



DUAL-POWERED PORTABLE FOOD WASTE PROCESSOR

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Abstract: One of the most important issues that must be addressed globally is food waste management. The Philippines has already been facing home food waste that contributes to the overall issue. The country has launched programs like “no segregation, no collection” by various local governments to promote source segregation of organic materials like food waste to easily recycle and compost. Although there has been progress, the main issues and concerns that still exist because of food waste management are the uniform regulations that must be used and the waste management facilities or equipment that are electricity-dependent and not feasible to use where there is a scarcity of electricity. However, there is still the need for fast and sustainable onsite processing solutions that could cater specifically to areas with limited electricity. This study aims and seeks to design and develop a dual-powered portable food waste processor that has fast particle grinding, fast fluid extraction, and dual operation modes: 220V AC and battery-powered. Moreover, the battery could be recharged with either solar or AC. The research method employed was descriptive development research, in which a processor made from stainless steel, due to its durability, was designed and its functionality determined through a controlled trial of moisture content reduction (19.1-26.34%) and charging (40 minutes using AC, 60 minutes using solar, depending on sunlight intensity). Acceptability was evaluated using a researcher-made questionnaire with content validity (CVI = 0.904) and reliability (Cronbach’s alpha = 0.804), administered to 25 experts from local government waste management units, the agriculture sector, and the Department of Education. Data analysis utilized mean and standard deviation, revealing very high acceptability scores (overall means ranging from 4.27 to 4.59). Additionally, an operating manual was created. Data showed that this machine has minimized stinky odor and the onsite processing of food waste converts kitchen and organic trash into useful materials for fertilizer.

Keywords: Dual-powered food waste processor, food waste management, portable waste processor, solar-powered device, fertilizer raw material.

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INTRODUCTION

Food waste management has become a critical environmental and socio-economic concern due to the increasing volume of edible and organic waste generated worldwide. Globally, around 1.3 billion tons of food, or approximately one-third of all food produced for human consumption, is wasted annually, resulting in significant greenhouse gas emissions and the inefficient use of natural resources (FAO, 2019). In the Philippines, households are among the major contributors to food waste during the consumer stage. In response, the government has introduced initiatives such as the proposed Zero Food Waste Act of 2022 (Senate Bill No. 240) and the implementation of the "no segregation, no collection" policy to encourage proper waste segregation, recycling, and composting. These initiatives align with the principles of the Circular Economy, which promotes converting food waste into valuable resources while minimizing environmental impacts (FAO, 2011).

Despite existing policies and technological developments, significant gaps remain in household food waste management. Most food waste processing technologies, including anaerobic digestion systems and centralized composting facilities, require extensive infrastructure and investment, limiting their applicability at the household level. Commercial household processors such as Lomi 2 and FoodCycler are portable but rely solely on AC electricity, making them unsuitable for areas with unstable or limited power supply. Moreover, many available systems do not integrate rapid grinding with efficient moisture extraction, limiting their ability to reduce waste volume, suppress odor, and prevent microbial growth during processing (Ryu, 2024). These limitations highlight the lack of practical, energy-efficient, and accessible food waste processing technologies for both urban and rural communities.

Given these challenges, this study was conducted to develop a dual-powered portable food waste processor

capable of operating using either conventional electricity or solar energy while incorporating grinding and mechanical moisture extraction. The proposed device aims to provide an affordable, portable, and sustainable solution for reducing household food waste volume and producing a semi-dry by-product suitable for composting or fertilizer production. Ultimately, the study seeks to support sustainable waste management practices, promote resource recovery, and contribute to environmental protection through an accessible household-level technology.

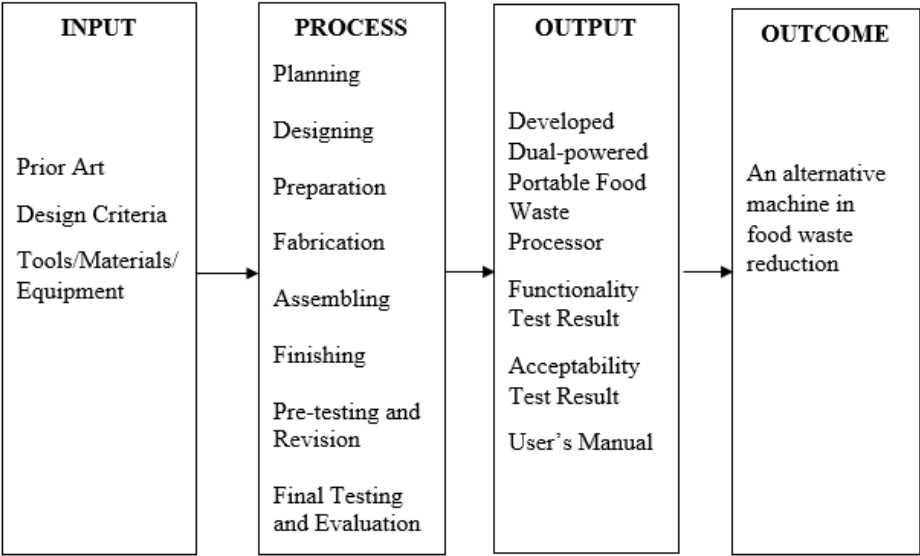
Objectives of the Study

The study aimed to develop a dual-powered portable food waste processor.

Specifically, it sought to:

1. design and fabricate a food waste processor with the following technical features:
 - a. grinding of food waste particles,
 - b. extraction of water from ground food waste, and
 - c. dual-powered operation;
2. test the functionality of the dual-powered portable food waste processor in terms of:
 - a. moisture content left, and
 - b. dual-powered charging sources;
3. evaluate the acceptability of the dual-powered portable food waste processor in terms of:
 - a. features,
 - b. cost,
 - c. serviceability, and
 - d. ease of use;
4. develop a user's manual for the dual-powered portable food waste processor

Figure 1: Schematic Diagram Illustrating the Framework of the Study



METHODOLOGY

Research Design

The research design for conducting the study was developmental-descriptive. The developmental approach was used during the development and manufacturing processes of the dual-powered portable food waste processor, while the descriptive approach was used to evaluate acceptability among experts.

Design Plan Preparation and Fabrication

It involves the development of the Dual-Powered Portable Food Waste Processor, materials used, tools and equipment, construction procedures, operating procedures, construction timeframe, production flow, and pre-testing and revisions made.

Figure 2: The Front and Right-Side View of External Parts of the Dual-Powered Portable Food Waste Processor

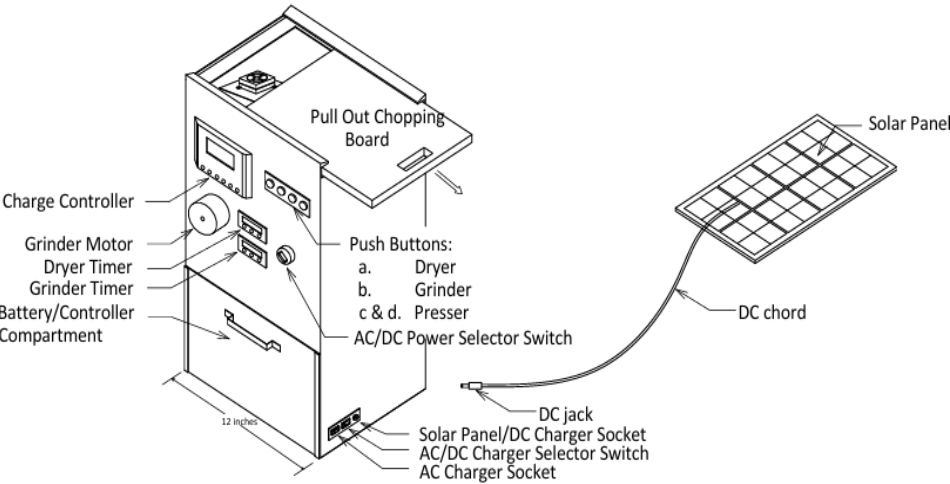


Figure 2 above presents the external components and front view of the Dual-Powered Portable Food Waste Processor. The device comes equipped with a pull-out chopping board at the top for processing the food waste. The device also has push buttons for a. Dryer, b. Grinder, and c & d. Presser, accompanied by an AC/DC Power Selector Switch. On the side, there are a Charge Controller, Grinder Motor, Dryer Timer, Grinder Timer, and a Battery/Controller

Compartment. Finally, at the bottom of the device, there is a 12-inch scale indicating the device's overall height, complete with sockets such as a Solar Panel/DC Charger Socket, an AC/DC Charger Selector Switch, an AC Charger Socket, and a DC Jack. A separate solar panel is also plugged in via a DC cord, demonstrating the device's dual-power functionality.

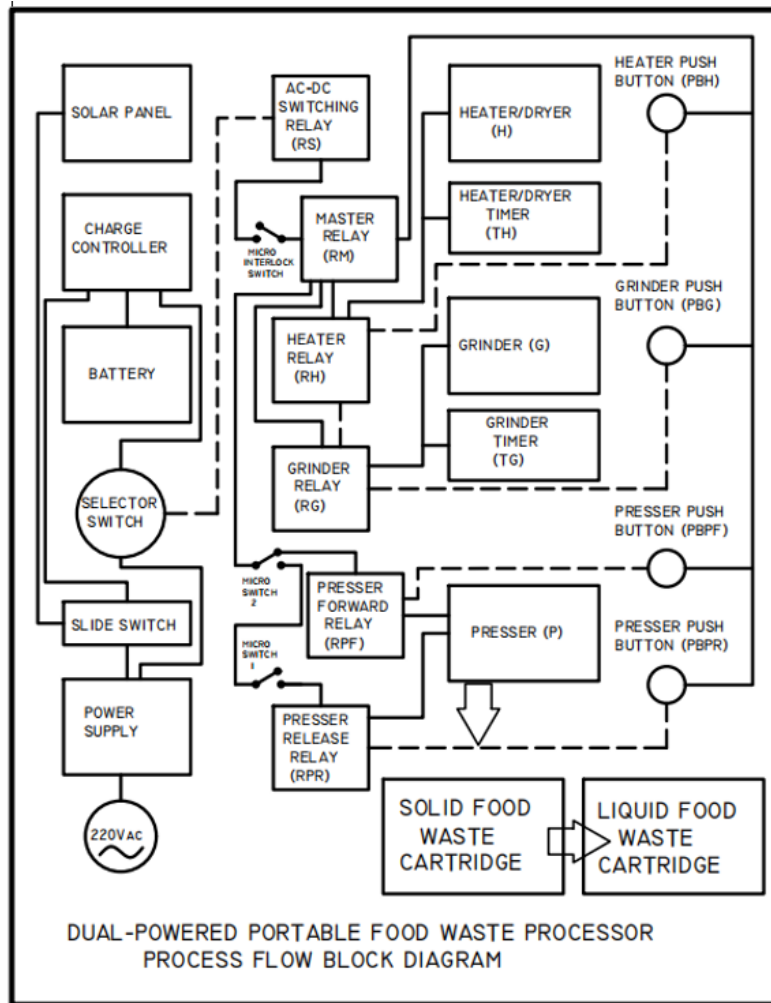
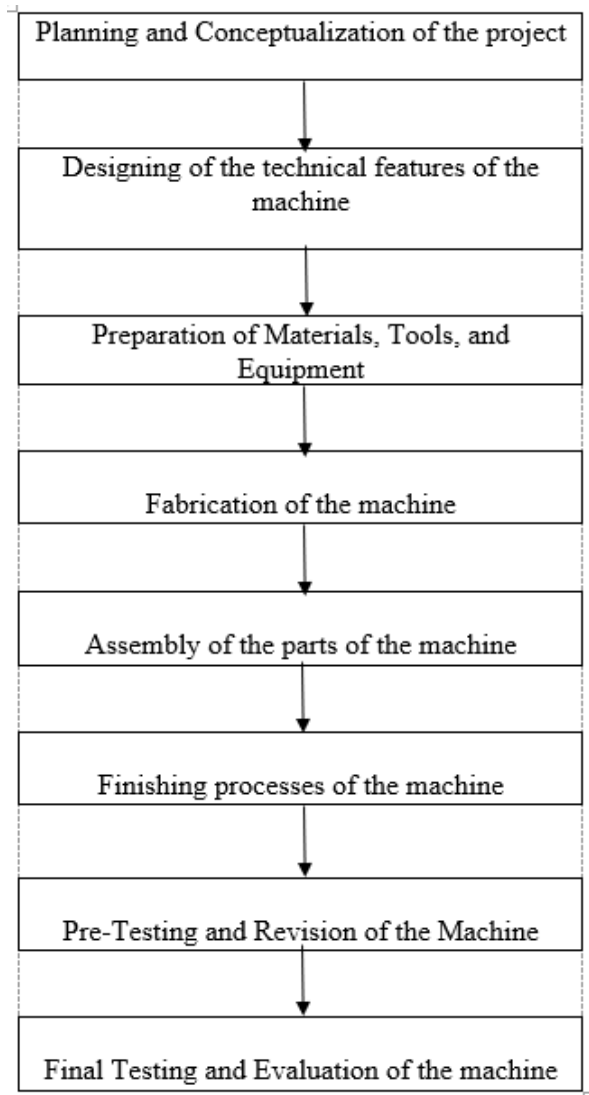
Figure 3: Block Diagram of Dual-Powered Portable Food Waste Processor Showing the Interrelationships of Parts

Figure 3 presents the overall process flow and interconnections among the mechanical, electrical, and control components, highlighting how the system handles food waste from input to output using dual power sources. The diagram is organized into a hierarchical structure to clearly display the power supply, control mechanisms, processing stages, and output pathways. At the top-left section, the power input begins with the Solar Panel, which connects to an AC-DC Switching Relay (Rs) for seamless transition between solar and grid power. This relay feeds into the Charge Controller, which regulates energy flow to the Battery for storage. The Battery then supplies power to the Master Relay (Rm), equipped with a micro-interlock switch for safety and operational control. The central portion focuses on the core processing units and their controls. From the Master Relay, power branches to the Heater Relay (Rh), which activates the Heater/Dryer (H) unit. This is timed by the Heater Timer (Ht) and initiated via the Heater Push Button (Phb). Adjacent to this, the Grinder Relay (Rg)

controls the Grinder (G), with timing managed by the Grinder Timer (Gt) and activation through the Grinder Push Button (Pgb). Below, the pressing mechanism is depicted with the Presser Forward Relay (Rpf) and Presser Release Relay (Rpr), controlling the Presser (P) unit. These are operated by the Presser Push Button Forward (Ppbf) and Presser Push Button Reverse (Ppbr), respectively, with a microswitch ensuring safe forward and reverse motion.

The bottom-left section shows an alternative power integration, with the Selector Switch selecting between battery power and the direct Power Supply (220V AC), and the mode toggled via a Slide Switch. This ensures dual-powered flexibility. At the bottom center and right, the process flow culminates in the output stages, where processed material is directed from the Solid Food Waste Cartridge to the Liquid Food Waste Cartridge, separating semi-dry solids (for composting or fertilizer) from extracted liquids and completing the waste transformation cycle.

Figure 9: Workflow of the Dual-Powered Portable Food Waste Processor Development



The development of the dual-powered portable food waste processor followed a systematic research and development process that began with project planning, problem identification, literature review, feasibility analysis, and conceptual design. The selected design was translated into detailed technical specifications, incorporating a stainless-steel enclosure, grinding, pressing, drying, and dual-power (AC and solar) systems with appropriate safety features. Required materials, tools, and equipment were then procured and prepared before the fabrication and assembly of the machine's mechanical and electrical components. After construction, the prototype underwent finishing processes to improve durability, hygiene, portability, and user safety. Finally, the machine was subjected to pre-testing

to identify and correct operational issues, followed by comprehensive performance testing using varying food waste loads to evaluate grinding efficiency, moisture reduction, charging performance, and overall functionality, ensuring that the prototype met the intended technical objectives prior to expert evaluation.

Cost Analysis

The design and construction of the machine were done with a major emphasis on its financial viability, as determined by the total investment requirement for the project. The total cost included development costs which is shown in Table 5.

Table 1: Development Cost

Expense	Cost
Total Cost of Materials	₱15,655.00
Labor Cost (40% of the total cost of materials)	6,262.00
Miscellaneous (Transportation and power cost)	2,500.00
Total	₱24,417.00

As shown in Table 1, the total development cost of the dual-powered portable food waste processor, including materials, labor, and miscellaneous expenses, was ₱24,417.00. The cost of materials, which accounted for the largest percentage, totaled ₱15,655.00, followed by labor, set at 40% of the material cost, or ₱6,262.00. Miscellaneous expenses, covering transportation and power costs, amounted to ₱2,500.00.

RESULTS AND DISCUSSIONS

The first objective of the study was to design and fabricate a dual-powered portable food waste processor with

the following technical features: grinding of food waste particles, extraction of water from ground food waste, and dual-powered operation, which were established through test trials.

Technical Features

a. Grinding of Food Waste Particles. The dual-powered portable food waste processor was designed to grind any type of food waste into fine particles rapidly and effectively with a high-speed grinding system. Table 6 summarizes the results of trials conducted to test its functionality.

Table 2: Grinding Cycle of Food Waste Using the Processor

Food Waste (g)	Grinding Cycle
100	2 GC = 200 seconds
150	2 GC = 200 seconds
200	3 GC = 300 seconds
<i>Note: 1 set drying time: 1 set grinding time: 100 seconds per grinding time</i>	

Table 2 shows that the dual-powered portable food waste processor efficiently grinds food waste, requiring two 200-second grinding cycles for both 100-gram and 150-gram loads, while a 200-gram load requires three 300-second cycles. Among the tested loads, 150 grams provided the most efficient and reliable performance, allowing smooth operation without choking or jamming because the waste volume fit well within the grinding chamber, enabling free movement and uniform particle reduction. The machine operates effectively with a battery voltage of 11.9–12.9 Vdc, consuming approximately 0.1 Vdc per grinding cycle, allowing up to 10 grinding cycles on a full charge, while AC operation provides a continuous power supply for unlimited grinding cycles. These findings demonstrate the machine's

operational efficiency and flexibility for both portable and stationary applications, consistent with the findings of Qamaruz Zaman et al. (2019), who reported that a domestic food waste dryer achieved approximately 70% mass reduction through dehydration while minimizing odor, biological decomposition, and energy consumption, producing dried biomass suitable for composting and other resource recovery applications.

b. Extraction of Water from Ground Food Waste. The presser in the dual-power portable food waste processor extracts water from ground food waste within the shortest time compared to other methods. Table 7 shows the summary statistics of the trials.

Table 3: Pressing Cycle of Food Waste Using the Processor

Food Waste (g)	Pressing Cycle	Time (seconds)
100	2 times	20 seconds
150	3 times	30 seconds
200	3 times	30 seconds
<i>Note: 1 press is equal to 10 seconds</i>		

As presented in Table 3, the dual-powered portable food waste processor effectively extracts water from ground food waste through its mechanical pressing system. The processor requires two pressing cycles (20 seconds) for 100 grams of food waste and three pressing cycles (30 seconds) for both 150-gram and 200-gram loads, demonstrating efficient moisture extraction with only a minimal increase in processing time as the waste volume increases. These findings indicate that the machine provides rapid and effective dewatering, enhancing its suitability for household food waste management. The results are consistent with the InSinkErator WasteXpress™ System (InSinkErator, n.d.), which utilizes a dewatering mechanism to reduce food waste volume by up to 85% while processing large quantities of waste. Although the InSinkErator is designed for commercial-scale operations, the comparable use of mechanical water extraction highlights the effectiveness of the developed processor in achieving efficient dewatering on a smaller, portable, and dual-powered platform.

c. Dual-Powered Operation. The dual-powered portable food waste processor also worked efficiently when using either a 30W solar panel or 220VAC power. It also utilized a 12V battery.

On the other hand, reviews of products such as Lomi 2 and FoodCycler FC-50 by Heinlein (2024) are limited to electric power, thereby incurring higher monthly costs of around \$10 due to the 220VAC energy requirements. This is significant because it highlights a disadvantage of the current processor, which operates on dual power and supports both solar and battery functions.

Functionality Testing

The second objective of the study was to test the functionality of a dual-powered portable food waste processor in terms of: moisture content left and dual-

powered charging sources. Tables 8 and 9 show the summary statistics of the results.

Table 4: Moisture Content Removed of Food Waste Using the Processor in Five (5) Trials for each Weight of Waste

Waste Input Weight (g)	Waste Output Weight (g)	Differ
100	80.9	1
150	114	
200	147.33	5
Note: The waste output weight is the average of the 5 trials of e		

As presented in Table 4, the dual-powered portable food waste processor effectively reduced the moisture content of food waste through its mechanical pressing mechanism. The average moisture reduction was 19.1% for a 100-gram load, 24% for a 150-gram load, and 26.34% for a 200-gram load, indicating that the processor consistently removed approximately 19–26% of the original food waste mass as moisture, with slightly higher moisture removal observed at larger input volumes. This reduction enhances waste stability by minimizing excess moisture that promotes microbial growth and odor formation. The findings support the observations of Wernick (2025), ESIUO (2025), and Senfter et al. (2024), which emphasize that moisture reduction through dehydration, airflow drying, or mechanical pressing effectively suppresses microbial activity and foul odors while improving waste stability. Although the prototype did not achieve the lower residual moisture levels of dedicated dehydrators, its performance is consistent with mechanical dewatering technologies and provides a practical, energy-efficient solution for odor control and household-scale food waste management.

Table 5: Charging Source of Food Waste Processor

Charging Source	Time (Minutes)
Solar	60 mins.
AC (220V)	40 mins.

As presented in Table 5, the dual-powered portable food waste processor demonstrated efficient charging performance using both solar and AC (220V) power sources. The battery reached full charge in an average of 60 minutes using solar energy, with charging time varying according to sunlight intensity, while AC charging required only 40 minutes. The processor can operate while charging through the solar system, although operation during AC charging is

not recommended to help preserve battery life. These results demonstrate the machine's versatility, providing reliable charging where grid electricity is available while offering a sustainable alternative for off-grid or power-limited areas. The findings are consistent with the projections of Food Waste Processor Navigating Dynamics Comprehensive Analysis and Forecasts 2025–2033 (2025) and Heinlein (2024), which highlight the growing demand for portable,

battery-powered food waste processors. Unlike existing AC-dependent models, the developed prototype successfully integrates dual-power capability, enhancing portability, energy efficiency, and operational flexibility for household food waste management.

Acceptability Evaluation

The third objective of the study was to evaluate the acceptability of the food waste processor in terms of features, cost, serviceability, and ease of use.

Table 6: Summary of the Mean of the Mean Scores of the Level of Acceptability of Dual-powered Portable Food Waste Processor

Criteria	Mean	SD	Interpretation
Feature	4.54	0.46	Very Highly Acceptable
Cost	4.27	0.70	Very Highly Acceptable
Serviceability	4.31	0.57	Very Highly Acceptable
Ease of Use	4.59	0.51	Very Highly Acceptable
Total	4.43	0.48	Very Highly Acceptable
<i>Note: 4.21 – 5.00 (Very Highly Acceptable VH); 3.41 – 4.20 (Highly Acceptable HA); 2.61 – 3.40 (Moderately Acceptable MA); 1.81 – 2.60 (Slightly Acceptable SA); 1.00 – 1.80 (Not Acceptable NA)</i>			

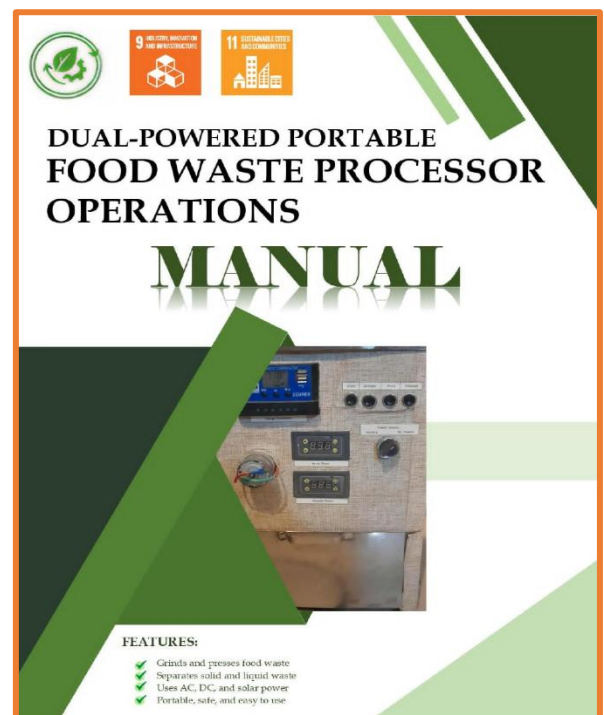
As shown in Table 6, the dual-powered portable food waste processor obtained Very Highly Acceptable ratings across the criteria of features, cost, serviceability, and ease of use, with mean scores ranging from 4.27 to 4.59. These findings indicate that the developed processor satisfactorily meets users' functional, economic, and operational requirements, demonstrating its practicality and strong potential for adoption in both household and institutional food waste management. The results are consistent with the study of Jakaria (2025), which employed a user-centered Quality Function Deployment (QFD) approach to develop a portable household waste shredder emphasizing safety, ease of use, portability, durability, affordability, and ease of maintenance. Similar to that study, the high acceptability ratings of the developed processor confirm that integrating user-oriented design features contributes to a practical, safe, durable, and efficient waste management solution suitable for broader community utilization.

User's Manual

The fourth objective of the study was achieved through the development of a comprehensive user's manual for the dual-powered portable food waste processor, providing clear guidance on the machine's parts, specifications, operating procedures, safety precautions, maintenance, troubleshooting, cautions, and warnings to ensure its proper and safe use. Beyond serving as an operational guide, the developed processor contributes to Sustainable Development Goal (SDG) 9: Industry, Innovation, and Infrastructure by introducing an innovative dual-powered technology capable of grinding and pressing

food waste using AC, DC, or solar energy, thereby improving accessibility and promoting sustainable waste-to-resource practices. Furthermore, it supports SDG 11: Sustainable Cities and Communities by enabling convenient, on-site household and community food waste processing, reducing landfill disposal, minimizing odors and sanitation concerns, and encouraging the use of renewable energy for cleaner and more sustainable communities as shown in Figure 4.

Figure 4: Cover of the Dual-Powered Portable Food Waste Processor User's Manual



Summary of Findings

The following are the findings of the study:

1. The dual-powered portable food waste processor was successfully designed and fabricated according to the specified design and operational workflow. Test trials verified its technical capabilities, including rapid grinding of food waste, efficient water extraction through mechanical pressing, and reliable operation using both AC and solar power sources. The results indicate that the processor is an efficient and versatile solution for food waste management in various settings.

2. The dual-powered portable food waste processor performed effectively in terms of moisture reduction and charging flexibility. Through mechanical pressing, it consistently reduced the moisture content of food waste across different load capacities, thereby minimizing odors and improving waste stability for composting or disposal. In addition, the processor demonstrated reliable charging performance using both AC and solar power, providing operational flexibility even in areas with limited or unstable electricity.

3. The acceptability evaluation revealed that the dual-powered portable food waste processor is Very Highly Acceptable overall. It received Very Highly Acceptable ratings for its features, reflecting its modern design, functionality, and suitability for institutional use. Cost was rated Highly Acceptable overall and Very Highly Acceptable by schools and waste management agencies, indicating strong perceived value. Likewise, serviceability and ease of use received ratings ranging from Highly Acceptable to Very Highly Acceptable, confirming that the processor is durable, easy to maintain, user-friendly, and a practical, affordable, and efficient solution for food waste management.

4. A comprehensive user's manual was developed for the dual-powered portable food waste processor to provide users with clear instructions on the machine's components, operating procedures, assembly, maintenance, troubleshooting, and safety precautions, ensuring its proper, safe, and efficient use.

Conclusions

Based on the findings of the study, the following conclusions were drawn:

1. The dual-powered portable food waste processor is a viable alternative for reducing food waste volume and producing feedstock suitable for fertilizer production.

Although the processor demonstrated efficient grinding performance, further improvements and additional testing may be conducted to increase its processing capacity and accommodate larger volumes of food waste.

2. The processor's Very Highly Acceptable ratings indicate that it is a practical, efficient, and suitable alternative for food waste management in various settings, including schools, households, and local government units.

3. The developed user's manual provides essential guidance for the proper operation, maintenance, and safe use of the processor, thereby helping extend the machine's service life and ensuring user safety.

Recommendations

Based on the findings and conclusions of the study, the following recommendations are proposed:

1. The dual-powered portable food waste processor is recommended for adoption by schools, households, local government units, barangay waste management facilities, agricultural cooperatives, and small-scale food establishments. The processor can help reduce food waste at the source, minimize unpleasant odors, and facilitate composting or proper disposal. Its dual-power capability, particularly its compatibility with solar energy, makes it especially suitable for communities with limited or unreliable access to electricity, thereby promoting resource recovery and supporting the principles of the circular economy.

Future studies are recommended to: (a) scale up the processor for larger waste volumes or commercial applications while maintaining portability and dual-power efficiency; (b) conduct long-term field testing to evaluate durability, maintenance requirements, and performance under actual operating conditions; (c) integrate additional features such as automatic odor control, improved drying mechanisms, and smart monitoring systems for waste processing; (d) conduct comparative evaluations with commercially available food waste processors to further assess cost-effectiveness and environmental impact; (e) develop mechanisms to minimize grinder choking during operation; and (f) explore alternative environmentally friendly construction materials to reduce production costs and improve sustainability.

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