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WE WILL RISE UP WE WILL SHINE

DESIGN AND CONSTRUCTION OF A PEDAL-POWERED WASTE SHREDDER

A thesis
by

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All praise and thanks are due to Allah, the lot of all worlds.

ABSTRACT

The growing demand for sustainable waste management and organic gardening solutions has led to increased interest in eco-friendly technologies. This project presents the design and development of a **DESIGN AND CONSTRUCTION OF A PEDAL-POWERED WASTE SHREDDER**. scope of this project was to design and development of Shredder machine focus on chopping of vegetables, food ,areca leaves, this chopped powder to prepare the vermin compos. By converting pedal motion into rotational force through a Chain system, the shredder efficiently processes dry foliage without the need for electricity or fossil fuels. Considering the users' needs and buying capacity, bearings, structural frame, cutter and single shaft. The machine frame is built using mild steel and tungsten carbide is used for cutter tip preparation. Five Blade are mounted on Single shafts, which rotate parallel driven by a bearing. The power from the by cycle is transmitted to cutter shaft through a chain drive.

This low-cost, portable, and environmentally conscious solution not only reduces the volume of yard waste but also accelerates composting, enriching soil fertility.

The project emphasizes sustainable living by combining physical activity with practical environmental benefits, making it especially suitable for small-scale urban gardeners, eco-conscious communities, and regions with limited access to electric power. Field testing demonstrates the device's effectiveness in producing mulch of consistent particle size while promoting circular resource use through renewable human energy.

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Chapter 1

Introduction

1.1 Introduction

In recent years, the need for sustainable and energy-efficient solutions in waste and food processing has become increasingly important, particularly in rural areas, small communities, and urban settlements with limited access to electricity. Shredding of organic materials—such as vegetable waste, food scraps, and biodegradable household waste—is a crucial step in composting, animal feed preparation, and waste management. However, conventional shredding machines are often powered by electricity or fuel, making them expensive, environmentally taxing, and inaccessible to many low-income users.

The design and construction of a pedal-powered food/waste shredder machine presents a practical and eco-friendly solution to this problem. By utilizing human mechanical energy through pedaling, this machine offers an off-grid, cost-effective alternative that supports both environmental sustainability and local economic empowerment. The concept is modeled on the principle of bicycle mechanics, converting rotational motion from pedaling into shredding action via a system of gears, shafts, and blades.

This project aims to develop a manually powered shredder capable of efficiently processing organic food and kitchen waste into smaller, manageable particles. These shredded materials can be used for composting, biogas production, livestock feed preparation, or volume reduction for easier disposal. The design focuses on durability, ease of use, safety, and affordability. It is particularly suited for small-scale farmers, urban gardeners, waste collectors, and environmentally conscious individuals or communities.

Key features of the design include:

- A robust frame to support pedaling activity and withstand mechanical loads.

- An efficient cutting or shredding mechanism made from stainless or high-carbon steel for longevity and hygiene.
- A transmission system (chain drive, belt, or gear system) that ensures efficient transfer of power from pedal to blades.
- Safety enclosures and ergonomic considerations to protect the user and enhance usability.

The adoption of this technology can significantly reduce the environmental impact of organic waste, minimize reliance on fossil fuels, and empower communities to manage their waste and food processing needs independently. The project not only supports the principles of green engineering but also contributes to the circular economy by promoting reuse and recycling of organic matter.[1]

1.2 OBJECTIVE

The main objective of this project is:

- To study about DESIGN AND CONSTRUCTION OF A PEDAL-POWERED WASTE SHREDDER
- To Design a Model DESIGN AND CONSTRUCTION OF A PEDAL-POWERED WASTE SHREDDER
- To Construct DESIGN AND CONSTRUCTION OF A PEDAL-POWERED WASTE SHREDDER
- To collect related data of DESIGN AND CONSTRUCTION OF A PEDAL-POWERED WASTE SHREDDER

Chapter 2
Literature Review

2.1 Literature Review

Pedal-Powered Technology

Pedal-powered machines have been used for various applications such as water pumps, grain mills, blenders, and washing machines. According to Singh et al. (2019), such systems convert human mechanical energy into useful mechanical work with efficiencies ranging between 60% to 80%. The concept is especially practical in rural or off-grid settings, where access to electricity is limited.

A study by Dehene and Gebresenbet (2016) on pedal-powered grain grinders highlights the ergonomics of pedal operation, indicating that prolonged use is sustainable if properly geared. The gear ratio between the pedals and the output shaft plays a crucial role in balancing effort with productivity.[2]

Organic Waste Shredding

Shredding is a preliminary step in composting and bio-waste treatment, aiding in volume reduction and increasing the surface area for microbial action. According to Tchobanoglous et al. (2002), shredding facilitates faster decomposition and improved efficiency in organic waste processing.

Commercial electric shredders, while effective, are energy-intensive and not suitable for remote or low-income communities. Studies by Adekunle et al. (2020) and Rahman et al. (2018) demonstrate that manual or low-power shredders can be effective for soft food waste and garden refuse when equipped with appropriate blade configurations and feeding mechanisms.[3]

Details of Waste in Bangladesh: Nowadays, solid waste management is a major challenge in many developing countries, as it creates environmental problems. In the Bangladesh, generations of waste, especially in the urban areas, have increased recently due to fast pace

industrialization, urbanization and population growth. According to the National Solid Waste Management Status Report (2012), the yearly amount of waste in the country is expected to increase from 22.2 million tons in 2012 to 32.5 million tons in 2018 to 47.064 million tons in 2025. In managing this significant volume of waste, the strong option to households offered by the local government is collection services. In the study entitled “Relationship between the Level of Knowledge and Solid Waste Management Practices of the Households. I” which was conducted by the project proponents, it was found that the majority of the respondents, which comprise 56.8% of the total population, prefers burning their solid wastes. However, according to the National Center for Atmospheric Research (as cited by Lacurci, 2014), this practice of solid waste management emits gases and particles that can substantially affect human health and the environment. Every year, 3 million metric tons of e-waste are generated in the country. Of this, 1.5 million tons of e-waste are generated from smart devices alone. At least 296,302 units of discarded televisions generate 1.7 million tons of e-waste. More than 2.5 million tons come from the ship breaking industry. The concern is that this waste is increasing at a rate of 30% every year.[4]

E-Waste plant in Bangladesh: This is the first e-waste management plant in Bangladesh being built in Gazipur. Luxury goods like cell phones-laptops and refrigerators-air conditioners have now become daily necessities. Along with this, the amount of post-consumption waste has increased. Many businessmen personally recycle this electronic e-waste. However, there is a lack of safety equipment and health risks. This is the first e-waste management plant being built keeping these aspects in mind.

A project called Bangladesh Environmental Sustainability and Transformation (BEST) is being implemented under the fourth component of the project of the Ministry of Environment, funded by the World Bank, to increase the government's capacity in environmental matters. An e-waste management plant will be built under the fourth component of this project. An initial expenditure of about Tk 300 crore will be spent for this.

Sources said that the project will be implemented at Kaliakair Hi-Tech Park in Gazipur.

Deputy Director of Kaliakair Hi-Tech Park Md. Mahfuzul Kabir said, "Bangladesh has become a rapidly emerging economy. Along with economic progress, the purchasing power of people has also increased. The use of electronic products has increased in both cities and

villages. As a result, electronic waste has become a challenging issue. The annual amount of e-waste will be about 1.6 million tons in 2030. A complete recycling system for e-waste management has not yet been developed in the country.

He said that the project period is until June 2028. We are taking forward the initial work to build an e-waste plant. The process of hiring a consulting firm is underway. The feasibility study will be verified. Then the infrastructure work will start.

According to the project source, initially land development, construction of a 35-foot high steel shed and construction of an electro-mechanical workstation will be carried out. In addition, boundary walls, buildings, vehicle sheds, RCC roads, drainage facilities, landscaping and housing facilities, consultancy services, equipment and furniture will be procured. Every year, millions of cell phones, computers, laptops, televisions, refrigerators, washing machines, air conditioners, photocopy machines and other electronic equipment become useless. There is no environmentally friendly and formal management of these electronic equipment. They are thrown in the dustbin along with household garbage. If e-waste can be collected properly and recycled in an environmentally friendly way, it will be possible to convert it into a resource.

In this context, waste management expert Dr. Md. Safiullah Siddique Bhuiyan said, e-waste collection is a big challenge. It is important to formulate a proper outline of how it will be collected. In this case, those who produce or import electronic products are the major sources. E-waste must be collected from them in the right way. In addition, it is important to collect the waste generated in homes, industries and commercial establishments separately from the source in a planned manner. Then, when the waste reaches the plant, it must be recycled in a scientific way without harming the environment. If there is a deficiency in these two basic issues, then no matter how big an initiative we take regarding e-waste, it will not be successful.[5]



Figure 2.1 Padel Mechanism

- Cycling refers to the activity of riding a bicycle (Oxford Living Dictionaries, 2018). In this study, cycling was used to refer to the act of using the pedal cranks attached to the blades to shred dry leaves to turn it into organic mulch.



Figure 2.2 Pedal-powered leaf shredder

- Pedal-powered leaf shredder is a simple machine that is used for cutting dry leaves into small pieces. In this study, this machine is the proposed product of the researchers to prevent leaf burning in the community.
- Plant development is an overall term which refers to the various changes that occur in a plant during its life cycle (Bareja, 2014). In this study, plant development was measured by the number of flowers and fruits which the calamansi plant bore.

- Plant growth is irreversible, quantitative increase in size, mass, and/or volume of a plant or its parts (Bareja, 2014). In this study, plant growth was measured by the height of the tallest stem of calamansi plant.

The Pedal-Powered Leaf Shredder is an eco-friendly, human-powered machine designed to convert fallen food through the use of bicycle pedaling. It eliminates the need for electricity or fuel by harnessing mechanical energy from pedaling to rotate a set of shredding blades. This sustainable solution promotes green waste recycling, reduces landfill load, and produces nutrient-rich mulch for gardening or composting. Ideal for small-scale farmers, urban gardeners, and environmental enthusiasts, it merges fitness with sustainability by transforming a common chore into an efficient, emission-free activity. It was estimated by the Department of Science and Technology (as cited by Ong, 2015) that Five billion metric tons of biomass such as wood, leaves, trees, grass, and trash are being burned worldwide. This solid waste management practice, however, is prohibited under Government of the People's Republic of Bangladesh Act 2021 or the Ecological Solid Waste Management Act. People found to violate this law will be penalized with imprisonment of one to 15 days and a corresponding fine. In this regard, it was estimated that biomass burning produces 40 percent of the carbon dioxide, 32 percent of the carbon monoxide, and 50 percent of polycyclic aromatic hydrocarbons which pose negative effects to public health and the environment especially when released in great amount. First, too much carbon dioxide can lead to global warming and the destruction of the ozone layer. Meanwhile, when carbon monoxide binds to the hemoglobin in the red blood cells of a person, it reduces the amount of oxygen in the blood. For this reason, when one is exposed to large amounts of smoke, that person can collapse and die in a short span of time. Patients with asthma, emphysema, lung disease, and heart disease are more susceptible to the ill effects of leaf smoke (Ong, 2015).

In relation to the negative health impacts of waste incineration, the study of Wielgosinski and Targaszwska (2014) found that pollutants generated in waste incineration plants, as by-products of the thermal process are mainly heavy metals and various volatile organic compounds. Results showed that adverse effects on the lungs and kidneys and possible lung prostate cancer are sufficient with cadmium, skin inflammation and lung cancer for chrome and increased risk of lung and nose cancer and frequent allergic reactions to nickel.

In addition, a critical review of epidemiologic studies was conducted by Hu and Shy (2001) to enhance understanding of the potential health effects of this waste management practice. In their study, health effects of waste incineration among community residents showed some similar and some inconsistent results. It was observed from the study of Elliott (1995) and Biggeri (1996) that a significant positive relation with lung cancer incidence and laryngeal cancer deaths. Meanwhile, the study of Michelozzi (1998) and Elliott (1992), found no excess in lung cancer incidence and laryngeal cancer deaths with waste burning in the community. Similarly, results for the association between incineration and reproductive effects were conflicting. In the study of Lloyd (1998) higher frequency of twinning was found in the areas at most risk in, but in the study conducted by Rydhstroen (1998), it was stated that the higher frequency of twinning was not observed in municipalities with incinerators.[6]

Chapter 3
Working Principle

3.1 Working Principle

The pedal-powered food and waste shredder operates on the principle of mechanical energy conversion, where human pedaling effort is converted into rotational motion to drive a shredding mechanism. The machine utilizes simple mechanical components, such as a chain and sprocket system, flywheel, and rotating blades, to achieve effective waste size reduction without the need for electricity.

1. **Energy Input (Pedal Power)**

- The user pedals using a bicycle-style crank system.
- Pedaling rotates a sprocket, which is connected to a chain drive.
- The chain transmits torque to a larger sprocket or gear connected to the shaft of the shredder, thereby increasing rotational force through gear ratio manipulation.

2. Power Transmission System

- The mechanical energy is transferred via a chain and sprocket or belt and pulley system.
- To maintain smooth and continuous shredding, a flywheel is often attached to the shaft, which stores kinetic energy and ensures consistent blade rotation even during brief lapses in pedaling effort.

3. Shredding Mechanism

- The central shredding unit consists of a rotating drum or shaft fitted with sharp, hardened steel blades.
- These blades are designed to cut, crush, or tear soft and semi-solid food waste and garden waste as it passes through the chamber.
- The waste is fed through a hopper and contacts the rotating blades.
- As the waste is shredded, it drops through a screen or grate that controls the output particle size.

4. Discharge and Collection

- The shredded material is discharged through an outlet at the bottom of the chamber.

- The output can be collected in a bin or tray and used for composting, animal feed, or other recycling processes.

5. Safety and Ergonomics

- The system may include safety features like guards, enclosed blades, and overload protection mechanisms.
- Ergonomic design ensures that users can operate the system comfortably for extended periods, with adjustable seat height and pedal resistance.

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Chapter 4

Design, Construction & Costing

4.1 Design

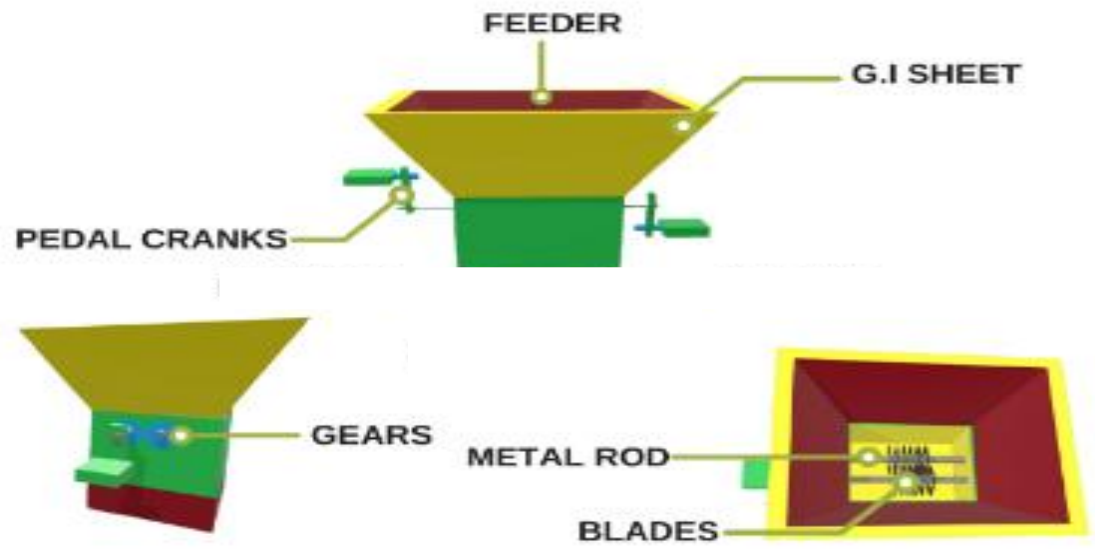


Figure 4.1 Pedal powered food Shredder Model (use solidworks)

1. Frame Structure

- Material: Mild steel (MS) or angle iron
- Function: Provides a stable base for mounting all components including pedals, shredding unit, flywheel, and seat.
- Design: A welded or bolted steel frame, often with a rectangular base to ensure stability during pedaling. It includes support brackets for the shaft and bearing housings.

2. Pedal Mechanism

- Source: Modified bike crank set
- Components:
    - Crank arms
    - Pedals

    - Front sprocket (chaining)
- Design Consideration: Should be ergonomically positioned for comfortable pedaling (similar to a stationary exercise bike).

3. Power Transmission System

- Type: Chain and sprocket or belt and pulley
- Components:
    - Chain (bicycle type)
    - Front sprocket (connected to crank)
    - Rear sprocket (mounted on shredder shaft)
    - Tensioned or idler (optional)

4. Shredding Chamber

- Housing Material: Mild steel sheet or stainless steel (if for food-safe operation)
- Blade Shaft:
    - Material: High-carbon steel or alloy steel (e.g., EN8)
    - Diameter: 1–1.5cm
    - Bearings: Pillow block or ball bearings to reduce friction and support rotating shaft
- Cutting Mechanism:
    - Multiple rotating blades or hammer blades mounted on the shaft
    - Counter blades (fixed) may be added inside the chamber for more aggressive shredding
    - Blades spaced evenly around the shaft for balanced rotation
- Blade Material: High-carbon steel or hardened stainless steel for durability and sharpness retention

5. Hopper /Feeder (Input Feed)

- Material: Galvanized iron sheet, plastic, or stainless steel
- Shape: Funnel-shaped for easy feeding of waste

6. Output Chute / Discharge

- Material: Sheet metal or plastic
- Design: Sloped or vertical channel that guides shredded material into a collection bin or bag

- Screening: Optional mesh at the bottom to control particle size

7. Safety Features

- Blade cover or shroud to prevent user contact
- Chain guard over the transmission
- Emergency stop (manual brake or quick-release mechanism)

8. Dimensions (Example)

Component	**Size/Dimension**
Frame base	465 mm × 315 mm
Hopper opening	480 mm × 340 mm
Shredder shaft length	510 - 520 mm
Blade thickness	1mm – 1.5 mm
Shaft rotation speed	344 rpm

Table 4.1 Dimensions

09. Application Capacity

- Ideal Waste: Vegetable peels, leftover food, fruit waste, dry leaves, soft garden waste
- Through put: ~ 10–15 kg/hour depending on user effort and blade configuration

4.2 Total Costing in this Project:

SL No	Part's Name	Total Cost(BDT)
1	Shedder Frame	2,500.00
2	Pedal Crank set	900.00
3	GI sheet Hopper/Feeder	2,000.00
4	Cutting Blades	900.00
5	Cutting Frame	500.00
6	Ball Bearing	360.00
7	Metal Rod/Shaft	1,300.00
8	Bike chain	1,000.00
9	Sprocket	450.00
10	Other Cost	5,000.00
	Total Cost(BDT):	14,910.00

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Chapter 5

Specification of parts in project

5.1 Specification of parts in project

1. Pedal Crank set:



Figure 5.1 Pedal Crank Set

The crank set – often referred to as a chain set – is one of the most important parts of a bicycle. As one of the key components that helps move the chain as you pedal, it's at the heart of the drive train and helps make a bike, well, a bike.

Cranks are constructed of either an aluminum alloy, titanium, carbon fiber, chromoly steel, or some less expensive steel. Tubular steel cranks (such as Tioga's Revolver) can be light and very strong, are usually found on BMX bikes, and are slowly finding their way to mountain bikes (dirt jumping and urban assault).[7]

2. **GI sheet Feeder/Hopper**

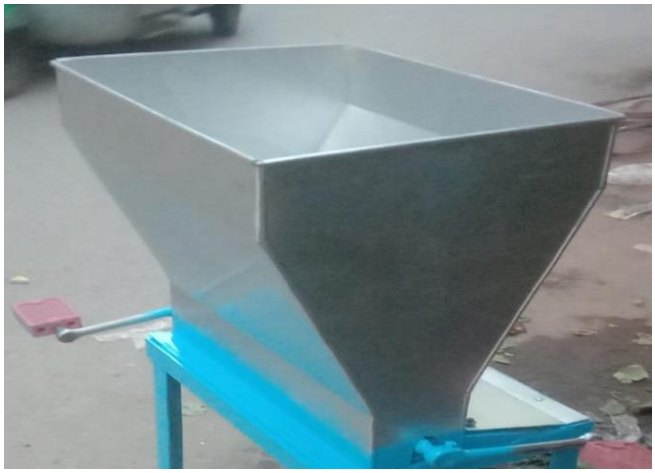


Figure 5.2 GI sheet Feeder/Hopper

A waste shredder feeder is a system designed to transport and regulate the flow of waste material into a shredder.

Function of a Waste Shredder Feeder:

Regulated Feeding: Ensures a consistent and even flow of material into the shredder, preventing overloading or jams.

Waste Material Preparation: May include a pre-shredding stage to make the waste more manageable for the shredder.

Material Handling: Transports waste from storage or collection points to the shredder inlet.

Examples of Waste Shredder Feeder Applications:

Municipal Solid Waste Shredders: Used to reduce the size of household waste for easier recycling or disposal.

Industrial Waste Shredders: Handle a variety of industrial materials, like plastic, metal, and wood.

A GI sheet feeder is typically a poultry feeder made of galvanized iron (GI) sheet metal. These feeders are commonly used for feeding livestock, such as chickens, ducks, or other poultry, and can be either standing or hanging. They are known for their durability and are often used in farm settings.

Key features of GI sheet feeders Material: Made of galvanized sheet metal for strength and durability.

Capacity: Typically available in various sizes, with capacities ranging from 5 kg to larger volumes.

Design: Can be designed for standing on the ground or for hanging from a roof or structure.

Features: Some models may include a black plastic lid, adjustable outlets, or other features to improve feeding.[8]

3. Cutting Blades:

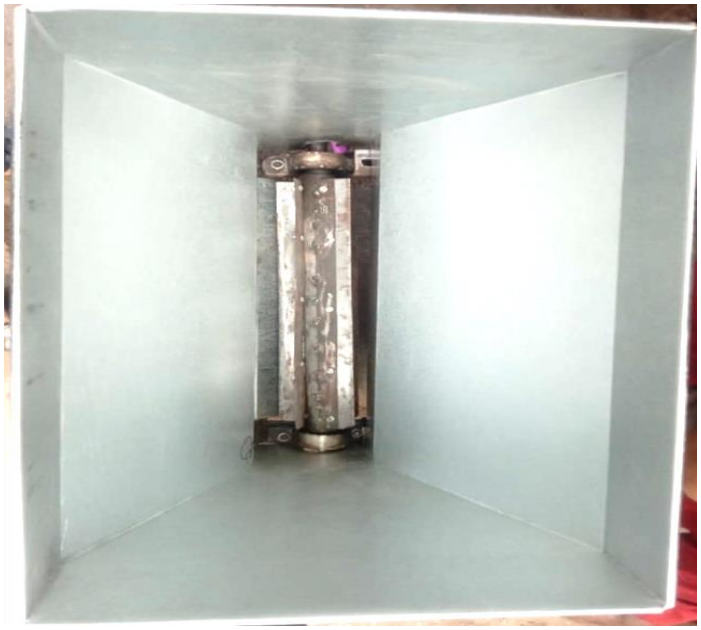


Figure 5.3 Cutting Blades

A tooth brush cutter blade is a circular metal blade with sharp teeth around its edge, designed for cutting through thick grass, woody shrubs,dry leaf and even small trees. It's used with brush cutters or heavy-duty trimmers.[9]

Blades Materials:

Component	Material	Purpose
Blade Body	High-carbon steel / Manganese	Strength and wear resistance
Teeth (if tipped)	Tungsten carbide	Extra hardness for cutting wood
Coating (optional)	Anti-corrosion paint / powder	Rust resistance, extended life

Table 5.2 Blades Materials

4. Metal Rod/Shaft:



Figure 5.4 Metal Rod/Shaft

A metal shaft is a cylindrical rotating component used to transmit mechanical power, motion, or torque between parts in a system — found in motors, gearboxes, crank systems, and more.

Metal Rod/Shaft Materials:

Material	Properties	Typical Uses
Stainless Steel	Rust-resistant, strong, and durable	Outdoor/food-grade machines, marine use
Carbon Steel	Higher strength than mild steel, wear-resistant	Heavy-duty shafts, gear systems
Alloy Steel	Added elements chromium, nickel) for toughness	Automotive, aerospace applications
Aluminum	Lightweight, corrosion-resistant, lower strength	Light weight systems, bicycles

Table 5.2 Metal Rod/Shaft Materials

5. Bike chain:



Figure 5.5 Metal Rod/Shaft Bicycle chain

A bike chain is a roller chain that transfers power from the pedals to the rear wheel, allowing the bike to move. A chain is made up of a series of links. Most chains have alternating wide and narrow links that are repeated for the length of the chain. Each link has two side plates, held together by rivets (also called pins), and a roller sits on the shoulder of the outer link.[10]

Bike chain Materials: Most bike chains are made from plain carbon or alloy steel, but some are nickel-plated to prevent rust, or simply for aesthetics.

6. Ball Bearing:



Figure 5.6 Ball Bearing

A ball bearing reduces friction between two surfaces that rotate or move relative to each other, allowing for smooth and efficient motion. It supports rotational loads (radial, axial, or both) while minimizing wear.

Rotation Begins: When the **inner ring** is mounted on a shaft and the shaft rotates, the inner ring rotates with it.

Ball Movement: The balls roll in the **raceways** (grooves) of the inner and outer rings.

Friction Reduction: Instead of sliding friction (as in bushings), the rolling motion significantly reduces resistance.

Load Distribution: The balls distribute the load (radial or axial) across the raceways.

Low Heat Generation: Rolling contact produces less heat and wear than sliding.[11]

Comparison Table

Material	**Hardness (HRC)**	**Corrosion Resistance**	**Load Capacity**	**Cost**
SAE 52100	60–66	Low	High	Low
AISI 440C	58–60	Medium	High	Medium
Ceramic (Si_3N_4)	~80 (Vickers)	Very High	Medium	High

Table 5.3 Comparison

7. Frame:



Figure 5.7 Frame

The pedal-powered food shredder machine is a manually operated mechanical device designed to efficiently shred food items such as vegetables, fruits, and root crops without the need for electricity or fuel. It is especially suited for rural or off-grid areas, small-scale farms, and communities focused on sustainability. The machine operates by converting human energy, via a bicycle-like pedaling mechanism, into rotational motion that drives a shredding blade assembly.

Its design emphasizes low cost, simplicity, environmental friendliness, and ease of use. Built using locally available materials, the machine supports local food processing needs, reduces post-harvest losses, and empowers users by promoting physical activity and independence from fossil fuel-powered devices.

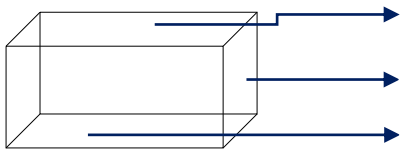
By addressing the dual challenges of food processing and energy scarcity, this machine represents a practical innovation for sustainable agricultural practices, rural development, and small-scale food industries.

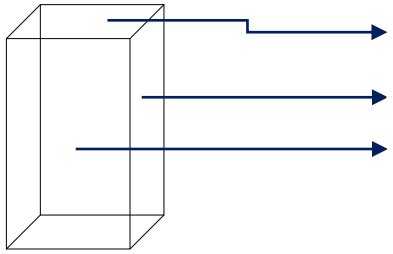
Chapter 6

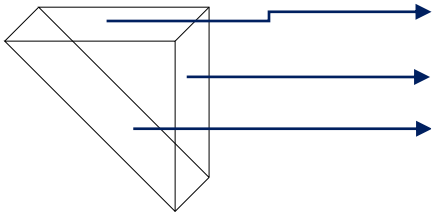
Data Calculation

6.1 Data Calculation

1. Feeder/Hopper Volume Calculation: Given Data from project,

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We know,

Hopper/Feeder total Volume: {(Length × Width × Height) + (Length × Width × Height) + (1/2 × Base × Height × Thickness) × 2}

= { (0.465m × 0.335m × 0.09m) + (0.115m × 0.27m × 0.465m) + (1/2 × 0.11m × 0.27m × 0.465m) × 2}

= (0.01402 + 0.014439 + 0.01381) m^3

= 0.04227 m^3 (Hopper/Feeder total Volume)

∴ Hopper/Feeder total Volume: **0.04227 m^3**

2. Measuring the human body's heartbeat by pedaling in the project,

SL	Time	Heart bit ♥
1	Normal Heartbeat	73 ~ 78
2	0 - 2 min	75 ~ 79
3	2 - 4 min	85 ~ 90
4	4 - 6 min	91~ 95
5	6 - 8 min	93 ~ 96
6	8 - 10 min	94 ~ 97

3. Load & No load measurement product testing of shaft rpm,

Product Testing	Trial 1(rpm)	Trial 2(rpm)	Trial 3(rpm)	Average(rpm)
No load measurement	350	340	344	344
Load measurement	252	260	255	255

4. Data gathered during experiment on the presence of food,

Padel Crank Cycle - 01					
Simple Materials Name	**Total Volume (c.c)**	**After cutting the products, count the pieces**			
		1st pieces (c.c)	**2nd pieces (c.c)**	**3rd pieces (c.c)**	**4th pieces (c.c)**
Okra	14 × 1.5 × 1.4=29.4	2.5 × 0.7 × 1.4 =2.45	3.0 × 0.8 × 1.3 = 3.12	5.5 × 1.0 × 1.1=6.050	-
Cabbage	7.0 × 4.5 × 4.3=135.45	4.5 × 2.0 × 2.2=19.800	-	-	-
Chichinga	12.5 × 3.0 × 2.9=108.750	3.2 × 2.2 × 2.3=16.192	-	-	-

5. Final Project Picture:

Top View:



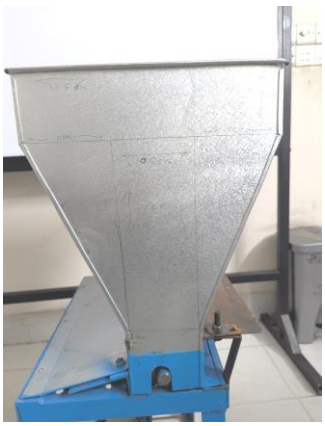
Front View



Left Side View:



Right Side View:



3D Full Picture:



Figure 6.1 Final Project Picture

Chapter 7

Discussion

7.1 Discussion

The successful design and construction of a pedal-powered food and waste shredder demonstrate the feasibility of using human-powered mechanical systems for small-scale waste management, especially in off-grid or low-income communities. The project integrates principles of mechanical engineering, ergonomics, and sustainability to deliver a functional solution with minimal environmental impact. System Performance and Functionality

The system effectively converted human pedaling energy into rotational motion to drive the shredding blades. During testing, the shredder was able to handle a variety of organic materials including vegetable peels, fruit waste, and dry leaves, reducing them into smaller pieces suitable for composting. The inclusion of a flywheel improved rotational stability and allowed for smoother operation, even when the pedaling force varied.

Blade sharpness and shaft alignment played critical roles in performance. Proper material selection, such as high-carbon steel for the blades and hardened steel for the shaft, ensured durability and resistance to wear. The shredding chamber, designed with sufficient clearance and fixed counter blades, provided effective shearing action.
Ergonomics and User Interaction

Ergonomic factors were central to the machine's usability. Adjustments such as seat height, pedal crank length, and posture alignment allowed users to operate the shredder for extended periods without excessive fatigue. The gear ratio between the pedal and the shredder shaft was optimized to reduce the physical effort while maintaining adequate blade speed (250–350 RPM).

However, extended use revealed that continuous pedaling could be tiring for some users, especially if the shredder encountered tougher or fibrous waste. This points to the importance of balancing torque and speed, and possibly integrating a dual-mode drive (pedal + motor) in future models.

Moreover, it serves as an educational tool to raise awareness about waste management and sustainable practices in schools and community programs.

Limitations

Despite its advantages, the design has some limitations:

- Manual operation limits throughput to 10–30 kg/hour depending on waste type and user endurance
- Not suitable for hard or non-organic materials, such as plastics, metals, or large woody debris
- Weather dependence if used outdoors, and limited usage by elderly or physically disabled users

These limitations suggest the system is best suited for small institutions, households, or community gardens where daily organic waste volumes are manageable.

Recommendations for Improvement

Based on performance observations, the following improvements are recommended:

- Addition of a gearbox or speed increaser for greater mechanical advantage
- Use of interchangeable blade types for different waste textures
- Integration of a hybrid power system (manual + solar/electric)
- Development of modular designs for ease of transport and maintenance
- Enhanced safety mechanisms such as full blade enclosure and chain guards

1. Advantages:

- Eco-Friendly
    - No electricity or fuel needed, reducing carbon footprint.
- Cost-Effective
    - Low operational and maintenance costs.
    - Inexpensive to build using local materials.
- Energy Independent
    - Ideal for off-grid or rural areas without reliable power supply.
- Portable
    - Easy to transport and use in various locations, such as farms or community kitchens.
- Promotes Physical Fitness

    - Encourages exercise while performing a productive task.
- Simple Design
    - Easy to build, repair, and maintain without advanced technical skills.
- Supports Small-Scale Processing
    - Helps farmers or small businesses process food efficiently (e.g., vegetables, cassava, fruits).

Disadvantages:

- Labor-Intensive
    - Requires continuous pedaling; not ideal for people with limited physical ability or endurance.
- Low Throughput
    - Slower than electric shredders; may not be suitable for large-scale or commercial use.
- Inconsistent Output
    - Manual effort can lead to uneven shredding compared to motorized systems.
- Limited Shredding Power
    - May struggle with hard or fibrous foods without extra gearing or strong build.
- User Fatigue
    - Prolonged use can be tiring, especially in hot climates or for long processing sessions.
- Manual Start/Stop
    - Lack of automation makes it less convenient for continuous or unattended use.

3. **Application:**

- It’s using agriculture
- Using manufacturing composite fertilizer
- Chopping the agriculture waste

Chapter 8
Conclusion

8.1 Conclusion

The design and construction of a pedal-powered food and waste shredder successfully demonstrate the practicality of utilizing human-powered mechanical systems for sustainable waste management. The machine efficiently converts pedaling energy into rotational motion to drive a shredding mechanism capable of processing organic waste such as food scraps, fruit peels, and dry leaves. This not only aids in volume reduction and promotes faster composting but also provides an environmentally friendly alternative to electric-powered shredders.

The use of locally available materials, recycled components, and simple fabrication techniques makes the shredder both cost-effective and accessible for rural communities, schools, and small-scale waste processing facilities. Ergonomic design considerations ensured user comfort and operational efficiency, while the overall system required minimal maintenance and zero external energy input.

While the current prototype effectively meets its objectives, future improvements—such as increasing shredding capacity, integrating a hybrid (pedal + electric) power source, and enhancing safety features—could further expand its functionality and user accessibility. Overall, the project contributes meaningfully to grassroots sustainability efforts and offers a scalable solution for decentralized organic waste management.

Chapter 9
REFERENCE

9.1 REFERENCE

1. https://www.researchgate.net/publication/361436829_Fabrication_of_Waste_Food_Shredder_Machine_for_Generation_of_Organic_Fertilizers
2. https://www.permaculture.org.uk/practical-solutions/pedal-powered-technology
3. https://www.ijesi.org/papers/Vol(7)i6/Version-3/F0706032631.pdf
4. Wikipedia, Waste management in Bangladesh. Retrieved from:https://en.wikipedia.org/wiki/Waste_management_in_Bangladesh
5. Dr. Md. Shafiullah Siddique Bhuiyan In this context, waste management expert Dr. Md. Shafiullah Siddique Bhuiyan said, e-waste collection is a big challenge. Retrieved from: https://dailyinqilab.com/national/news/650130
6. Anzalone, A., Cirujeda, A., Aibar, J, Pardo, G. & Zaragoza, C. (2010). Effect of biodegradable mulch materials on weed control in processing tomatoes. Retrieved from https://www.jstor.org/stable/40801450?seq=1#page_scan_tab_content
7. https://en.wikipedia.org/wiki/Crankset
8. https://www.globalspec.com/specsearch/searchform/material_handling_packaging_equipment/material_handling_equipment/hoppers
9. https://www.researchgate.net/figure/Some-technical-specifications-of-circular-saw-blades-used-in-the-machining-of-wood-and_tbl2_330289196
10. https://bike.bikegremlin.com/3555/bicycle-drive-chain-dimension-standards/
11. https://www.skf.com/group/products/rolling-bearings/ball-bearings/deep-groove-ball-bearings
12. https://www.researchgate.net/publication/348222963_PEDAL-POWERED_LEAF_SHREDDER_CYCLING_LEAVES_TO_ORGANIC_MULCH_A_Research_Paper_presented_to_the_Faculty_of_Senior_High_School
13. Department of Environment Government of the People's Republic of Bangladesh. Retrieved from: https://doe.gov.bd/site/page/01a2d55d-75b8-417c-920b-ba58c0e11350/nolink/%E0%A6%86%E0%A6%87%E0%A6%A8%E0%A6%93%E0%A6%AC%E0%A6%BF%E0%A6%A7%E0%A6%BF%E0%A6%AE%E0%A6%BE%E0%

A6%B2%E0%A6%BE:%E0%A6%AC%E0%A6%BF%E0%A6%A7%E0%A6%BF%E0%A6%AE%E0%A6%BE%E0%A6%B2%E0%A6%BE

14. Wikipedia Details of mulch.Retrieved from: https://en.wikipedia.org/wiki/Mulch
15. Gear. Retrieved from: https://www.iqsdirectory.com/articles/gear/types-of-gears.html

16. Bareja, B. (2014). Introduction: What are Plant Growth, Differentiation and Development? Retrieved from http://www.cropsreview.com/plant-growth.html
17. Biggeri, A. (1996). Mortality for non-Hodgkin lymphoma and soft-tissue sarcoma in the surrounding area of an urban waste incinerator. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.597.3022&rep=rep1&ype=pdf
18. Bubot. (2018.) In Depinisyon.com. Retrieved from https://www.depinisyon.com/depinisyon-25108-bubot.php Center for Innovation in Research and Teaching. (n.d.). Quantitative approach . Retrieved from https://cirt.gcu.edu/research/developmentresources/research_ready/quantresearch/approaches