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DESIGN AND CONSTRUCTION OF A CORN SHELLER POWERED BY A SOLAR POWER SYSTEM WITH AN ESP32 BASED CONTROL SYSTEM IN SUKOSEWU VILLAGE GANDUSARI SUBDISTRICT BLITAR REGENCY

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Load cell
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ABSTRACT

This study aims to design a corn sheller machine based on a solar power generator with an ESP32 microcontroller in Sukosewu Village, Gandusari District, Blitar Regency. The machine uses a 50 Wp solar panel and a 12V 22Ah $LiFePO_4$ battery as its power source. A 1200W DC-DC Step-Up Converter boosts the voltage to 18V for the DC motor 895, while a DC-DC Step-Down XL4015 lowers it to 5V for the ESP32, INA260 sensor, relay, HX711, and I2C LCD. Test results show the solar panel generates an average of 42.64 Watts per day, requiring about 5 days to charge the battery to 80%. The INA260 sensor shows an average error of 7.74% for voltage, 7.06% for current, and 1.36% for power compared to a digital multimeter, while the Load Cell shows an average error of 0.82 % compared to a digital scale. This device achieves a productivity rate of 7.604 grams per second, while the traditional method only reaches 1.946 grams per second, a difference of 5.673 grams. The average efficiency using the device reaches 77.88%, while the traditional method only achieves 62.74%. These results indicate the device operates efficiently.

INTRODUCTION

Corn (Zea mays) is one of Indonesia's main food commodities, with high economic value and an important role in national food security. As the main source of carbohydrates after rice, corn is used not only as food but also as animal feed and raw material for the food industry. According to data from the Central Statistics Agency, the corn harvest area in Indonesia in 2023 reached 2.48 million hectares, with several provinces such as East Java, Central Java, North Sumatra, South Sulawesi, and West Nusa Tenggara being the largest contributors to production. (Badan Pusat Statistik, 2024).

However, post-harvest processes such as shelling remain a challenge, particularly in rural areas like Sukosewu Village, Gandusari Subdistrict, Blitar Regency. Most farmers in this village are elderly with limited access to modern technology, so they still use inefficient and labor-intensive manual methods. The conventional shelling tools available also rely on electricity or fossil fuels, which are costly.

In a previous study conducted by (Setiawan et al., 2024), an IoT-based dry corn sheller machine powered by a 20 Wp solar panel and a 12V 7.5Ah battery was developed. The system uses a 12V DC motor and is controlled via a Telegram app, enabling remote monitoring and control. As part of the development, the device in this study was designed to be simpler and more self-sufficient without an internet connection, considering the limited signal availability in this village. The device uses an 895 DC motor with an 18V voltage, powered by a 50 Wp solar panel and a 12V 22Ah battery, equipped with a boost converter to increase the motor voltage, and a DC Motor PWM Speed Controller to regulate the DC motor speed. Current and voltage monitoring is performed locally using an INA260 sensor and displayed via an I2C LCD. This innovation aims to enhance the reliability of the device in the field, maintain efficiency, and ensure ease of operation in areas without internet connectivity.

The use of renewable energy in the form of a Solar Power Plant was chosen to improve energy efficiency and reduce dependence on fossil fuels, which are expensive and cause pollution. Additionally, solar energy is a renewable and environmentally friendly resource, making it highly suitable for supporting sustainable agricultural activities. By leveraging this technology, it is hoped that the corn sheller machine will help farmers significantly increase productivity while providing a cost effective and environmentally friendly solution

RESEARCH METHOD

This section describes the methods used in designing and building a solar powered dry corn sheller machine controlled by an ESP32 microcontroller. The process begins with system planning, component selection, machine assembly, microcontroller programming, and field testing of the machine's performance. The entire process is focused on producing an energy-efficient, environmentally friendly machine that can be operated independently using solar panel energy.

Research Steps

The steps in this research were carried out systematically so that the objectives of designing and constructing a corn sheller machine based on solar power with ESP32 controller could be achieved optimally. The research flow is shown in the following flowchart.

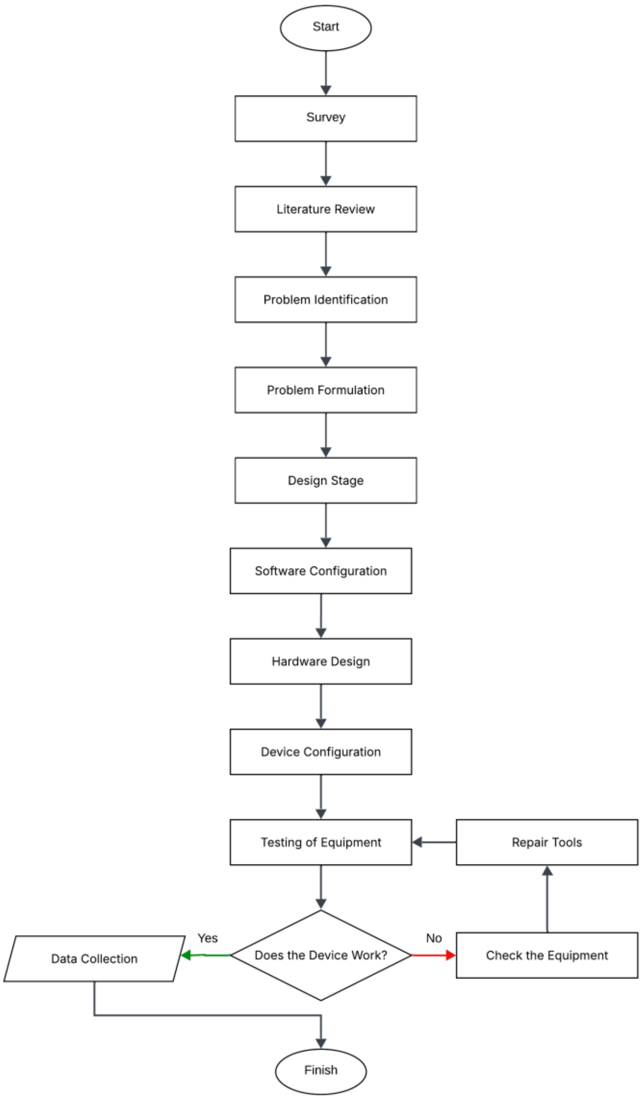

Figure 1. Research Flow Chart
Source : Personal documents

Here is an explanation of each step in the flowchart:

1. A survey was conducted at the research site, namely Sukosewu Village, to determine the field conditions, farmers' needs, and obstacles faced in the corn shelling process.
2. The literature study aimed to explore references from journals, books, and scientific articles related to solar panel, ESP32, and corn sheller.
3. Based on the survey results and literature review, the main issues faced by farmers were identified, particularly the limitations of efficient and energy-saving corn sheller tools.
4. The identified issues were formulated specifically to become the primary focus of this research.
5. Designing a technical solution in the form of a solar-powered corn shelling system controlled by a microcontroller.

6. Configuring and programming the software for the ESP32 to automatically control and monitor the device.
7. Determining the hardware components used, such as the DC 895 motor, INA260 sensor, Load Cell sensor, I2C LCD, and others.
8. Integrating all hardware and software components into a single system that operates synergistically.
9. The assembled device is tested to determine if the system functions properly and according to design.
10. Decisions are made based on test results. If the device does not function, inspections and repairs are conducted.
11. If the device is not functioning optimally, the system is checked and faulty components are repaired before retesting.
12. Once the device is functioning properly, comprehensive data collection is conducted, including energy efficiency, productivity, and sensor accuracy.

Schematic Diagram

The circuit schematic is a comprehensive overview of the electronic system used in this solar-powered corn sheller. The circuit is designed so that all components can work together seamlessly, efficiently, and in accordance with their respective functions. In this design, solar panels are used as the primary energy source, regulated by a Solar Charge Controller (SCC) and stored in a $LiFePO_4$ battery. The ESP32 microcontroller serves as the central controller, responsible for regulating motor operation, reading sensor data, and displaying information via an LCD screen. The general schematic diagram of the system can be viewed in the following figure:

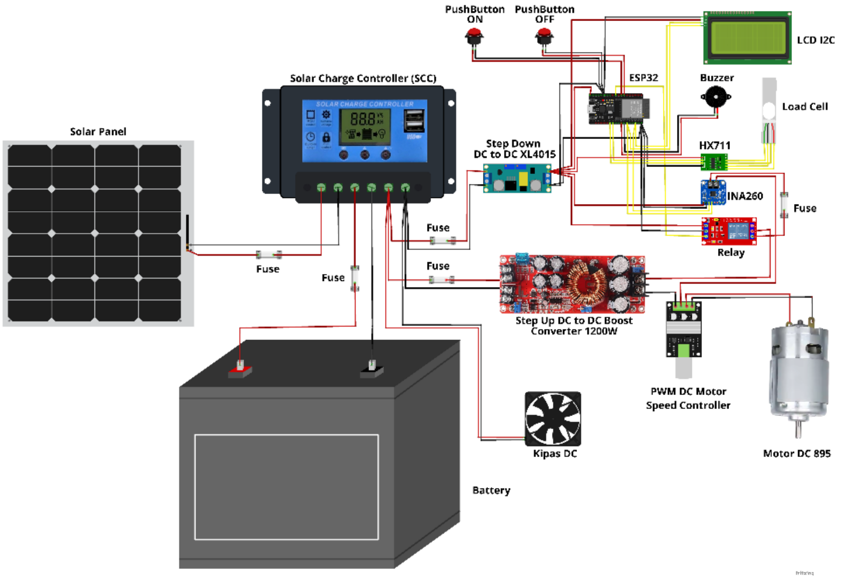

Figure 2. Wiring diagram of the device
Source : Personal documents

The wiring design for this solar-powered corn sheller was created systematically so that all components are properly connected and function as intended. The primary energy source is a 50 Wp solar panel, connected to a Solar Charge Controller (SCC) to regulate the charging process to the 12V 22Ah $LiFePO_4$ battery. From this battery, the electrical current is divided into two main paths through two voltage conversion modules: a 1200W DC-DC Step-Up Converter and a DC-DC Step-Down Converter XL4015. The first path increases the voltage from 12V to 18V to supply power to the 895 DC motor, while the second path reduces the voltage to 5V, which is used to power the ESP32 microcontroller, INA260 sensor, HX711 module, and I2C LCD.

The ESP32 serves as the central controller for the entire system. This microcontroller controls the on/off state of the 5V 30A relay, which functions as an automatic switch to connect the current from the battery to the DC motor 895. Additionally, the ESP32 receives data from the INA260 sensor to monitor the system's voltage, current, and power in real-time, as well as from the Load Cell converted via the HX711 module to determine the weight of the corn kernels. All critical information is displayed on the I2C 20x4 LCD, including the device status, current, voltage, power values, and the weight of the corn kernels.

To protect the circuit from the risk of damage, a fuse is used as a current protector and a DC fan as a cooling system installed inside the panel box. The entire circuit is designed with safety, power distribution efficiency, and ease of maintenance in the field in mind.

RESULTS AND DISCUSSION

This research resulted in a corn shelling machine that uses energy from a solar power plant and is automatically controlled by an ESP32 microcontroller. Tests were conducted on several key aspects, namely the performance of the solar panel, the accuracy of the voltage, current, and power sensors, the speed of the 895 DC motor, weight, shelling efficiency, and corn shelling productivity.

Results of the tools design

Figure 3. Hardware component design results
Source : Personal documents

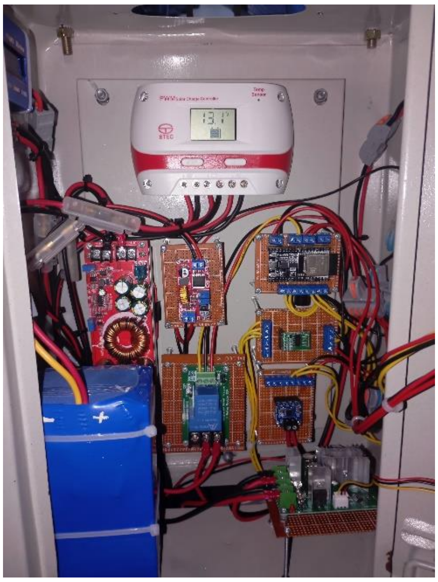

Figure 4. Wiring diagram results for the device
Source : Personal documents

Software configuration display results

Figure 5. LCD display for monitoring
Source : Personal documents

The LCD I2C on this device has three main pages that automatically change every 15 seconds. Page 0 displays the device status and operating time, page 1 displays voltage, current, and power data from the INA260 sensor, while page 2 displays the weight of the corn from the Load Cell sensor when the plate is ready. The START button is used to turn on the device and begin the husking process, while the STOP button is used to temporarily pause the device when pressed once, and pressing it again will reset the system, returning the device to its initial state.

Solar panel test results
The first data collection was conducted on the solar panels used. The testing of these solar panels was carried out in Sukosewu Village, Gandusari Subdistrict, Blitar Regency, in accordance with the title of this research. The solar panel testing was carried out over three days, from June 27, 2025, to June 29, 2025. Although a DC Watt Meter was installed on the device, data collection in the form of voltage and current was performed using a digital multimeter to obtain accurate and reliable data.

Table 1. First day solar panel testing table

No	Time (WIB)	Voltage (V)	Current (A)	Power (W)	Solar Radiation Intensity (W/m2)	Weather Conditions Description
1	09.00	20,68	0,00	0	270,2	Cloudy
2	10.00	20,83	0,00	0	303.3	Cloudy
3	11.00	13,42	0,61	8,1862	213,6	Cloudy
4	12.00	13,42	0,39	5,2338	120,4	Cloudy
5	13.00	13,52	0,74	12,4384	569,3	Partly cloudy
6	14.00	13,46	0,40	5,2455	150,3	Cloudy
7	15.00	13,45	0,24	3,228	74,3	Dark

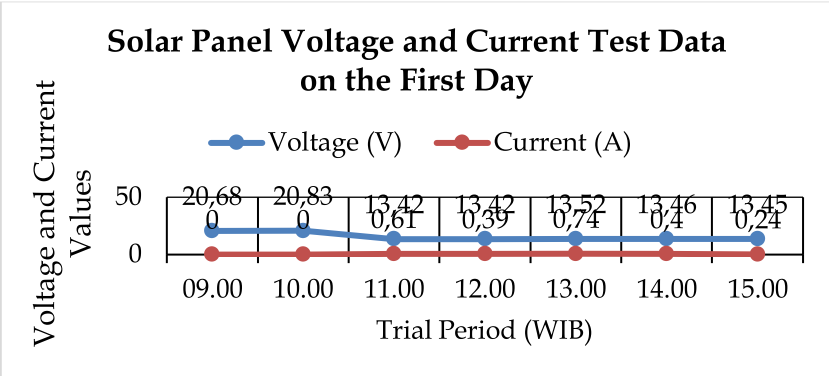

Figure 6. Solar Panel Voltage and Current Test Data on the First Day
Source : Personal documents

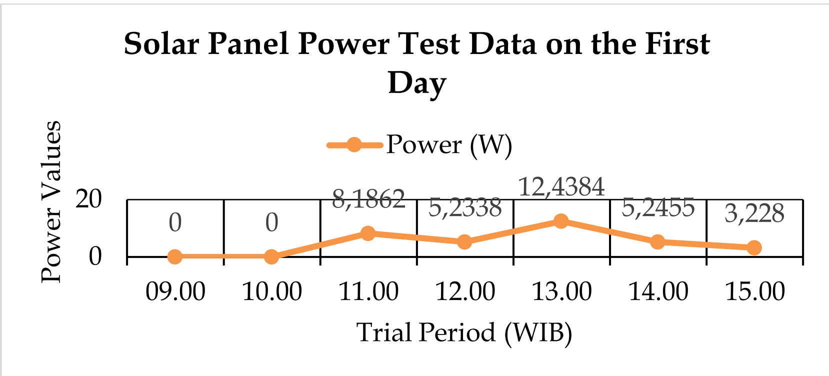

Figure 7. S Solar Panel Power Test Data on the First Day
Source : Personal documents

On June 27, 2025, the power generated by solar panels to charge batteries can be indicated by the following equation:

Total energy (W) = Power per hour (W) x time
= (0 + 0 + 8.1862 + 5.2338 + 12.4384 + 5.2455 + 3.228) x 1
= 34.3319 W

Table 2. Second day solar panel testing table

No	Time (WIB)	Voltage (V)	Current (A)	Power (W)	Solar Radiation Intensity (W/m2)	Weather Conditions Description
1	09.00	19,59	0,00	0	74,3	Cloudy
2	10.00	19,49	0,01	0,1949	101,3	Cloudy
3	11.00	20,40	0,01	0,204	353,8	Cloudy
4	12.00	13,38	0,98	13,1124	461,6	Partly cloudy
5	13.00	19,94	0,44	8,7736	158,0	Cloudy
6	14.00	13,31	0,15	1,9965	36,7	Rain
7	15.00	13,29	0,23	3,0567	87,5	Rain

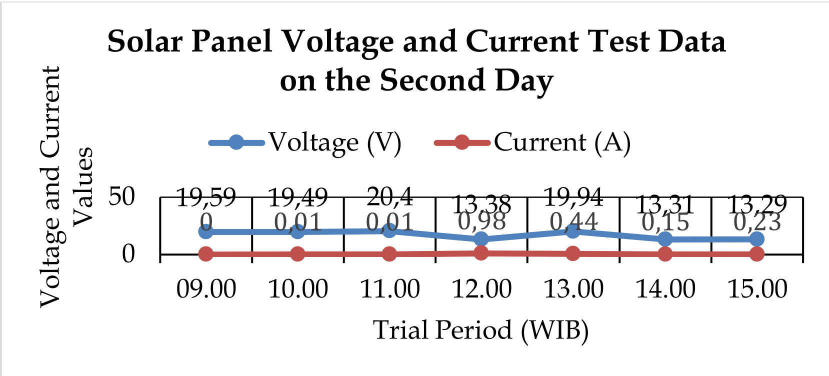

Figure 8. Solar Panel Voltage and Current Test Data on the Second Day
Source : Personal documents

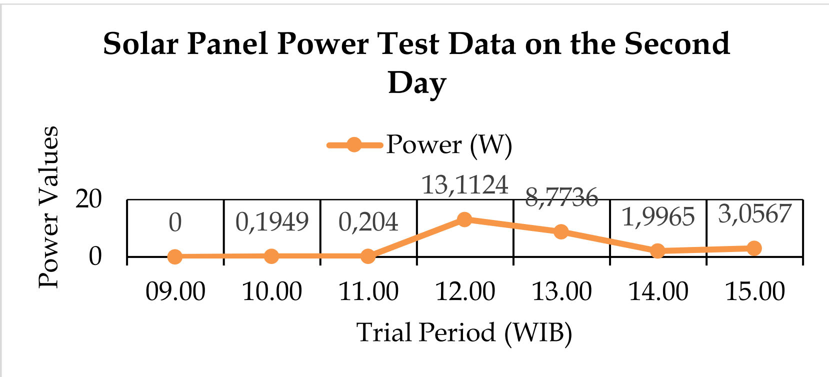

Figure 9. S Solar Panel Power Test Data on the Second Day
Source : Personal documents

Where on June 28, 2025, the power generated by the solar panels to charge the batteries can be indicated by the following equation:

Total energy (W) = Power per hour (W) x time

= (0 + 0.1949 + 0.204 + 13.1124 + 8.7736 + 1.9965 + 3.0567) x 1

= 27.3381 W

Table 3. Third day solar panel testing table

No	Time (WIB)	Voltage (V)	Current (A)	Power (W)	Solar Radiation Intensity (W/m2)	Weather Conditions Description
1	09.00	19,50	0,27	5,265	104,9	Cloudy
2	10.00	13,35	1,30	17,355	401,7	Partly cloudy
3	11.00	13,56	2,29	31,0524	938,6	Clear
4	12.00	13,41	0,54	7,2414	225,4	Cloudy
5	13.00	13,40	0,40	5,36	170,1	Cloudy
6	14.00	13,17	0,00	0	17,4	Rain
7	15.00	13,25	0,00	0	4,9	Rain

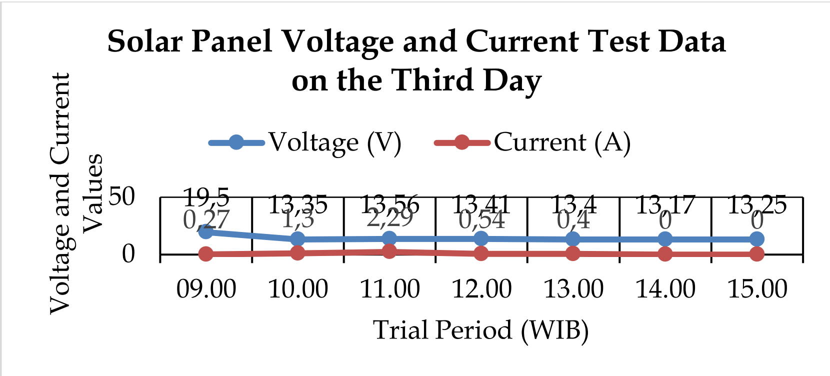

Figure 10. Solar Panel Voltage and Current Test Data on the Third Day
Source : Personal documents

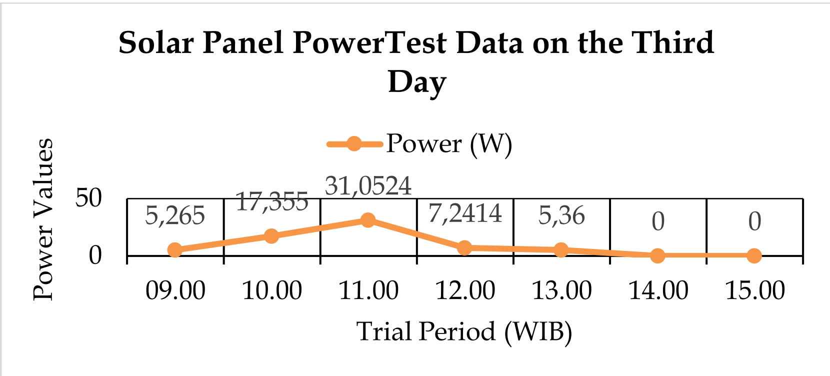

Figure 11. Solar Panel Power Test Data on the Third Day
Source : Personal documents

On June 29, 2025, the power generated by the solar panels to charge the batteries can be indicated by the following equation:

Total energy (W) = Power per hour (W) × time
= (5,265 + 17,355 + 31,0524 + 7,2414 + 5,36 + 0 + 0) × 1
= 66,2738 W

Based on the solar panel data collected on June 27-29, 2025, the average energy of the solar panel in charging the battery was 42.64 watts. Meanwhile, the time required to charge the battery was 5 days.

INA260 Sensor Test Results

The second data collection was conducted on the installed INA260 sensor. This sensor is responsible for monitoring the voltage, current, and power used by the DC Motor PWM Speed Controller as the source for the DC895 motor. The sensor was tested 10 times, and the voltage, current, and power detected by the INA260 sensor were compared with a digital multimeter. This is very important for research purposes to determine how accurate the monitoring performed by the INA260 sensor is.

Table 4. Test data for INA260 sensor voltage with digital multimeter

Experiment	INA260 Sensor	*Digital Multimeter*	Difference	*Error (%)*
	Voltage (V)	Voltage (V)		
1	18,03	17,79	0,24	1,35
2	18,03	17,73	0,30	1,69
3	18,03	17,56	0,47	2,68
4	18,03	17,24	0,79	4,58
5	18,03	16,67	1,36	8,16
6	18,00	16,36	1,64	10,02
7	17,90	16,02	1,88	11,74
8	17,92	16,01	1,91	11,93
9	17,67	15,56	2,11	13,56
10	17,06	15,27	1,79	11,72
Average error (%)				**7,74**

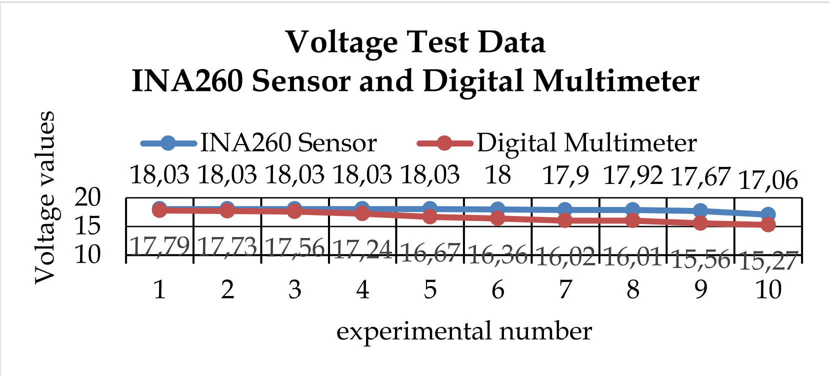

Figure 12. Voltage Test Data INA260 Sensor and Digital Multimeter
Source : Personal documents

Next, the average voltage error between the INA260 sensor and the digital multimeter is calculated using the following equation:

Average error = (P1+P2+P3+P4+P5+P6+P7+P8+9+P10)/10
= (1.35 + 1.69 + 2.68 + 4.58 + 8.16 + 10.02 + 11.74 + 11.93 + 13.56 +11.72) / 10
= 77.43 / 10
= 7.743%

Table 5. Test data for INA260 sensor current with digital multimeter

Experiment	INA260 Sensor Current (A)	*Digital Multimeter* Current (A)	Difference	*Error (%)*
1	0,76	0,76	0,00	0,00
2	0,87	0,87	0,00	0,00
3	1,34	1,37	0,03	2,19
4	2,12	2,21	0,09	4,07
5	3,42	3,67	0,25	6,81
6	4,01	4,47	0,46	10,29
7	4,83	5,29	0,46	8,70
8	4,65	5,36	0,71	13,25
9	5,54	6,30	0,76	12,06
10	6,10	7,03	0,93	13,23
Average error (%)				7,06

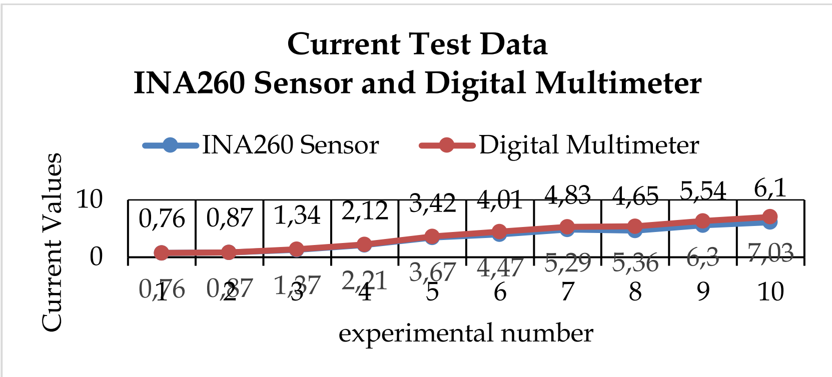

Figure 13. Current Test Data INA260 Sensor and Digital Multimeter
Source : Personal documents

Next, the average current error between the INA260 sensor and the digital multimeter is calculated using the following equation:

Average error = (P1+P2+P3+P4+P5+P6+P7+P8+9+P10)/10

= (0.00 + 0.00 + 2.19 + 4.07 + 6.81 + 10.29 + 8.70 + 13.25 + 12.06 + 13.23) / 10

= 70.60 / 10

= 7.06%

Table 6. Test data for INA260 sensor power with digital multimeter

Experiment	INA260 Sensor Power (W)	*Digital Multimeter* Power (W)	Difference	*Error (%)*
1	13,67	13,52	0,15	1,11
2	16,03	15,42	0,61	3,96
3	24,36	24,05	0,31	1,29
4	38,25	38,10	0,15	0,39
5	61,25	61,17	0,08	0,13
6	72,04	73,12	1,08	1,48
7	84,00	84,74	0,74	0,87
8	82,96	85,81	2,85	3,32
9	97,63	98,40	0,77	0,78
10	107,00	107,34	0,34	0,32
Average error (%)				**1,36**

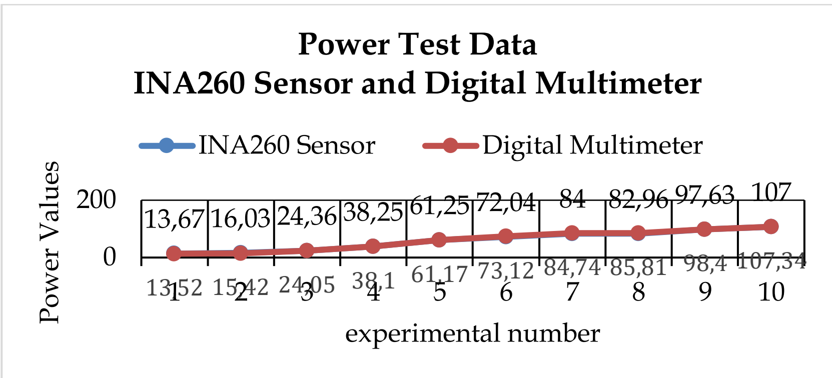

Figure 14. Power Test Data INA260 Sensor and Digital Multimeter

Source : Personal documents

Next, the average power error between the INA260 sensor and the digital multimeter is calculated using the following equation:

Average error = (P1+P2+P3+P4+P5+P6+P7+P8+9+P10)/10

= (1.11 + 3.95 + 1.28 + 0.39 + 0.13 + 1.47 + 0.87 + 3.32 + 0.78 + 0.31) / 10

= 13.61 / 10

= 1.361%

Therefore, based on the above equation, the average error in voltage, current, and power between the INA260 sensor and the digital multimeter is 7.06%, 7.743%, and 1.361%.

Results of corn sheller experiments

This section will describe the comparison of dry corn shelling using a solar-powered corn sheller with the traditional method or manual labor. In this section, 3 kg of corn was used for each method. Using the machine, 21 kernels were obtained, while using the traditional method, 20 kernels were obtained. This difference in quantity is quite reasonable, as the corn produced by the machine is not always the same in size and weight. However, this study focuses on the total weight of corn used, which is 3 kg or 3000 grams of dried corn for each method.

Table 7. Results of corn shelling efficiency data using the tool method

Experiment	Weight of Whole Corn (grams)	Weight of Shelled Corn (grams)	Efficiency (%)
1	96	72	75,00
2	146	119	81,51
3	171	142	83,04
4	139	120	86,33
5	121	101	83,47
6	146	122	83,56
7	159	137	86,16
8	166	124	74,70
9	152	134	88,16
10	162	133	82,10
11	169	148	87,57
12	96	82	85,42
13	127	108	85,04
14	142	120	84,51
15	115	102	88,70
16	162	144	88,89

Experiment	Weight of Whole Corn (grams)	Weight of Shelled Corn (grams)	Efficiency (%)
17	152	128	84,21
18	138	117	84,78
19	112	95	84,82
20	209	180	86,12
21	120	97	80,83
Total	**3000**	**2525**	**1764,92**
Average sorting efficiency (%)			**84,04**

After conducting experiments and collecting data for corn shelling using the PLTS-based dry corn shelling method, the next step is to calculate the average efficiency value using the following equation:

Average efficiency = (P1+P2+P3+P4+P5+P6+P7+P8+9+P10+P11+P12+P13+P14+P15 +P16+P17+P18+P19+P20+P21)/21

= (75,00+81,51+83,04+86,33+83,47+83,56+86,16+74,70+88,16+82,10+ 87.57+85.42+85.04+84.51+88.70+88.89+84.21+84.78+84.82+86.12+ 80.83)/21

= 1764.92/21

= 84.04%

Table 8. Results of corn shelling productivity data using the tool method

Experiment	Weight of Whole Corn (grams)	Weight of Shelled Corn (grams)	Time (seconds)
1	96	72	8,74
2	146	119	29,92
3	171	142	34,23
4	139	120	16,92
5	121	101	15,06
6	146	122	21,92
7	159	137	18,35
8	166	124	17,87
9	152	134	11,27
10	162	133	10,12
11	169	148	14,08
12	96	82	10,37
13	127	108	5,14

Experiment	Weight of Whole Corn (grams)	Weight of Shelled Corn (grams)	Time (seconds)
14	142	120	9,42
15	115	102	11,29
16	162	144	13,27
17	152	128	15,57
18	138	117	27,77
19	112	95	13,52
20	209	180	18,56
21	120	97	8,64
Total	**3000**	**2525**	**332,03**
Corn shelling efficiency (grams/second)			**7,604**

Meanwhile, Table 8 shows that the total weight of whole corn is 3000 grams, while the weight of shelled corn is 2525 grams, and the total time is 332.03 seconds. Therefore, to calculate the productivity value, the following equation is used, which will be consistent with the productivity value of corn shelling using this traditional method. The equation is:

Productivity value = (Total shelled corn)/Time
= 2525/332.03
= 7.605 grams/second

Table 9. Results of corn shelling efficiency data using traditional methods

Experiment	Weight of Whole Corn (grams)	Weight of Shelled Corn (grams)	Efficiency (%)
1	168	143	85,12
2	164	141	85,98
3	158	140	88,61
4	153	136	88,89
5	138	119	86,23
6	115	100	86,96
7	96	83	86,46
8	157	139	88,54
9	155	136	87,74
10	95	81	85,26
11	120	101	84,17

Experiment	Weight of Whole Corn (grams)	Weight of Shelled Corn (grams)	Efficiency (%)
12	209	183	87,56
13	184	162	88,04
14	155	134	86,45
15	176	153	86,93
16	122	106	86,89
17	112	97	86,61
18	165	144	87,27
19	192	167	86,98
20	166	146	87,95
Total	**3.000**	**2.611**	**1.738,63**
Average sorting efficiency (%)			**86,93**

After conducting experiments and collecting data on corn husking using traditional methods, the next step is to calculate the average efficiency value using the following equation:

Average efficiency = (P1+P2+P3+P4+P5+P6+P7+P8+9+P10+P11+P12+P13+P14+P15 +P16+P17+P18+P19+P20) / 20
= (85,12+85,98+88,61+88,89+86,23+86,96+86,46+88,54+87,74 +85,26+84,17+87,56+88,04+86,45+86.93+86.89+86.61+87.27 +86.98+87.95) / 20
= 1,738.63 / 20
= 86.93%

Table 10. Results of corn shelling productivity data using the traditional method

Experiment	Weight of Whole Corn (grams)	Weight of Shelled Corn (grams)	Time (seconds)
1	168	143	64,08
2	164	141	88,08
3	158	140	57,07
4	153	136	53,65
5	138	119	118,27
6	115	100	54,04
7	96	83	72,21
8	157	139	56,78
9	155	136	48,02

Experiment	Weight of Whole Corn (grams)	Weight of Shelled Corn (grams)	Time (seconds)
10	95	81	35,63
11	120	101	50,53
12	209	183	102,15
13	184	162	56,62
14	155	134	86,25
15	176	153	67,05
16	122	106	56,48
17	112	97	77,81
18	165	144	72,48
19	192	167	80,87
20	166	146	53,65
Total	**3.000**	**2.611**	**1.351,72**
Corn shelling efficiency (grams/second)			**1,931**

Meanwhile, Table 10 shows that the total weight of whole corn is 3000 grams, while the weight of shelled corn is 2611 grams, and the total time is 1,351.72 seconds. Therefore, to calculate the productivity value, the following equation is used, which is consistent with the productivity value of corn shelling using the machine method. The equation is:

Productivity value = (Total shelled corn)/Time
= 2,611/1,351.72
= 1.932 grams/second

Therefore, there is a significant difference in the experiments conducted. Although the data collection involved the drying of corn using the same weight of corn, namely 3 kg or 3000 grams each, based on table 7 and 9, the average efficiency of the dry corn husking process was obtained, where the efficiency of dry corn husking using a machine was 84.04%, while the efficiency of dry corn husking using the traditional method was 86.93%. The difference in efficiency between the two methods is relatively small, at 2.89%. This is quite reasonable since each corn kernel has different sizes and weights, resulting in only a slight difference in efficiency.

Meanwhile, based on table 8 and 10, the productivity of corn shelling is also obtained in units of grams per second. In the data, there is a significant difference in values, where dry corn shelling using a machine yields a productivity value of 7.604 grams/second, while dry corn shelling using the traditional method yields a productivity value of 1.931 grams/second. The difference in corn shelling productivity values is quite large and significant, amounting to 5.673 grams/second. This difference is quite substantial, as the processing time using the solar-powered corn husking machine is nearly three times faster than using the traditional method.

Motor speed test results

This section will describe the speed in terms of Revolutions Per Minute (RPM), which is measured using a tachometer. A digital tachometer was chosen to obtain accurate and validated figures.

This speed measurement is used to determine the speed of the DC 895 motor, which serves as the drive for the corn husking blade. In addition to measuring motor speed, this section will also display data on voltage, current, and real power used by the DC 895 motor. The voltage, current, and power data are obtained from a DC Watt Meter installed before the DC 895 motor.

Table 11. Results of speed testing (RPM) of DC motor 895

Experiment	Power (W)	Speed (RPM)
1	**24,88**	**337,9**
2	**37,22**	**901,0**
3	**50,44**	**1422**
4	**54,05**	**1650**
5	**61,13**	**1989**
6	**67,10**	**2175**
7	**70,26**	**2439**
8	**78,24**	**2841**
9	**83,74**	**3063**
10	**90,55**	**4496**

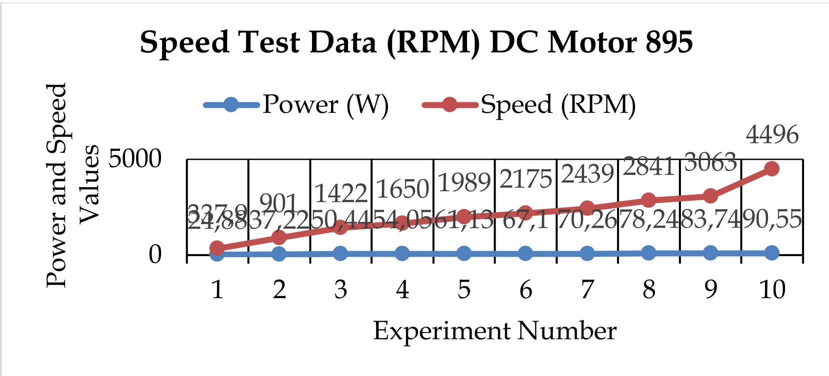

Figure 15. Speed Test Data (RPM) DC Motor 895
Source : Personal documents

According to Figure 10, which shows the graph of power and speed for the DC Motor 895, the highest RPM value achieved in this experiment was 4496 RPM, which was obtained at a voltage of 8.10V and a current of 11.18A, or at a power of 90.55 Watts. while the lowest motor speed was 337.9 RPM, which originated from a voltage of 2.90V and 8.58A or a power of 24.88 Watts. This demonstrates that as the power used by the DC Motor 895 increases, the RPM value produced also increases.

Load cell sensor test results

The next data collection was carried out on the installed load cell sensor. This sensor is tasked with measuring or weighing the dry corn that has been shelled using a PLTS-based dry corn shelling machine. This sensor was tested 10 times, and the weight values in grams were then compared with a digital scale. This is very important in order to measure the accuracy of the calibration and measurements carried out by the load cell.

Table 11. Results of load cell sensor testing with digital scales

Experiment	Load Cell Sensor	Digital Scale	Difference	*Error* (%)
1	71	72	1	1,39
2	120	119	1	0,84
3	142	142	0	0,00
4	120	120	0	0,00
5	103	101	2	1,98
6	123	122	1	0,82
7	138	137	1	0,73
8	127	124	3	2,42
9	134	134	0	0,00
10	133	133	0	0,00
Total				**8,18**
Average *error* (%)				**0,82**

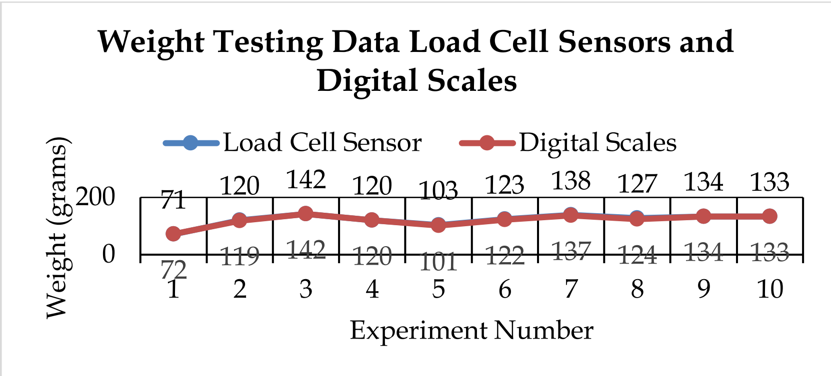

Figure 16. Weight Testing Data Load Cell Sensors and Digital Scales
Source : Personal documents

Next, the average error value between the load cell sensor and the digital scale will be calculated using the following equation:

Average error = (P1+P2+P3+P4+P5+P6+P7+P8+9+P10)/10
= (1.39+0.84+0.00+0.00+1.98+0.82+0.73+2.42+0.00+0.00)/10
= 8.18/10
= 0.82%

CONCLUSION

Based on the results of the design, testing, and analysis conducted on the solar-powered corn husking machine with an ESP32 controller, the following conclusions were drawn:

1. Weather conditions significantly influence the performance of this solar-powered corn husking machine. Following data collection over three days in Sukosewu Village, the average energy output from the solar panels was found to be 42.64 Watts. This results in a relatively long charging time for the battery, approximately five days to achieve an 80% charge, in accordance with the Depth of Discharge (DoD) value of the LiFePO4 battery.
2. The INA260 sensor used for monitoring the input from the DC Motor PWM Speed Controller performs very well, with the sensor showing an average error of 7.74% for voltage, 7.06% for current, and 1.36% for power. This makes the INA260 an accurate sensor for monitoring voltage, current, and power used by this device.
3. The load cell sensor used to measure the weight of shelled corn has an average error of 0.82% compared to weight measurements using a digital scale. This result indicates that the load cell sensor can provide accurate measurement results and can be used for weighing.
4. This device has proven to significantly increase the productivity of dry corn shelling, where based on experiments conducted using 3000 grams of corn, the productivity reached 7.604 grams/second, compared to the traditional method which only produced 1.931 grams/second. This represents a difference of 5.673 grams/second, making corn shelling using the device method nearly three times faster than traditional methods.

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