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Stock of Nuts/Bolts System With A Load Cell Sensor of Digital Scale As An Iot-Based

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A B S T R A C T

The passage highlights the importance of having a reliable supply of nuts and bolts for Micro, Small, and Medium Enterprises (MSMEs) involved in the manufacturing of appropriate technology tools. Nuts and bolts are critical components in the production process of such manufacturing. Therefore, it is essential to ensure their constant availability to avoid interruptions in the workflow. Currently, many MSMEs still monitor their stock levels manually. This manual method has its drawbacks, as stock levels can sometimes go unnoticed, leading to stockouts when the components are needed. When stock runs out unexpectedly, it can cause delays, as additional time is required to purchase more supplies from wholesalers. In this study, a digital scale with a load cell sensor was developed as a medium for taking inventory or stocking bolts and nuts. This device features several buttons: a button for selecting the size of bolts or nuts, a button for choosing between stocking or taking items, and a button for displaying stock information of bolts or nuts in the warehouse. The results from this digital scale are sent to a website using the Internet of Things (IoT) system as a communication medium between the digital scale and the monitoring website. The results of this study show that the digital scale has an accuracy of 99.95%, and the accuracy of the counted items or stock is 100%.

INTRODUCTION

The availability of goods or stock inventory in the manufacturing sector is very important, as it can prevent several factors that affect manufacturing businesses. Some factors that can be prevented if the monitoring system runs smoothly include preventing production delays, saving time and effort, preventing stock shortages, optimizing costs, and enhancing competitiveness. [1], [2], [3], [4]. There has been some research on the application of web-based monitoring systems for inventory or other systems in several companies to streamline production. [4], [5], [6], [7], [8], [9], [10], [11].

CV Baja Diva, located on Lintas Timur KM 17 Street, Kulim Pekanbaru Riau, is a micro-enterprise in the manufacturing sector that produces appropriate technology equipment. Bolts and nuts are essential components in manufacturing appropriate technology at CV Baja Diva. Currently, the stock of bolts and nuts at CV Baja Diva i still managed manually; when employees need bolts or nuts, they go directly to the warehouse to check if the items are in stock. If they are unavailable, an employee is sent to purchase the items from a store in Pekanbaru about 17 km away, potentially delaying the production process. Therefore, researchers have conducted a study on the inventory of bolts and nuts using IoT-based load sensors to monitor the availability of these items. [5], [10], [12], [13], [14], [15].

This research method uses a load cell sensor as a weight sensor for nuts or bolts, which converts the weight into the stock count of nuts and bolts. In this study, a digital scale was developed as a medium for taking inventory or stock of nuts and bolts. The tool includes several buttons: a button to select the size of the nut or bolt, a button to choose between checking stock or taking items, and a button for viewing stock information on nuts or bolts in the warehouse. The results from this digital scale are sent to the web using the Internet of Things (IoT) system to communicate between the digital scale and web-based monitoring. The web interface monitors the size of nuts and bolts, the available stock count, and the history of items going in and out.

METHODS

In this research method, a block diagram system is used as shown in Figure 1. Based on Figure 1, the input, in the form of nuts/bolts, is weighed using a digital scale with a load cell sensor, and the weighing results will be converted into the number of nuts/bolts. Then, the stock of nuts/bolts will be displayed on a web interface using IoT.

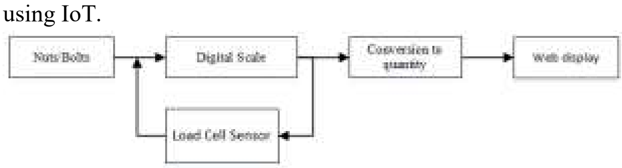

Figure 1. A Block Diagram System

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This study uses a load cell sensor as the main component to read physical quantities in the form of weight. The sensor readings are processed using a microcontroller, which acts as the brain of this tool, which is a digital scale. The research method can be depicted in a block diagram as shown in Figure 2.

The workflow based on Figure 2 shows that there are two input processes for this system to function: input from the keypad in the form of menu options to either take items or check stock, as well as the type of item, whether it's a nut or bolt and its specific type; and input from the item itself, i.e., the nut or bolt. The power supply for this device comes from a battery that provides energy to the microcontroller and load cell sensor. The item, whether a nut or bolt, which serves as the input, is placed on the load cell, which detects changes in the strain gauge values and sends the voltage readings to the HX711 module. The HX711 module conditions the signal from the load cell before sending it to the microcontroller so that the readings can be interpreted and converted into a mass unit (grams). [15], [16], [17], [18], [19] The flowchart can be seen in Figure 3. The processed result from the microcontroller is then displayed on an LCD and shown on the web. An example of the web display relationship scheme can be seen in Figure 4.

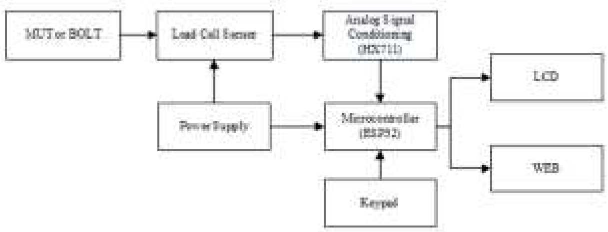


Figure 2. Block Diagram of the Research Method for IoT-Based Nut or Bolt Weighing System

A linear equation method will convert the weight of a bolt/nut obtained from the digital scale to the number of bolts/nuts. This linear equation is obtained using Google Sheets. The expected linear equation is as follows in Equation 1.

$$y = a x + b \quad (1)$$

Based on equation (1), the relationship between the number of units and the mass of a nut or bolt is described. **y** represents the number of units, **x** represents the mass of the nut/bolt, and **a** and **b** are constants obtained from the data equation through Google Sheets.

The results of the digital weighing tool used in the research are obtained using the methods previously described. The form of this tool can be seen in Figure 5, and an example of the web display can be seen in Figure 6.

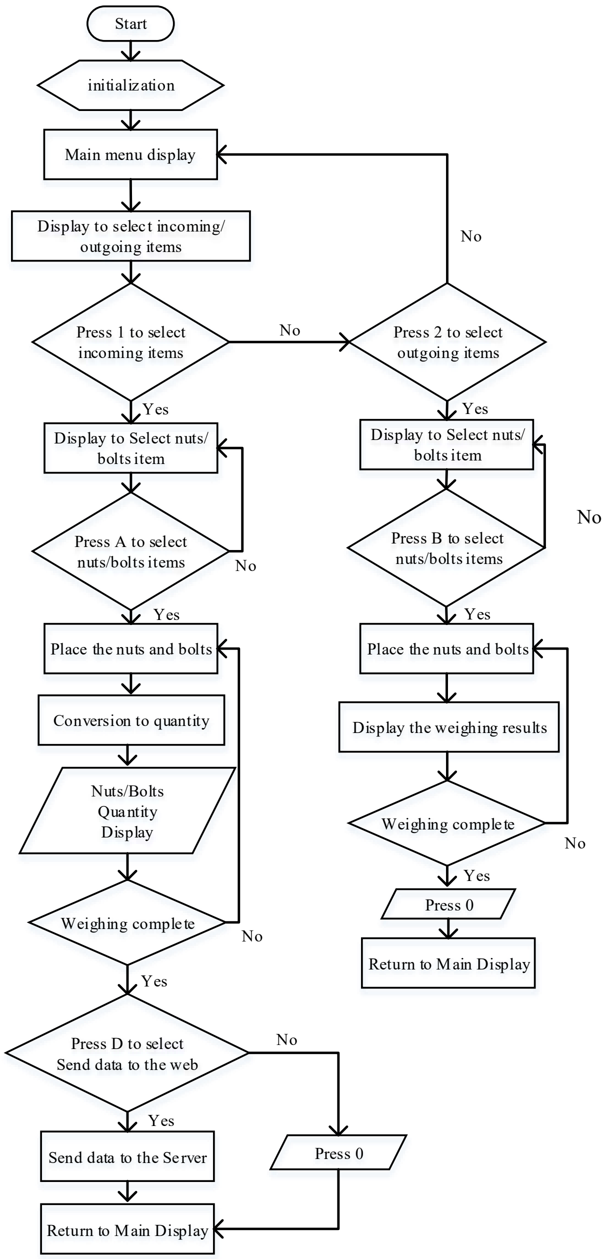


Figure 3. Flow Chart of the Research Method for IoT-Based Nut or Bolt Weighing System

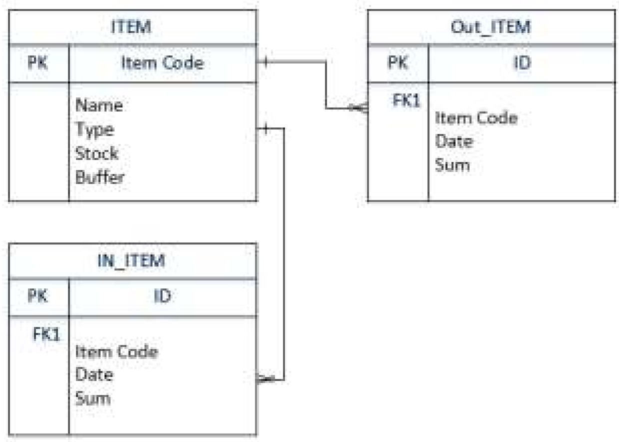
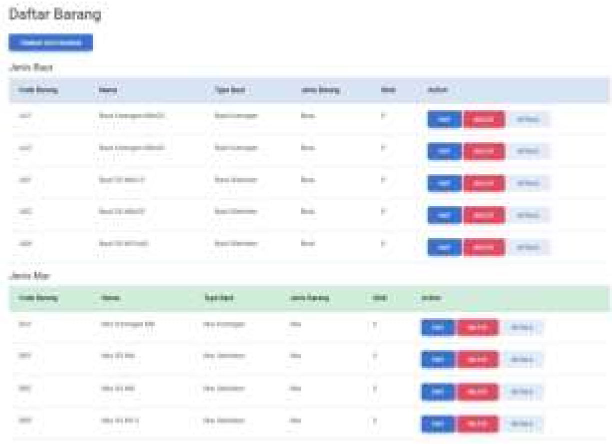


Figure 4. Web Relationship Schema

Figure 5. Form of the IoT-Based Nut or Bolt Weighing Tool



(a)

(b)

Figure 6. (a) Stock Data Display on Website (b) Incoming Item Display on Website

The testing method for the digital scale that has been developed uses components frequently used by the research partner, CV Baja Diva, consisting of 6 types of bolts and 4 types of nuts. These components are commonly used by the partner, which operates in the manufacturing sector. The types of nuts and bolts are as follows: Brass Bolt M8x25, Brass Bolt M8x40, Stainless Steel Bolt M6x10, Stainless Steel Bolt M8x30, Stainless Steel Bolt M10x20, Stainless Steel Bolt M10x45, Brass Nut M8, Stainless Steel Nut M6, Stainless Steel Nut M8, Stainless Steel Nut M10.

RESULTS AND DISCUSSION

In this research, the data that will be discussed includes load cell sensor data, data on the relationship between the number of nuts/bolts and the mass of the nuts/bolts with various types and sizes of nuts/bolts, data on testing the retrieval and stock of nuts/bolts, and data on synchronization between the device and information on the website through IoT.

The load cell sensor data used in this digital scale device is collected using a digital scale available on the market as a reference for measuring the weight of an object. The data obtained is shown in Table 1.

Table 1. Load Cell Test Data for Digital Scales Compared with Reference Digital Scales

No	Reference Digital Scales	Digital Scales	Difference (Gr)	Error (%)	Accuracy (%)
1	1095	1095	0	0	100,00
2	640	641	1	0,16	99,84
3	1731	1732	1	0,06	99,94
4	360	360	0	0	100,00
5	1555	1555	0	0	100,00
6	760	761	1	0,13	99,87
7	866	866	0	0	100,00
8	510	510	0	0	100,00
9	223	223	0	0	100,00
10	480	480	0	0	100,00
11	1955	1957	2	0,10	99,90
12	870	871	1	0,11	99,89
13	1240	1241	1	0,08	99,92
14	2648	2649	1	0,04	99,96
15	1375	1377	2	0,15	99,85
16	1960	1961	1	0,05	99,95
17	3645	3646	1	0,03	99,97
18	3435	3435	0	0	100,00
19	4527	4527	0	0	100,00
20	4405	4405	0	0	100,00
	Average		0,60	0,05	99,95

According to the data in Table 1, the error measured is 0.05%, indicating a precision level of 99.95%. The following data explores the relationship between the weight of objects—specifically, nuts and bolts—and the quantity of these items. In this study, six types of bolts and four types of nuts were examined.

Data was collected from each bolt and nut type to obtain a conversion formula from weight to unit count. The data collection method for obtaining the conversion formula from weight to quantity will employ the Simple Linear Regression method.

Simple Linear Regression is a statistical method used to identify the relationship between two variables. If there is a relationship between variable X and variable Y, the known value of variable X can be used to estimate or predict the value of variable Y. In developing this bolt and nut scale, the relationship between weight and quantity for each type can be determined using the Simple Linear Regression method. The data collection involved determining the quantity of bolts/nuts based on their weight when measured.

The data collection model involves weighing the bolts/nuts and then recording the weight and the number of bolts/nuts weighed. For each bolt and nut, data was collected 50 times, and the unit quantity of bolts/nuts was set at 50 pieces. Data collection continued by reducing the count by one piece of the bolt/nut each time. With this extensive data collection, the linear equation for determining the number of bolts based on weight is expected to be more accurate. The data collection process can be seen in Figure 7.

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Figure 7. Data Collection Process

To facilitate the calculation process and obtain the linear equation, Google Spreadsheet software was used to assist in processing the Simple Linear Regression data using Trendline, deriving the formula for the number of bolts/nuts versus weight from the scale. For example, the data obtained for the M8 x 25 brass bolt, as shown in Table 2, and the process of generating the graph and equation based on the data in Table 2 can be seen in Figure 8. [10], [20], [21], [22], [23]

Table 2. Weight and quantity data for M8 x 25 brass bolts

Weight (mg)	Quantity (Unit)	Weight (mg)	Quantity (Unit)
626	50	301	24
614	49	289	23
601	48	276	22
589	47	264	21
576	46	251	20
564	45	239	19
551	44	226	18
539	43	214	17
526	42	201	16
514	41	189	15
501	40	176	14
489	39	164	13
476	38	151	12
464	37	139	11
451	36	126	10
439	35	114	9
426	34	101	8
414	33	89	7
401	32	76	6
389	31	64	5
376	30	51	4
364	29	39	3
351	28	26	2
339	27	14	1
326	26	0	0
314	25		

The results of the data collection for all bolts and nuts can be seen in Table 3.

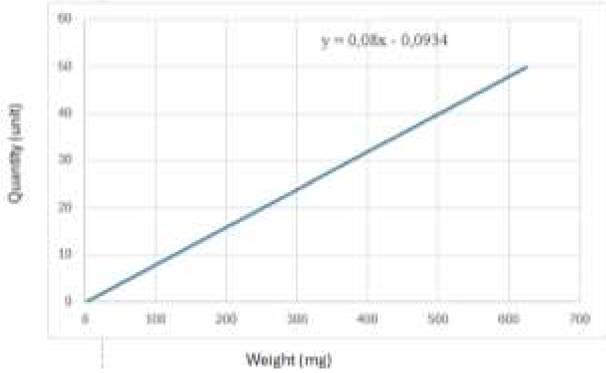

Figure 8. Brass Bolt M8 x 25 data retrieval using a spreadsheet

Table 3. Linear Equation for Data on All Bolts and Nuts

No	Bolts/Nuts Type	Linear Regression Equation
1	Brass Bolt M8x25	0.08 x - 0.0934
2	Brass Bolt M8x40	0.0586 x + 0.00664
3	Stainless Steel Bolt M6x10	0.234 x - 0.0266
4	Stainless Steel Bolt M8x30	0.0671 x - 0.00826
5	Stainless Steel Bolt M10x20	0.0464 x - 0.112
6	Stainless Steel Bolt M10x45	0.0295 x + 0.0184
7	Brass Nut M8	0.301 x + 0.473
8	Stainless Steel Nut M6	0.463 x + 0.0909
9	Stainless Steel Nut M8	0.215 x + 0.0373
10	Stainless Steel Nut M10	0.0977 x + 0.0382

For testing the retrieval or stock of nuts/bolts, synchronization with the website display through the Internet of Things (IoT) can be seen in Figures 9, 10, and 11.

Figure 9. Stock of SS M8 x 30 Bolts: 24 Units

Figure 10. LCD Display During Item Dispatch: 10 pcs

Figure 11. Website Display During SS M8 x 30 Bolt Stock Withdrawal

Figure 11. Website Display During SS M8 x 30 Bolt Stock Withdrawal

The data on the testing of the number of nuts/bolts using various types of nuts/bolts, with 8 tests and various quantities of nuts/bolts, can be seen in Table 4.

Table 4. Testing Variations in the Number of Different Types of Nuts/Bolts

Type	Number of test	Variation in Testing the Number of Nuts/Bolts						Accuracy (%)
		13	20	26	34	45	50	
Brass Bolt M8x25	8	13	20	26	34	45	50	100
Brass Bolt M8x40	8	13	20	26	34	45	50	100
Stainless Steel Bolt M6x10	8	13	20	26	34	45	50	100
Stainless Steel Bolt M8x30	8	13	20	26	34	45	50	100
Stainless Steel Bolt M10x20	8	13	20	26	34	45	50	100
Stainless Steel Bolt M10x45	8	13	20	26	34	45	50	100
Brass Nut M8	8	13	20	26	34	45	50	100
Stainless Steel Nut M6	8	13	20	26	34	45	50	100
Stainless Steel Nut M8	8	13	20	26	34	45	50	100
Stainless Steel Nut M10	8	13	20	26	34	45	50	100

The data collection based on Table 1 aims to determine the load cell's accuracy in measuring an object's mass. As shown in Table 1, the data obtained includes 20 variations of object mass with a comparison between the digital scale available on the market and the digital scale with a load cell sensor. The results show a high accuracy of 99.95%. This result is more precise than the previous study by previous researchers, which had a digital scale error of 0.133% or a precision level of 99.867%. [16] From several studies related to digital scales, precision levels range from 95% to 99.5%. [24], [25], [26], [27]

Based on previous research, the digital scale only measured up to the weight value or mass. The digital scale we used in our research has a higher accuracy than previous studies, allowing us to extend our research into a stock application for nuts or bolts. This makes our research more advanced, as this digital scale can determine the stock availability of nuts or bolts by simply weighing them. Therefore, the high accuracy value concludes that the digital scale with a load cell sensor is deemed suitable for weighing nuts or bolts to the partner.

The next test involves converting the mass of nuts and bolts into the number of items in stock or during withdrawal. The partner frequently uses six types of bolts and four types of nuts, which will be tested. According to Table 3, there are linear equations for each of the six types of bolts and four types of nuts commonly used by the partner. Each type of nut and bolt has a different equation due to the varying mass of each type. These equations are programmed into the microcontroller, with options for the different types of nuts and bolts available via the keypad of the digital scale equipped with a load cell.

After inputting the linear equations, the next test involves checking the number of each type of nut/bolt with 8 tests per type and variations in the number of nuts/bolts. The data obtained, as shown in Table 3, resulted in an accuracy of 100% for the quantity detected by the digital scale with load cell compared to the manual data tested. This indicates that the scale developed through this research suits the partner.

To monitor the stock of nuts/bolts, the display on the website with real-time data was tested, as shown in Figures 9 through 11. Figure 9 shows the stock of SS M8 x 30 bolts at 24 pcs. The test involved removing 10 pcs of these bolts, which were displayed on the LCD of the device. This removal process was transmitted via IoT, and the website display was updated accordingly, as shown in Figure 11. The results of the IoT data transmission displayed on the LCD are accurate, precise, and consistent with the data obtained by previous researchers.[10] The stock monitoring system displayed on the web produces the same results as other researchers regarding web-based inventory information systems.[28] The advantage of this research is that the real-time item input system is sent to the web. In previous research, the input and output system was still manual, whereas in our research, the nuts/bolts entering or leaving are automatically recorded through a digital scale. Based on this data, it can be concluded that monitoring nuts/bolts on the website is effective, and the stock or retrieval process can update the data on the digital scale with a load cell.

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CONCLUSIONS

In general, the results of the discussion and analysis from this study produced digital weighing equipment that uses load cell sensors with an accuracy of 99.95%. The data transmission from the digital weighing device to the web server using the Internet of Things (IoT) has achieved 100%, along with a real-time web display corresponding to the stock of nuts and bolts available, including various types of nuts and bolts that have been specified. The limitation during the research was in the timing of trials and data collection, which often did not align with the research partner's schedule. For future research, it can be expanded to other types of inventory with the following research partner.

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REFERENCES

[1] Y. Ladhe, "Implementation of Inventory Management Technique in Manufacturing Industry," *Int. J. Sci. Res. Eng. Trends*, vol. 9, no. 4, 2021.

[2] A. Sharma and V. Arya, "Study of Inventory Management in Manufacturing Industry," *Int. J. Adv. Eng. Glob. Technol. I*, vol. 04, no. 03, 2016.

[3] M. Marsudi, "Inventory Management In AnManufacturing Industry: A Case Study," *J. JIEOM*, vol. 1, no. 2, 2018.

[4] N. K. Sriwinarti, I. Murapi, and N. Fathona, "Sistem Informasi Persediaan Stok Barang Pada Toko Kelontong Berbasis Web," *Riset, Ekon. Akunt. dan Perpajak.*, vol. 2, no. 2, 2021, doi: 10.30812/rekan.v2i2.1405.

[5] K. Nur, "Rancang Bangun Prototype Alat Monitoring Tangki Bahan Bakar Solar di PLTD Berbasis IoT," *PETIR*, vol. 16, no. 2, 2023, doi: 10.33322/petir.v16i2.2019.

[6] A. A. Rafiq, M. Yusuf, and P. Pujono, "DIGITAL IMAGE PROCESSING MENGGUNAKAN PERANGKAT LUNAK NI VISION DAN IP KAMERA DENGAN ROVER BOGIE ROBOT," *J. Ecotipe (Electronic, Control. Telecommun. Information, Power Eng.*, vol. 6, no. 1, 2019, doi: 10.33019/ecotipe.v6i1.940.

[7] A. F. Saiful Rahman, M. W. Kasrani, and I. Muslimin, "PROTOTIPE TIMBANGAN DIGITAL PADA GUDANG SEMBAKO BERBASIS WEB," *J. Tek. Elektro Uniba (JTE UNIBA)*, vol. 6, no. 2, 2022, doi: 10.36277/jteuniba.v6i2.142.

[8] S. Sanjaya, Jasmir, and D. Meisak, "Perancangan Sistem Informasi Stok Barang Berbasis Web Pada PT. Jambi Agung Lestari," *J. Manaj. Teknol. Dan Sist. Inf.*, vol. 2, no. 1, 2022, doi: 10.33998/jms.2022.2.1.55.

[9] S. N. R. Sika and Putri Aisyiyah Rakhma devi, "Sistem Informasi Persediaan Stok Barang Berbasis Web Pada Toko Putra Gresik," *J. FASILKOM*, vol. 11, no. 3, 2021, doi: 10.37859/jf.v11i3.3163.

[10] V. Silviani, N. Hiron, and F. M. S. Nursuwars, "INTERNET OF THINGS (IoT) BASED SCALES FOR DYNAMIC LOADS WITH WEIGHT FORECASTING FEATURE," *J. Energy Electr. Eng.*, vol. 5, no. 1, 2023, doi: 10.37058/jeee.v5i1.6017.

[11] A. Bagus Setiawan, W. Rachmawati, A. Taufiq Arrahman, N. Natasyah, and F. N. S. Fadil, "Aplikasi Monitoring Stok Barang Berbasis Web Pada PT. Intermetal Indo Mekanika," *ADI Bisnis Digit. Interdisiplin J.*, vol. 2, no. 2, 2021, doi: 10.34306/abdi.v2i2.254.

[12] T. Bhuvaneswari, J. Hossen, N. A. Amir Hamzah, P. Velrajkumar, and O. H. Jack, "Internet of things (IoT) based smart garbage monitoring system," *Indones. J. Electr. Eng. Comput. Sci.*, vol. 20, no. 2, 2020, doi: 10.11591/ijeecs.v20.i2.pp736-743.

[13] Y. D. S. Budoyo and A. D. Andriana, "Sistem Iot Timbangan Digital Menggunakan Sensor Load Cell Di Ud. Pangrukti Tani," *Tek. Inform. - Univ. Komput. Indones.*, 2019.

[14] W. Indani, A. Wahyudi, and S. Ramadona, "Timbangan Digital Buah Kelapa Sawit berbasis Internet of Things (IoT)," *J. Elektro dan Mesin Terap.*, vol. 8, no. 2, 2022, doi: 10.35143/elementer.v8i2.5777.

[15] E. Clinic, "IoT Weighing Scale using Load cell HX711,ESP32, & New Blynk V2 0." [Online]. Available: https://youtu.be/r-P6yv7AJ4Y

[16] B. Y. Wedha, A. B. P. B. Wedha, and H. Haryono, "Design and Build Mini Digital Scale using Internet of Things," *SinkrOn*, vol. 7, no. 2, 2022, doi: 10.33395/sinkron.v7i2.11345.

[17] A. Saputra, J. Junaidi, A. Supriyanto, and A. Surtono, "Desain dan Realisasi Alat Ukur Massa (Neraca Digital) Menggunakan Sensor Load Cell Berbasis Arduino," *J. Teor. dan Apl. Fis.*, vol. 10, no. 02, 2022, doi: 10.23960/jtaf.v10i2.2660.

[18] V. Dwiyanti, M. M. Rose, and S. Zefi, "Rancang Bangun Timbangan Digital dengan Menampilkan Berat dan Harga Menggunakan Output Suara Berbasis Internet of Things (IoT)," *J. Resist. (Rekayasa Sist. Komputer)*, vol. 6, no. 2, 2023, doi: 10.31598/jurnalresistor.v6i2.1453.

[19] H. T. Electronics, "IoT Weighing Scale with HX711 Load Cell & ESP8266." p. 1, 2020. [Online]. Available: https://how2electronics.com/iot-weighing-scale-hx711-load-cell-esp8266/

[20] C. M. Duong and T. T. Lim, "Use of regression models for development of a simple and effective biogas decision-support tool," *Sci. Rep.*, vol. 13, no. 1, 2023, doi: 10.1038/s41598-023-32121-6.

[21] M. Marie, F. Yirga, M. Haile, S. Ehteshammajd, H. Azadi, and J. Scheffran, "Time-series trend analysis and farmer perceptions of rainfall and temperature in northwestern Ethiopia," *Environ. Dev. Sustain.*, vol. 23, no. 9, 2021, doi: 10.1007/s10668-020-01192-0.

[22] M. Setiawati, I. N. Y. A. Wijaya, and N. M. Estiyanti, "Rancang Bangun Sistem Informasi Penjualan, Pembelian Dan Persediaan Berbasis Web (Studi Kasus Resto Jinggo Tutu)," *Jutisi J. Ilm. Tek. Inform. dan Sist. Inf.*, vol. 10, no. 3, 2021, doi: 10.35889/jutisi.v10i3.723.

[23] A. Sosianika, E. Sartika, and F. A. Amalia, "THE ROLE OF SCIENTIFIC CALCULATORS IN IMPROVING STATISTICS LEARNING," *J. Lebesgue J. Ilm. Pendidik. Mat. Mat. dan Stat.*, vol. 4, no. 2, 2023, doi: 10.46306/lb.v4i2.282.

[24] L. Listyalina, K. Mayasari, and Y. Yudianingsih, "Analisis Perancangan Digital Nutrition Scale Berbasis Sensor Load Cell," *AVITEC*, vol. 5, no. 2, 2023, doi: 10.28989/avitec.v5i2.1767.

[25] A. M. Muslimin and T. Lestari, "PERANCANGAN ALAT TIMBANGAN DIGITAL BERBASIS ARDUINO LEONARDO MENGGUNAKAN SENSOR LOAD CELL," *J. Nat.*, vol. 17, no. 1, 2021,

doi: 10.30862/jn.v17i1.145.

[26] J. Setiyono, "UJI KALIBRASI (KETIDAKPASTIAN PENGUKURAN) TIMBANGAN DIGITAL MENGACU PADA STANDAR JCGM 100:2008," *J. Tek. Mesin Cakram*, vol. 1, no. 1, 2018, doi: 10.32493/jtc.v1i1.1342.

[27] F. N. Hulu, "Analisis Perbandingan Tingkat Akurasi Timbangan Digital Dan Manual Sebagai Alat Pengukur Berat Badan Anak," *J. Ilmu Komput. dan Bisnis*, vol. 9, no. 1, 2018, doi: 10.47927/jikb.v9i1.120.

[28] J. S Pasaribu, "Development of a Web Based Inventory Information System," *Int. J. Eng. Sci. Inf. Technol.*, vol. 1, no. 2, 2021, doi: 10.52088/ijesty.v1i2.51.

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