.} = \left|\frac{1.1}{10}\right| = 0.11 \text{ Kg}$$

The equation used to calculate the error value:

$$Error = \left|\frac{\text{Yn} - \text{Xn}}{\text{Yn}}\right| \tag{3}$$

$$Error = \left|\frac{10.6 - 10.4}{10.6}\right| \times 100\% = 0.2\ \%$$

To obtain the average error value, the following equation is used:

$$\text{Avg. Error Value} = \left|\frac{\text{Amount of Error value}}{\text{Testing Number}}\right| \times 100\% \quad (4)$$

$$\text{Avg. Error Value} = \left|\frac{0.10}{10}\right| \times 100\% = 0.01\ \%$$

The equation used to calculate the accuracy value:

$$\text{Accuracy} = 100\ \% - error \quad (5)$$

$$\text{Accuracy} = 100\ \% - 0.01\% = 99.99\ \%$$

However, to obtain the average accuracy value, the following equation is used:

$$\text{Avg. Of Accuracy} = \left|\frac{\text{Amount of Accuracy Value}}{\text{Testing Number}}\right| \times 100\% \quad (6)$$

$$\text{Avg. Of Accuracy} = \left|\frac{999.90}{10}\right| \times 100\% = 99.99\ \%$$

Table 1 shows the tests carried out ten times to calculate the difference in the weight of the cow feed, the error of the weighing results, and the accuracy of the sensor cell load to read the mass data of the cow feed weighing. The tests were conducted with the same weight of 10.6 kg of cow feed. Based on the data from Table 1, we found an average difference value of 0.11 kg, an average error value of 0.01%, and an average accuracy value of 99.99% of the loadcell sensor. Therefore, it can be concluded that the loadcell sensor can read the weighing mass data of cow feed with the same load based on the difference value of the cow feed weight, the error of the weighing result, and the accuracy. [14].

With this technology, farm managers can improve the efficiency of cattle feed management, ensure proper food intake, and optimize overall farm productivity. Documentation of the Smart Gerobak Sorong testing process as shown in Figure 10.

Figure 10. *Testing and Implementation of Smart Carts at PT IPB*

In this process, the developed technology will be placed under various situations and conditions that may be encountered in a farm environment. This includes evaluating the ability of the feed conveyance to transport cattle feed efficiently and accurately, as well as the ability of the automatic weighing system to measure the feed weight precisely. In addition, the tests will ensure that the technology can operate properly in a variety of weather environments and road conditions. The results of these tests will provide confidence that the cattle feed conveyance and automatic weighing system are reliable and meet the needs of farmers.

5. Conclusions

This research is based on references that have been searched and traced by the research team, no one has developed innovations in the form of Smart Carts for weighing cow feed. The tool developed is also environmentally friendly for users and this tool can be utilized and applied by all cattle farming companies. From a technological aspect, the Smart Gerobak Sorong and monitoring application utilize website technology, IoT and sensors to measure feed weight. This tool also has scalability for users and has reliability in its application. In terms of environmental aspects, the developed tool has the potential to reduce feed wastage and, as a result, reduce environmental impact. From the social aspect, the Smart Cart assists farmers in better feed management, improves operational efficiency, and can contribute to livestock welfare. It has significant social benefits for cattle farming. From the various studies that have been described, it can be concluded that the use of technology, especially in the form of IoT, makes a major contribution in improving efficiency and productivity in various fields, including cattle farming. The Smart Web-based Monitoring Application, for example, is an efficient solution in managing cattle feed, utilizing IoT technology to provide accurate and real-time information about cattle feed. Thus, the conclusion is that technology, especially IoT, provides many benefits in various aspects of life, including industry and animal husbandry, by providing efficient, accurate, and reliable solutions in managing various aspects of production and management. For further research, focus on increasing battery capacity in IoT devices. Battery optimization can be done by choosing a more efficient Lithium-ion or Lithium-polymer battery and using power management techniques such as sleep and wake modes to save energy. Solar panel integration can also reduce the need for manual charging.

References

[1] Y. Arkhiansyah and M. Hidayat, “Rancang Bangun Perangkat Lunak Monitoring Menggunakan Sensor Timbangan Dinamis Terhadap Muatan Kendaraan Dan Penindakan Pada Gerbang Tol,” *Jurnal SIMADA (Sistem Informasi dan Manajemen Basis Data)*, vol. 4, no. 2, pp. 118–127, 2021, doi: 10.30873/simada.v4i2.3005.

[2] S. Sintaro and E. Alfonsius, “Sistem Cerdas Sebagai Keamanan Kandang Ternak Sapi Menggunakan Camera Esp-Cam Dan Selenoid,” *Jurnal Teknologi dan Sistem Tertanam*, vol. 4, no. 1, 2023, doi: 10.33365/jtst.v4i1.2641.

[3] Dimas ade putra, “Alat Penghitung Jumlah Gerakan Pull Up Dan Push Up Menggunakan Sudut Kemiringan Pada Sensor Mpu6050 Berbasis Internet of Things,” vol. 8, pp. 1–10, 2023, doi: 10.30865/mib.v8i1.6937.

[4] Y. Yustika, A. Nugraha, and R. Adawiyah, “Analisis Pengendalian Persediaan Pakan Ternak Sapi Pada Pt Indo Prima Beef Di Kabupaten Lampung Tengah,” *Jurnal Ilmu-Ilmu Agribisnis*, vol. 9, no. 3, p. 425, 2021, doi: 10.23960/jiia.v9i3.5329.

[5] N. Niswah, S. Suroso, and S. Soim, “Rancang Bangun Sistem Peringatan Dini Bencana Hidrometeorologi Berbasis Internet of Thing (IoT) Di BMKG,” *SMATIKA JURNAL*, vol. 11, no. 02, pp. 153–159, Dec. 2021, doi: 10.32664/smatika.v11i02.593.

[6] Y. A. Janitra, A. Aditya, H. N. Hadi, D. A. P., and S. Widodo, “The Development Of Automatic Cigarette Smoke Detection System Using Ta12-100 And Mq-135 Sensors,” *Jurnal Techno Nusa Mandiri*, vol. 21, no. 1, pp. 29–36, Apr. 2024, doi: 10.33480/techno.v21i1.5294.

[7] F. T. Aprilia, A. Taqwa, and A. S. Handayani, “Perancangan Sistem Monitoring Kadar Kualitas Udara Menggunakan Particulate Matter 2,5 Berbasis Website,” *SMATIKA JURNAL*, vol. 11, no. 02, pp. 92–100, Dec. 2021, doi: 10.32664/smatika.v11i02.594.

[8] M. Munsyi, M. S. Febriadi, and N. Saubari, “Environmental Monitoring Berbasis Internet of Things Untuk Peternakan Cerdas,” *Jukung (Jurnal Teknik Lingkungan)*, vol. 5, no. 1, pp. 56–64, 2019, doi: 10.20527/jukung.v5i1.6201.

[9] T. Erlina, “Sistem Monitoring Suhu, Kelembaban Dan Gas Amonia Pada Kandang Sapi Perah Berbasis Teknologi Internet of Things (Iot),” *Journal on Information Technology and Computer Engineering*, vol. 1, no. 01, pp. 1–7, 2017, doi: 10.25077/jitce.1.01.1-7.2017.

[10] B. Satrio and T. Komputer, “Implementasi IoT dalam Monitoring Produksi Peternakan dengan Sensor Berat Hewan,” vol. 3, no. 9, pp. 1–21, 2023.

[11] A. A. Masriwilaga, T. A. J. M. Al-hadi, A. Subagja, and S. Septiana, “Monitoring System for Broiler Chicken Farms Based on Internet of Things (IoT),” *Telekontran : Jurnal Ilmiah Telekomunikasi, Kendali dan Elektronika Terapan*, vol. 7, no. 1, pp. 1–13, 2019, doi: 10.34010/telekontran.v7i1.1641.

[12] M. S. Oudah and A. T. Maolood, “Lightweight Authentication Model for IoT Environments Based on Enhanced Elliptic Curve Digital Signature and Shamir Secret Share,” *International*

Journal of Intelligent Engineering and Systems, vol. 15, no. 5, pp. 81–90, 2022, doi: 10.22266/ijies2022.1031.08.
[13] B. Mexico Fransiscus Sihombing and A. Bayu Primawan, "Sistem Monitoring Berat Muatan Truk Berbasis IoT (Internet of Things) Truck Weight Monitoring System Based on IoT (Internet of Things)," *Seminar Nasional Teknik Elektro*, no. November 2021, pp. 140–150, 2021.
[14] W. Indani, A. Wahyudi, and S. Ramadona, "Timbangan Digital Buah Kelapa Sawit berbasis Internet of Things (IoT)," *Jurnal Elektro dan Mesin Terapan*, vol. 8, no. 2, pp. 145–153, 2022, doi: 10.35143/elementer.v8i2.5777.
[15] I. Nirmala, D. Triyanto, and S. Suhardi, "Sistem Kendali dan Monitoring Pemberian Pakan Unggas Berbasis Internet of Things (IoT)," *Cybernetics*, vol. 5, no. 02, p. 57, 2021, doi: 10.29406/cbn.v5i02.2567.
[16] A. Nadzifarin and A. Asmunin, "Penerapan Elliptic Curve Digital Signature Algorithm pada Tanda Tangan Digital dengan Studi Kasus Dokumen Surat – Menyurat," *Journal of Informatics and Computer Science (JINACS)*, vol. 4, no. 01, pp. 1–9, 2022, doi: 10.26740/jinacs.v4n01.p1-9.
[17] B. Satrio, T. Komputer, T. Kalibrasi, A. Kesalahan, T. Industri, and A. Pengukuran, "Teknik Kalibrasi dan Analisis Kesalahan pada Sensor Load Cell dalam Sistem Timbangan Industri," vol. 3, no. 9, pp. 1–21, 2023.
[18] A. A. A. B. Iskandar Yahya Arulampalam Kunaraj P.Chelvanathan, "Analisis Perbandingan Performa Algoritma Eddsa Dan Ecdsa Pada Json Web Token Dalam Mekanisme Autentikasi Restful Web Service," *Journal of Engineering Research*, 2023.
[19] D. Anggreani, M. I. Nasution, and N. Nasution, "Sistem Penyortir Otomatis Kematangan Tomat Berdasarkan Warna dan Berat dengan Sensor Tcs3200 dan Sensor Load Cell Hx711 Berbasis Arduino UNO," *Jurnal Fisika Unand*, vol. 12, no. 3, pp. 374–380, 2023, doi: 10.25077/jfu.12.3.373-379.2023.
[20] Y. Mukhammad, A. Santika, and S. Haryuni, "Analisis Akurasi Modul Amplifier HX711 untuk Timbangan Bayi," *Medika Teknika : Jurnal Teknik Elektromedik Indonesia*, vol. 4, no. 1, pp. 24–28, 2022, doi: 10.18196/mt.v4i1.15148.
[21] R. Kristiyono, B. Nugroho, and B. Supriyanto, "Automatic Charging Battery Lithium Untuk Kendaraan Listrik," *Teknika*, vol. 7, no. 4, pp. 236–242, 2022, doi: 10.52561/teknika.v7i4.195.
[22] J. Maruli Tua Napitupulu, "Battery Management System untuk Baterai Lithium-ion 18650 3s," 2022.
[23] A. Kurniawan, "Analisis Laju Perpindahan Panas pada Baterai Ion Lithium 18650 terhadap Beban Keluarannya dengan Metode Numerik," *Journal of Mechanical Design and Testing*, vol. 2, no. 2, p. 87, 2020, doi: 10.22146/jmdt.53752.
[24] R. Saputra and B. Yulianti, "Alat Pendeteksi Originalitas Baterai Tipe 18650 Berbasis Arduino Nano," *Jurnal …*, pp. 2–6, 2021.
[25] D. Rahmawati, M. Ulum, M. Farisal, and K. Joni, "Lantai Pembangkit Listrik Menggunakan Piezoelektrik dengan Buck Converter LM2596," *Jurnal Arus Elektro Indonesia*, vol. 7, no. 3, p. 84, 2021, doi: 10.19184/jaei.v7i3.28128.
[26] A. D. Febriyanto, S. N. Hertiana, and Y. Purwanto, "Sistem Keamanan Data Pada IoT Berbasis MQTT Dan Database MySQL Menggunakan Metode RSA," vol. 8, no. 6, pp. 3932–3943, 2022.
[27] M. S. Novelan, Z. Syahputra, and P. H. Putra, "InfoTekJar : Jurnal Nasional Informatika dan Sistem Kendali Lampu Menggunakan NodeMCU dan Mysql Berbasis IOT (Internet Of Things)," *Jurnal Nasional Informatika dan Teknologi Jaringan*, vol. 1, 2020.