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Design and Development of a Hand-Operated Food Shredder for Domestic Composting

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Abstract

Food waste forms a major portion of municipal solid waste and is a significant contributor to environmental pollution when disposed of improperly. Most households continue to discard biodegradable waste in landfills, leading to greenhouse gas emissions and health hazards. This study focuses on the design and development of a low-cost, hand-operated food shredder composter suitable for domestic use. A primary survey was conducted to assess household food waste generation, disposal practices, and user interest in manual composting systems. Based on the survey responses, a simple, durable, and cost-effective prototype was designed using mild steel as the primary material. Material selection was optimized using the Multi-Criteria Decision Making (MCDM) method by evaluating factors such as cost, strength, ductility, weldability, corrosion resistance, recyclability, and availability. Mild steel was found to be the most suitable material for fabrication, offering a balance between strength, manufacturability, and affordability. The proposed composter efficiently shreds and processes household food waste into smaller biodegradable particles, facilitating rapid composting while minimizing energy use and environmental impact.

1. Introduction

Food waste comprises the main fraction (45%) of total municipal solid waste. [1] This percentage averages 55% in developing countries [2]. Until a few years ago, the final destination of Food Waste (FW) was either disposal in landfills or incineration. Although this situation persists in many countries, other nations have considered more sustainable methods for waste management and have developed it regarding the final disposal of solid wastes which involves material of food waste. The production of high-quality compost requires that the process must be properly controlled and managed. Food Waste is a highly heterogeneous material with a high moisture content, high organic to ash ratio, and an amorphous physical structure. Special attention is given to key parameters such as porosity, the microbiology of the process, Respiro-metric techniques, and stability limits. In addition, compost quality, greenhouse gases (GHGs) emissions, and compost in soil bioremediation are also reviewed.

Diverting municipal solid waste organic material from landfills to composting or anaerobic digestion has many environmental benefits. Among them, reduction in landfill emissions of GHGs and improvement of soil properties through compost application have been highlighted [3]. The processes for both cases are well known and have been discussed in recent literature; however, some aspects can be further improved, particularly for Food Waste composting. Thus, this study aims to provide a general overview of the composting of Food Waste by identifying the main challenges occurring in the process.

Problem statement

Improper disposal of food waste is one of the reason which leads to environmental pollution and health hazards and it also increase the favourable environment for mosquitoes. Existing composting solutions are expensive which cannot be affordable or required significant space, maintenance and lack of knowledge. [4] It is necessary to make a sustainable nature of agricultural & rural waste to reduce environmental pollution & to avoid the depletion of the natural resources.

2. Literature Review

The reviewed literature collectively highlights the advancement of small-scale and domestic composting systems aimed at sustainable food waste management. Researchers have explored design innovation, biological enhancement, and cost optimization to improve composting efficiency.

Table 1: Category wise literature survey:

Category	Author(s)	Key Contribution / Focus
1. Small-Scale Composter Design	S. Venkata Mohon [1], Huerta Pujao [8]	Design and testing of affordable home composters using plastic bins.
2. Composting Process Optimization	M.K. Manu [2], Li Yee Lima [6]	Use of microbial inoculants (Trichoderma, EM1) to speed up composting and improve quality.
3. System Innovation & Bioreactor Design	Chanakya H.N. [5]	Multi-compartment composting system for efficient home-scale use.
4. Environmental & Technical Evaluation	Francis Ehis [3]	Feasibility of home composting for organic waste management.
5. Cost and Process Efficiency	Prasanna Mahankar [7]	Economic analysis of composting plants highlighting cost-benefit and scale effects.
6. Component Design (Pre-processing)	Khan N. Clark [9]	Improved mechanical shredder design for waste pre-processing.
7. Compost Chemistry & C/N Ratio	Dr. Fauzia Siddiqui [4]	Role of carbon-nitrogen balance in microbial decomposition.
8. Community & Behavioral Studies	Markos Margaritis [10]	Household waste behaviour and composting awareness studies.

The effective management of household food waste through composting has been an area of growing research interest in recent years. Several studies have explored different techniques, system designs, and operational parameters to enhance the efficiency and feasibility of small-scale composting.

S. Venkata Mohon [1] developed and evaluated a small-scale, low-cost composter suitable for household use. The system utilized readily available 10-liter plastic bins and processed a mixture of food waste and eucalyptus wood chips. Three experimental trials were conducted to monitor composting parameters such as temperature, pH, moisture, organic matter, and nitrogen content over 144 days. The composting period varied between 39 to 63 days, achieving peak temperatures up to 46.2°C within three days of initiating the

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process. The results demonstrated that small domestic composters could effectively stabilize organic waste within a short duration when properly aerated and mixed.

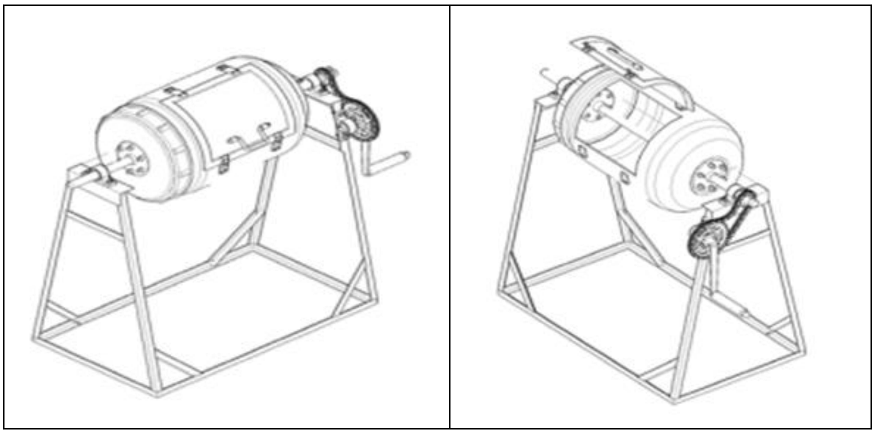


Fig 1. Pictorial view of the composter machine [1]

Similarly, Francis Ehis [3] assessed the technical and environmental feasibility of home composting using leftovers of raw fruits and vegetables. The 96-day outdoor composting experiment was conducted under shaded conditions, following the standard analytical methods of the USDA and US Composting Council. The findings confirmed that household-level composting can efficiently treat organic waste while maintaining favorable physical and chemical parameters such as moisture content, pH, and organic matter stability.

An innovative approach to household composting was presented by Chanakya H. N. [5], who designed a four-compartment bioreactor system with designated sections for feeding, composting, compost removal, and leachate collection. The system processed biowaste collected from households in Kifissia Municipality, Greece. Additives such as wood chips were used to improve aeration, while mineral additives enhanced physicochemical properties through ion exchange. The study concluded that even in regions with low C/N ratio waste, such as the Mediterranean, home composting can be successfully implemented using low-cost additives and ambient conditions to produce quality compost for domestic use.

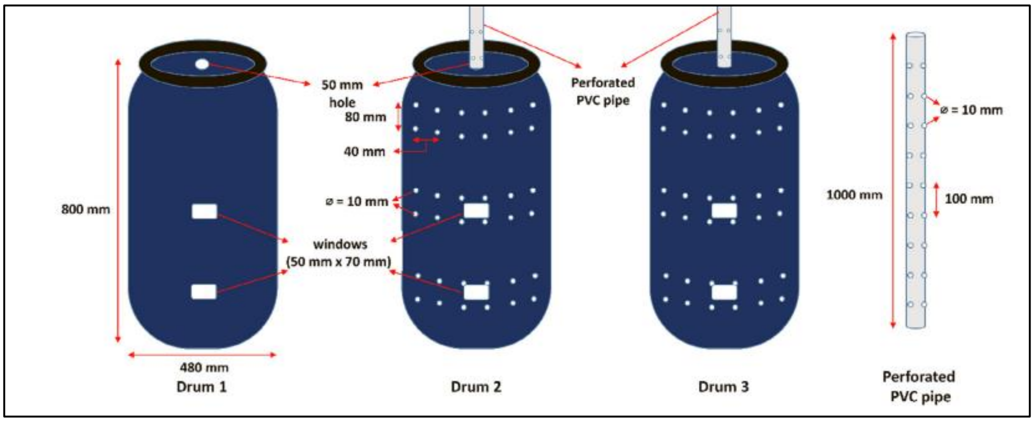


Fig 2. Schematic diagram of drums and perforated pipe with dimension [5]

Prasanna S. Mahankar [7] conducted a cost-benefit analysis of six food waste composting plants with varying scales and degrees of automation. The production output of these plants ranged from 72 to 18,000 tonnes per year. The study emphasized that the investment cost of composting machinery significantly influences the overall production cost. Smaller-scale units, although more accessible, often exhibited lower cost-efficiency due to higher per-unit operational costs. The research underscored the importance of optimizing production scale and process automation to achieve economic feasibility in food waste composting.

The work of Khan N. Clark [9] focused on the design and fabrication of an automated paper shredder machine, which offers valuable mechanical insights applicable to food waste shredding mechanisms. The machine utilized a feeding roller mechanism and knife rollers arranged in a juxtaposed configuration to achieve efficient cutting. The design replaced traditional partition rings with integrated blade plates, improving cost-efficiency and structural stability. The principles of this design — such as serrated blade edges and compact drive systems — provide inspiration for developing low-cost shredding units in composting applications.

M. K. Manu [2] designed and tested a compact household composting unit that incorporated *Trichoderma* as a bio-fertilizer additive. Experiments maintained a 40% moisture level and monitored the composting process for 21 days. The machine achieved a 75% reduction in food waste mass by day 15, producing mature compost within three weeks. The integration of *Trichoderma* accelerated decomposition, demonstrating that microbial agents can significantly enhance composting efficiency in small-scale systems.

Dr. Fauzia Siddiqui [4] highlighted the biological and chemical principles underlying food and agricultural waste composting. The study discussed the importance of the carbon-to-nitrogen (C:N) ratio, ideally around 30:1, for optimal microbial decomposition. Carbon serves as an energy source and structural component of microbial biomass, while nitrogen is essential for protein and enzyme synthesis. Maintaining a balanced C: N ratio is therefore crucial for efficient composting and high-quality humus production.

Li Yee Lim [6] evaluated an improved composting system incorporating aeration and microbial inoculation for food waste treatment. Conducted at IIT Bombay, the study processed a mixture of food and garden waste with microbial inoculum (EM1) containing lactic acid bacteria, yeast, and phototrophic bacteria. Results showed that natural ventilation and manual turning completed active decomposition in 54 days, while the inoculated system reduced this period to 36 days. The microbial additives enhanced lignocellulosic degradation and produced stable compost within 60 days, confirming the benefits of biological augmentation in small-scale composting.

Huerta Pujao [8] also explored household-level composting using small, low-cost plastic bins with natural aeration achieved through drilled holes. The study monitored parameters such as temperature, pH, moisture, organic matter, and nitrogen content over time. Results confirmed that proper aeration and moisture management in simple bin systems could yield high-quality compost efficiently, reinforcing the practicality of decentralized composting solutions.

Markos Margaritis [10] investigated household food waste management practices in Taman Seri Tanjung, Malaysia, through an online survey. The study revealed that most households generated food waste primarily from cooking and meal preparation. Although home composting practices were limited, there was significant potential for adoption with increased awareness and training. Composting experiments showed temperature and pH ranges between 29°C–40°C and 5–7, respectively. While these values did not reach optimal composting conditions, the study suggested that introducing additives and upscaling operations could improve compost quality and efficiency.

The reviewed studies collectively emphasize that household and small-scale composting systems can effectively process organic food waste when designed with proper aeration, moisture control, and microbial balance. Incorporating cost-effective materials, modular designs, and bio-enhancement techniques further improves system performance. These findings guided the present study’s focus on developing a hand-operated food shredder composter, aimed at bridging the gap between mechanical efficiency, affordability, and sustainability for domestic waste management.

3. Comparative Analysis of Available Shredder in Market

The market offers a wide range of shredders — from small domestic units to large industrial and composting-integrated systems — each designed for specific applications, capacities, and levels of automation. This comparative analysis highlights key features, performance parameters, and suitability of available shredders to guide selection based on scale, functionality, and operational requirements.

1. Domestic and Semi-Automatic Shredders: Domestic shredders are cost-effective, easy to install, and suitable for low-volume waste (<500 kg/hr). They are ideal for urban households, hostels, and small offices but lack full automation and require periodic manual supervision.

Table 2: Domestic and Semi-Automatic Shredders:

Brand / Model	Capacity	Power	Automation	Material	Key Features	Application
Ylem Energy Kitchen Waste Shredder	1–500 kg/hr	5–50 HP	Semi-Automatic	Mild steel / Stainless steel	Dual-shaft, top-feed, robust design	Household / Cafeteria / Small institutions
Indian Smart Planter Food Waste Shredder	500 kg/hr	200–250 V	Semi-Automatic	Stainless steel	Manual control, compact size	Domestic / Small canteens

2. Industrial Single / Dual Shaft Shredders: Industrial shredders offer high strength and throughput, suitable for large-scale operations. Their robust design and material compatibility make them efficient for mixed or fibrous wastes, but they are expensive and require skilled operators.

Table 3: Industrial Single / Dual Shaft Shredders:

Brand / Model	Capacity	Power	Automation	Material	Key Features	Application
AMEY Engineers OWS Series	200–500 kg/hr	3 HP	Automatic / Semi-Automatic	Steel body	Easy-to-clean, spray control	Industrial kitchens / Hotels / Composting units
Amey Shredtech Animal Carcass & Food Waste Shredder	Up to 5000 kg/hr	—	Automatic	Mild steel with hardened alloy blades	High throughput, strong build	Meat processing / Municipal waste systems

3. Specialized Waste Processing Shredders: These machines are tailored for specific organic wastes, ensuring high efficiency and hygienic operation. They are suitable for food industries but costlier due to specialized automation and specific waste compatibility.

Table 4: Specialized Waste Processing Shredders:

Brand / Model	Capacity	Automation	Key Features	Application
SHREDALL Meat Waste Shredder	500–1000 kg/hr	Fully Automatic	Optimized for tough organic waste	Slaughterhouses / Food industries
SHREDALL Automatic Food Waste Shredder	Up to 1000 kg/hr	Fully Automatic	Continuous feed, odourless, compost-ready output	Commercial kitchens / Food waste processors

4. Composting-Integrated Shredders: Composting-integrated systems provide a one-stop waste-to-compost solution, ideal for institutions, campuses, and large communities. Although high in capital cost, they reduce processing time and manpower.

Table 5: Composting-Integrated Shredders:

Brand / Model	Capacity	Automation	Key Features	Application
Amey Shredtech Shredder + Composting Solution	500 kg/hr	Semi-Automatic	Combines shredding + pre-treatment	Composting and biogas plants
Kelvin Water Technologies OWC	5–50 tons/day	Automatic	Dual-feed, odorless, rapid composting	Municipal / Institutional composting systems

4. Materials and Methods

The study adopted a structured questionnaire survey to collect primary data related to material selection parameters relevant to the Design of Hand-Operated Food Shredder Composter application.

A. Questionnaire Survey and Primary Data Collection

To identify user requirements and design preferences for a hand-operated food shredder composter, a structured questionnaire survey was conducted using Google Forms. The survey aimed to gather public opinions on food waste generation, disposal habits, awareness of composting practices, and interest in adopting a manual composting solution for domestic use.

The questionnaire included sections related to demographic details, daily food waste quantity, current waste disposal methods, and attitudes toward composting. Respondents were also asked about their preferences regarding cost, size, ease of operation, and maintenance of a home composter. The form was widely circulated through social media platforms and email, ensuring a diverse range of participants across various age groups and family types.

The survey comprised the following key questions:

1. Age
2. Gender
3. Family type and number of family members
4. Type of diet (vegetarian or non-vegetarian)
5. Daily quantity of food waste generated
6. Awareness and practice of waste segregation
7. Frequency of leftover food after meals
8. Meal planning habits
9. Disposal methods for leftover food
10. Main reasons for food wastage
11. Commonly discarded food items
12. Existing composting practices (if any)
13. Barriers to composting
14. Interest in using an affordable home composter
15. Preferred features such as cost, size, durability, and ease of use
16. Willingness to pay for a home composter
17. Importance of reducing household food waste

After collecting responses, primary data analysis was carried out to interpret public attitudes and design expectations. The results indicated that a majority of respondents preferred a low-cost, manual, and user-friendly composter suitable for small households.

These insights guided the design and fabrication of the proposed hand-operated food shredder composter, aiming to provide an effective, sustainable, and eco-friendly solution for domestic food waste management.

B. Questionnaire Survey Results

A total of 104 respondents participated in the questionnaire survey aimed at understanding household food waste generation and interest in using a hand-operated food shredder composter.

- Demographics: Most respondents were aged 21–30 years (70.2%), with 57.7% males and 60.6% belonging to nuclear families.
- Food Habits: 58.7% followed a non-vegetarian diet, while 41.3% were vegetarian.
- Food Waste Generation: Around 72.1% of respondents generated less than one bucket of food waste daily, and 80% identified their waste as biodegradable.
- Waste Management Practices: 80.8% of respondents believed in using different colored bins for segregation. However, 86.4% reported throwing away remaining food, and only a small portion engaged in composting.
- Reasons for Food Waste: The main reasons were food spoilage before use (52%) and cooking excess food (49%). Commonly discarded items included vegetables (44.6%) and cooked food (25.7%).
- Meal Planning & Leftovers: 55.3% of respondents planned meals in advance, while 42.7% frequently had leftovers.
- Composting Practices: Only a small percentage practiced composting — 41.9% used backyard composting, and 31.4% followed community or vermicomposting methods. The main barriers to composting included lack of knowledge (47%) and space constraints (30%).
- Interest in Home Food Composter: A strong 61.7% showed interest in using an affordable home composter, while 30% were unsure. The most desired features included ease of use (80.6%), low cost (69.8%), and environmental benefits (57%).
- Willingness to Pay: 80.9% were willing to pay less than ₹2000, indicating a preference for a low-cost manual composter.
- Environmental Concern: 79.4% considered reducing food waste very important, highlighting environmental awareness and readiness for sustainable household solutions.

The survey results reveal strong public awareness about waste segregation and environmental sustainability. Most households produce a manageable amount of biodegradable food waste and show a clear preference for a cost-effective, compact, and easy-to-operate manual food shredder composter. These insights guided the design and fabrication of the proposed hand-operated composter prototype.

C. Material Selection using MCDM technique:

To determine the most suitable material, a comparative evaluation was carried out using a Multi-Criteria Decision Making (MCDM) approach. The analysis considered key parameters such as cost, ductility, weldability, strength, recyclability, corrosion resistance, and availability. Based on the weighted scoring results, mild steel emerged as the most appropriate material for fabrication due to its high strength, excellent formability, good weldability, and low cost, making it ideal for small-scale and domestic applications.

Procedure of the MCDM technique for material selection:

Step 1: Selection of Criteria and Assignment of Weights

The first step involves identifying the key material selection criteria relevant to the application. In this case, seven criteria were considered: cost, ductility, weldability, strength/durability, recyclability, corrosion resistance, and availability. Each criterion was assigned a weight based on its relative importance, ensuring that the total of all weights equals 1.00. These weights reflect the decision-maker's priorities.

- Cost: 0.20
- Ductility: 0.15
- Weldability: 0.10
- Strength / Durability: 0.20
- Recyclability: 0.10
- Corrosion Resistance: 0.15
- Availability: 0.10

Step 2: Defining the Scoring Scale

A uniform scoring scale ranging from 1 to 5 was established, where 1 represents poor performance and 5 represents excellent performance. This scale standardizes how each material is evaluated across all criteria.

Step 3: Assigning Raw Scores to Materials

Each material was assessed against all criteria using the 1–5 scoring scale. These raw scores are based on material properties such as cost, ductility, weldability, corrosion behaviour, and availability. The scores capture the inherent strengths and weaknesses of each material.

Table 6: Raw scores:

Material	Cost	Ductility	Weldability	Strength	Recyclability	Corrosion	Availability
Mild Steel (MS)	5 (very low cost)	5	5	4	5	2 (prone to rust)	5
Stainless Steel (SS)	2 (expensive)	4	3	5	5	5 (excellent)	4
Aluminium (Al)	3	4	3	3	5	4	4
HDPE (Plastic)	4	5	2 (different welding)	2	3	5 (resistant)	5
Galvanized Steel (GS)	4	5	5	4	5	4 (zinc coating)	4

Step 4: Weighted Score Calculation

The raw scores were multiplied by their corresponding criterion weights to obtain weighted scores for each material. This step quantifies how well each material performs when both performance and importance are considered together. The weighted scores were then summed to obtain the total score for each material.

Table 7: Weighted Score Calculation for Material Selection:

Criteria (Weight)	Mild Steel (MS)	Galvanized Steel (GS)	Stainless Steel (SS)	HDPE (Plastic)	Aluminium (Al)
Cost (0.20)	0.20 × 5 = **1.00**	0.20 × 4 = **0.80**	0.20 × 2 = **0.40**	0.20 × 4 = **0.80**	0.20 × 3 = **0.60**
Ductility (0.15)	0.15 × 5 = **0.75**	0.15 × 5 = **0.75**	0.15 × 4 = **0.60**	0.15 × 5 = **0.75**	0.15 × 4 = **0.60**
Weldability (0.10)	0.10 × 5 = **0.50**	0.10 × 5 = **0.50**	0.10 × 3 = **0.30**	0.10 × 2 = **0.20**	0.10 × 3 = **0.30**
Strength (0.20)	0.20 × 4 = **0.80**	0.20 × 4 = **0.80**	0.20 × 5 = **1.00**	0.20 × 2 = **0.40**	0.20 × 3 = **0.60**
Recyclability (0.10)	0.10 × 5 = **0.50**	0.10 × 5 = **0.50**	0.10 × 5 = **0.50**	0.10 × 3 = **0.30**	0.10 × 5 = **0.50**
Corrosion Resistance (0.15)	0.15 × 2 = **0.30**	0.15 × 4 = **0.60**	0.15 × 5 = **0.75**	0.15 × 5 = **0.75**	0.15 × 4 = **0.60**
Availability (0.10)	0.10 × 5 = **0.50**	0.10 × 4 = **0.40**	0.10 × 4 = **0.40**	0.10 × 5 = **0.50**	0.10 × 4 = **0.40**
Total Weighted Score	**4.35**	**4.35**	**3.95**	**3.70**	**3.60**

Step 5: Ranking of Materials

The total weighted scores were compared, and materials were ranked from highest to lowest. A higher total score indicates a more suitable material considering all criteria collectively. Mild Steel and Galvanized Steel ranked highest, followed by Stainless Steel, HDPE, and Aluminium.

1. Mild Steel (MS) — 4.35 (tie)
2. Galvanized Steel (GS) — 4.35 (tie)
3. Stainless Steel (SS) — 3.95
4. HDPE (Plastic) — 3.70
5. Aluminium (Al) — 3.60

Step 6: Interpretation of Results

The final step involves interpreting the weighted scores and the ranking outcomes. The analysis helps understand why certain materials outperform others by linking scores back to their practical properties. Materials with a balanced combination of strength, manufacturability, and cost—such as MS and GS—achieved the highest overall suitability.

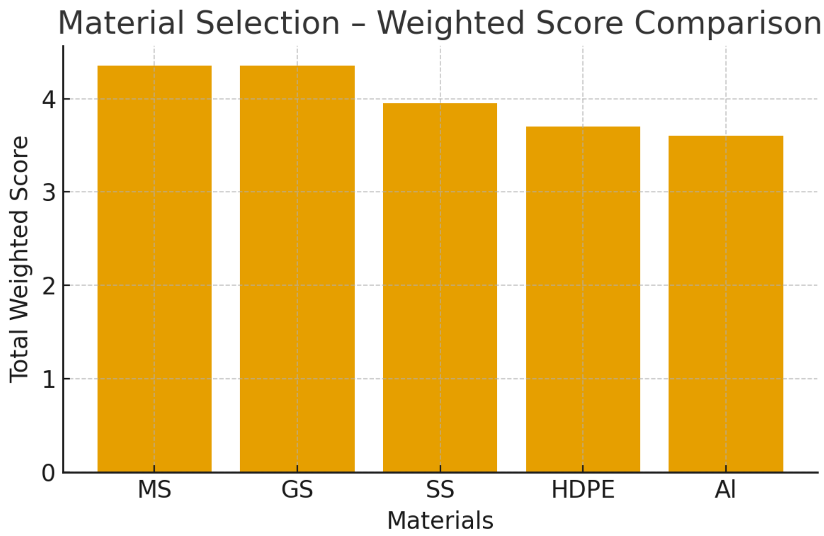


Fig 3. A graphical comparison using bar chart

Fig 3. Shows the graphical comparison of following materials Mild Steel (MS), Galvanized Steel (GS), Stainless Steel (SS), HDPE (Plastic) and Aluminium (Al).

Mild Steel (MS) and Galvanized Steel (GS) emerged as the top-performing materials with identical total weighted scores of **4.35**, indicating a balanced combination of cost-effectiveness, ductility, weldability, strength, recyclability, and availability. Stainless Steel (SS), although superior in strength and corrosion resistance, scored **3.95**, primarily due to its higher cost and moderate weldability. HDPE achieved a weighted score of **3.70**, performing well in terms of ductility, corrosion resistance, and availability, but its lower strength and weldability reduced its overall suitability for structural applications. Aluminium (Al) recorded the lowest score of **3.60**, despite its good recyclability and corrosion resistance; this is attributed to its moderate strength and weldability.

Overall, the analysis suggests that MS and GS offer the most optimized combination of attributes for applications emphasizing cost, manufacturability, and structural performance.

5. Design Of Hand-Operated Food Shredder Composter

Based on the results of the user survey, a hand-operated food shredder composter was designed to address the key user requirements of low cost, ease of operation, and effective shredding of household food waste. The system is entirely manually operated, making it suitable for both domestic and rural applications without dependency on electricity.

The machine (fig.4) primarily consists of a hopper, blade assembly, shaft with handle, and supporting frame. The main functional component, the cutting blades, are fabricated from mild steel owing to its high strength, ductility, good weldability, and cost-effectiveness. Each blade is designed with two cutting edges positioned in opposite directions to enhance shredding efficiency. One cutting edge is placed 0.5 cm above the reference plane and the opposite edge 0.5 cm below, creating a shearing action that ensures smooth and uniform cutting of food waste. The blade diameter is 20 cm, mounted on a shaft of 50 cm length, supported on both sides by circular walls to provide stability and minimize vibration during manual operation. A handle is attached to the top end of the shaft to enable rotational motion by human effort.

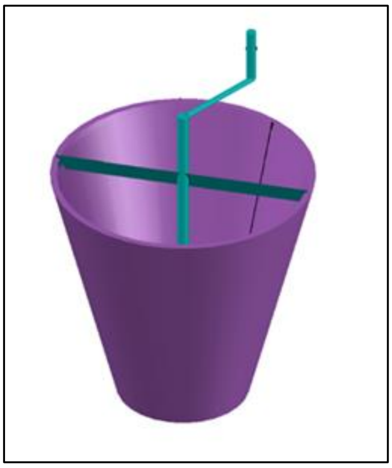
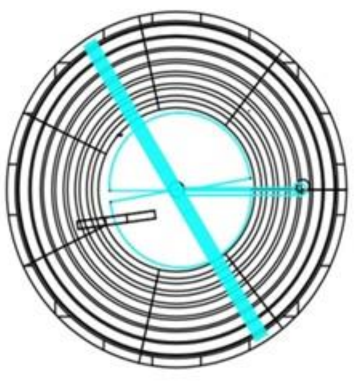
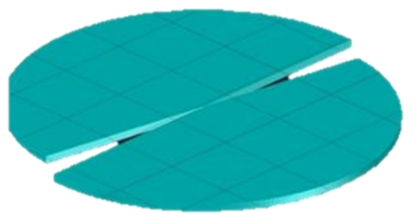


Fig 4. 3D view of the Hand-Operated Food Shredder Composter

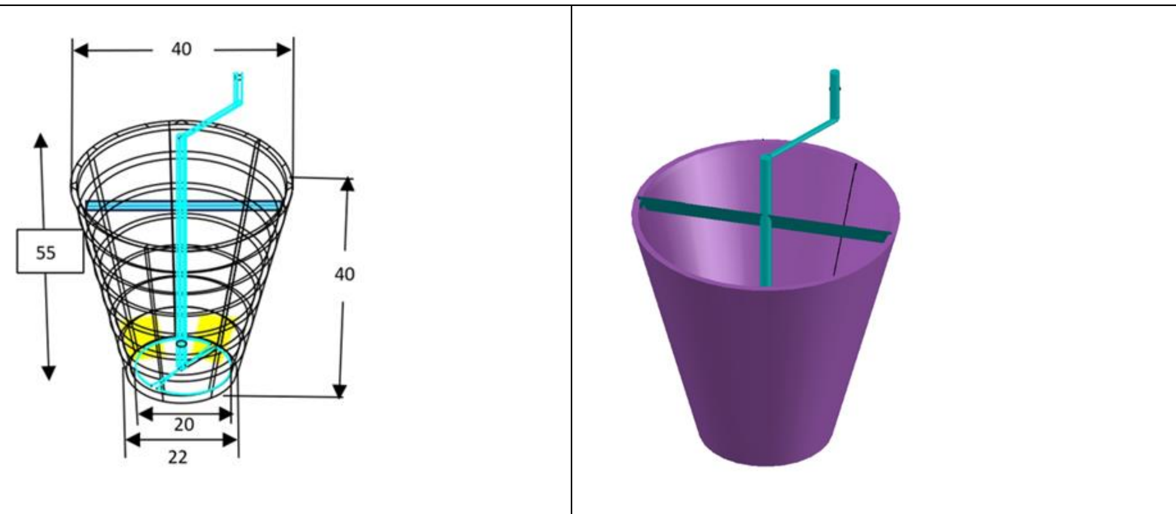
The assembly (fig. 5) is enclosed within a circular container, resembling a well-shaped structure, with a lower diameter of 22 cm and an upper diameter of 50 cm. This tapering design enhances material flow and operational efficiency. A perpendicular plate is attached to the inner wall of the chamber, serving as a stationary obstacle during operation. When larger food materials are introduced, this plate prevents them from rotating along with the blades, ensuring that they come into contact with the cutting edges and are effectively shredded into smaller pieces.



(a) Top view of the machine



(b) 3D view of cutter blade of the Machine



(c) Dimensions of the machine (d) 3D view of the food shredder

Fig 5. Various parts of the Hand-Operated Food Shredder Composter

The design emphasizes simplicity, mechanical efficiency, and durability, enabling easy fabrication and maintenance using locally available materials. The system effectively converts kitchen food waste into smaller biodegradable particles suitable for composting, thus promoting eco-friendly waste management at the household level.

Table 8: Key Specifications of Hand-Operated Food Shredder Composter

Blade diameter	18 cm
Shaft(rod) diameter	2 cm
Height of the shaft	50 cm
Lower diameter of the outer circular wall	20 cm
Higher diameter of the outer circular wall	40 cm
Handle	32 cm
MS Sheet	160 cm
Thickness	1 mm
Barring	40-60 OD

6. Results and Discussion

The household food waste survey received 104 responses from participants across various age groups and family types. The results revealed that over 70% of respondents generated less than one bucket of food waste daily, and nearly 80% identified it as biodegradable. Despite a high level of environmental awareness, most households relied on traditional disposal methods, with only a small portion practicing home composting. The main reasons for not composting were lack of knowledge (47%) and space limitations (30%). However, a significant 61.7% of respondents expressed interest in adopting a manual composter, with preferred features being low cost, ease of use, and minimal maintenance.

The MCDM analysis was applied to select the most suitable material for the composter. The evaluation considered seven key criteria—cost, ductility, weldability, strength, recyclability, corrosion resistance, and availability—weighted according to their relevance to fabrication and functionality. Among the five materials assessed (mild steel, galvanized steel, stainless steel, aluminium, and HDPE), mild steel and galvanized steel both scored the highest (4.35 out of 5). Mild steel was chosen for fabrication due to its lower cost, ease of manufacturing, and local availability.

The designed prototype consists of a manually operated shredding mechanism with a hopper, blade assembly, shaft, and handle. The blades, made from mild steel, have dual cutting edges positioned at different levels to create an efficient shearing effect. The overall assembly is compact, stable, and ergonomically designed for household use. The mechanical shredding process ensures the food waste is converted into smaller, uniform particles that enhance aeration and microbial activity during composting.

By integrating user feedback and engineering design, the prototype provides an energy-free, eco-friendly, and cost-effective solution for managing domestic food waste. It can be easily fabricated using locally available materials and supports sustainability goals by promoting composting at the source.

7. Conclusion

The development of the hand-operated food shredder composter demonstrates a sustainable approach to household food waste management. The study identified the need for affordable and simple composting solutions suitable for small families and limited spaces. The survey findings confirmed strong public willingness to adopt such devices if they are cost-effective and user-friendly. The MCDM-based material selection approach established mild steel as the most suitable material due to its strength, durability, weldability, and economic advantage. The designed system efficiently shreds food waste into compostable particles without external power, reducing landfill burden and promoting circular waste utilization. Overall, this project contributes toward sustainable domestic waste management and supports environmental conservation through a low-cost, manually operated, and locally manufacturable composting system.

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