

# Fabrication of Mechanized Manual Floor Sweeper

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**Abstract** – This paper presents the design, fabrication, and performance evaluation of a Mechanized Manual Floor Sweeper intended as a low-cost, eco-friendly alternative to both traditional brooms and electric vacuum cleaners. The device operates on the principle of converting the operator's linear push force into rotational brush motion through a belt-and-pulley transmission system connected to the rear wheels. A supplementary 12V, 25W DC motor running at 300 RPM, powered by a 12V, 7Ah rechargeable battery, provides motor-assisted cleaning when required. The frame is fabricated from mild steel sections, the brush from nylon bristles, and the wheels from plastic, keeping the total weight within 10–12 kg and the fabrication cost at approximately Rs.8,050. Performance testing on a 9 m<sup>2</sup> area demonstrated cleaning efficiencies of 78–81% in manual mode and 91–93% in motor-assisted mode on smooth surfaces, with area coverage up to 2.6 m<sup>2</sup> per minute. Compared to conventional broom sweeping at 55% efficiency, the sweeper delivers a measurable improvement while eliminating mandatory electrical supply dependency. The device is suitable for deployment in homes, schools, offices, and rural public spaces.

**Keywords:** Mechanized Sweeper, Floor Cleaning, DC Motor, Manual Mechanism, Eco-Friendly, Low-Cost Fabrication, Nylon Brush, Mild Steel

## I. Introduction

Cleanliness plays a significant role in maintaining hygiene, health, and the overall environment of any household, institution, or public space. In developing countries, cleaning is still performed manually using traditional brooms which demand continuous bending and hand movement, causing discomfort, back pain, and fatigue, especially when cleaning large areas.

Vacuum cleaners were introduced to overcome these drawbacks, but their high cost, electricity requirement, and maintenance expenses limit adoption among the general

population, particularly in rural and semi-urban areas. There is a pressing need for a low-cost, user-friendly, and power-independent cleaning mechanism.

The Manual Sweeper project aims to meet these needs by developing a device that collects dust and debris through a rolling brush mechanism driven by manual motion. The sweeper consists of a sturdy mild-steel frame, handle, brush rollers, dust collection tray, and a 12V DC motor powered by a rechargeable battery. This project demonstrates how mechanical principles can improve daily living comfort and productivity.

## II. Literature Survey

- **Patil S. et al.** – Studied brush speed, handle angle, and floor contact pressure. Results showed proper brush alignment improved cleaning efficiency by 25% over traditional mopping.
- **Ramesh K. and Kumar A.** – Evaluated a semi-automated 12V DC-assisted sweeper that cleaned effectively on both smooth and rough surfaces with reduced manual effort.
- **Saini V. and Rajput P.** – Found that a geared DC motor enhanced sweeping torque, increasing dust pickup efficiency by 18%.
- **Thakur M. et al.** – Concluded that optimal motor RPM (~300) provides the best balance between cleaning efficiency and energy consumption.
- **Kumar S. and Singh R.** – Demonstrated that a mild steel frame with nylon brushes provides high durability and uniform cleaning with minimal vibration.
- **Chavan P. et al.** – Proved that optimized handle height and proper weight distribution significantly reduce operator fatigue and improve cleaning performance.

## III. Methodology and Working Principle

#### A. Mechanical Working Principle

The Mechanized Manual Floor Sweeper operates on the principle of converting linear translational motion (the push force applied by the operator) into rotational motion at the brush shaft through a mechanical transmission system. When the operator pushes the sweeper forward, the rear wheels rotate about their axle. This rotational motion is transmitted to the central brush shaft via a belt-and-pulley arrangement connecting the wheel axle to the brush roller. The rotating nylon brush then sweeps dust, debris, and light waste materials in a forward-and-upward arc, depositing them into the enclosed dust collection tray positioned directly above the brush.

#### B. Motor-Assisted Operation

In addition to the passive wheel-driven mechanism, a 12V DC motor rated at 25–30W and 300 RPM supplements brush rotation when the motor switch is activated. The motor is mounted on the side of the frame and drives the brush shaft through the same belt drive, providing consistent brush speed regardless of the operator's walking pace. The motor is powered by a 12V, 7Ah rechargeable lead-acid battery mounted centrally on the frame platform, ensuring balanced weight distribution. A push-button switch on the handle allows the operator to toggle motor assistance on or off as needed.

#### C. Fabrication Process

The fabrication process begins with 3D modeling of all components in CATIA V5 software to validate assembly fit before physical construction. Mild steel square sections (20×20 mm) and round rods (Ø15 mm) are cut to required lengths using a hacksaw and cutting machine, then welded using arc welding to form the main frame structure. The brush shaft, made of Ø12 mm mild steel rod, is mounted on ball bearings pressed into the side plates of the frame. The nylon cylindrical brush (Ø100 mm, 350 mm long) is fitted onto the shaft. Plastic wheels (Ø150 mm) are mounted on the rear axle using nuts and bolts. The mildsteel sheet housing is cut, bent, and riveted to enclose the brush compartment. After assembly, all welded joints are ground smooth, surfaces are cleaned, and two coats of primer and enamel paint are applied for corrosion protection.

#### D. Tools and Equipment Used

Fabrication tools employed include: hacksaw and angle grinder (cutting), arc welding machine (frame joining), bench drill (hole making), bench vice and spanner set (assembly), and measuring instruments including vernier caliper (±0.02 mm accuracy) and steel scale. Testing instruments include a tachometer for brush speed

measurement and a stopwatch for timing performance tests.

#### IV. Future Scope

The mechanized manual floor sweeper can be further improved to enhance its performance and usability. Future work may focus on:

- Improving brush design to increase cleaning efficiency for fine dust and uneven surfaces.
- Adding an adjustable brush height mechanism to suit different floor types.
- Incorporating a simple gear mechanism to optimize brush rotation and reduce user effort.
- Developing a larger or detachable dust container for easier waste disposal.
- Integrating a semi-mechanized version with a small rechargeable motor to reduce manual effort.
- Using corrosion-resistant and lightweight materials for better durability and portability.
- Standardizing components for mass production and commercialization in schools, offices, and public institutions.
- Exploring solar-powered operation for completely off-grid, sustainable cleaning.

#### V. Objectives

- Design and fabricate a manual floor sweeper to efficiently clean dust and light debris.
- Develop an ergonomic handle minimizing back strain and physical effort.
- Create a cost-effective, eco-friendly device from locally available materials.
- Optimize brush rotational motion for effective dust collection and smooth operation.
- Ensure lightweight, portable, and durable construction for long-term use.
- Integrate 12V DC motor and rechargeable battery for semi-automatic functionality.
- Compare efficiency of the sweeper with traditional cleaning methods.
- Promote innovation through simplicity and sustainable energy-free cleaning.

#### VI. Results and Discussion

The fabricated Mechanized Manual Floor Sweeper was successfully designed, developed, and tested. The model demonstrated satisfactory performance in cleaning dust,

small debris, and lightweight waste from smooth surfaces including tiles, cement floors, and classroom flooring.

**Mechanical Performance:** The sweeper effectively collected dirt through the rotating brush mechanism powered by wheel motion. Brushes rotated smoothly and directed waste into the storage compartment without slippage under normal load.

**Ergonomics & Usability:** The device reduced bending and minimized physical strain compared to traditional broom cleaning. Users of various age groups found the handle comfortable and the device easy to maneuver across large areas in less time.



Fig. 1: Mild Steel Tubes



Fig. 2: Plastic Wheels



Fig. 3: 25W DC Motor



Fig. 4: 12V Battery



Fig. 5: Button Switch



Fig. 6: Nylon Brush

**IMPROVEDMECHANIZED MANUAL FLOOR SWEEPER**

**IMPROVED MECHANIZED MANUAL FLOOR SWEEPER**



Fig. 7: Fabricated Improved Mechanized Manual Floor Sweeper

The fabricated sweeper also incorporates a rubber strip fitted along the front and rear edges of the brush housing. This strip acts as a guide that channels loose dust and debris inward toward the rotating brush, preventing material from escaping sideways during operation. It improves cleaning efficiency on smooth floors by ensuring all debris within the sweeping width is directed into the collection tray rather than scattered to the sides.

**Cost Analysis:** Total fabrication cost was approximately ₹8,050 using locally available materials, making it affordable for rural and urban users. The absence of mandatory electrical components ensures usability in areas with limited electricity supply.

Table I. Cost Estimation

Component	Cost (₹)
Mild Steel Rods & Sheets	450
Nylon Brush	600
Plastic Wheels (×2)	500
12V DC Motor	850
12V Rechargeable Battery	1,400
Switch, Wires, Connectors	250
Aluminium Sheet	350
Bearings & Shaft	700
Paint & Finishing	250
Fasteners & Misc.	350
Battery Charger	900

Total	8,050
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#### A. Quantitative Performance Testing

Performance testing was conducted over three sessions on three different floor surface types: smooth ceramic tiles, rough cement floor, and smooth linoleum. In each session, a standard test area of 3 m × 3 m (9 m<sup>2</sup>) was prepared by distributing a pre-weighed quantity of mixed debris (50 g of fine dust, 30 g of paper bits, and 20 g of light particles totaling 100 g). Three trials were performed per surface per mode (manual-only and motor-assisted), and average values were computed.

The results confirm that motor-assisted operation improves cleaning efficiency by approximately 13–15 percentage points across all surface types compared to manual-only mode. Smooth surfaces (ceramic tiles and linoleum) consistently outperformed rough cement floors due to better brush-surface contact. The sweeper covered 9 m<sup>2</sup> in under 4 minutes in manual mode and under 3.5 minutes with motor assistance, demonstrating significant time savings over traditional broom sweeping, which required approximately 6–7 minutes for the same area.

#### B. Comparative Evaluation

A direct comparison was made between the fabricated sweeper, a conventional broom, and a standard household vacuum cleaner on the same 9 m<sup>2</sup> test area. The traditional broom achieved approximately 55% debris collection efficiency and required 6.5 minutes, demanding significant bending effort from the operator. The vacuum cleaner achieved 96% efficiency but required an electrical outlet and cost approximately Rs.10,000–15,000 for a comparable domestic unit. The mechanized sweeper thus delivers a practical middle ground: 78–93% efficiency at a fabrication cost of Rs.8,050, with no dependence on mains electricity.

#### C. Structural and Durability Observations

During testing, no structural deformation, weld failure, or bearing failure was observed in the mild steel frame under normal operational loads. The nylon brush showed no visible wear after 30 minutes of continuous testing. The 12V, 7Ah battery supported approximately 45 minutes of continuous motor operation before requiring recharge, which aligns with the rated capacity and the 25W motor power draw.

### VII. Conclusion

This project successfully demonstrated the design, fabrication, and testing of a Mechanized Manual Floor Sweeper as a practical, low-cost, and eco-friendly cleaning device. The developed prototype effectively integrates a

passive wheel-driven brush mechanism with an optional 12V DC motor drive, offering the operator flexibility between fully manual and motor-assisted cleaning modes without dependence on mains electricity.

Quantitative performance testing confirmed cleaning efficiencies of 78–81% in manual mode and 91–93% in motor-assisted mode on smooth floor surfaces, with area coverage rates of up to 2.6 m<sup>2</sup>/min. These results represent a significant improvement over conventional broom sweeping (55% efficiency, 6.5 min for 9 m<sup>2</sup>) while keeping fabrication cost at Rs.8,050 – well below the Rs.10,000–15,000 entry price of domestic vacuum cleaners. The sweeper is thus positioned as a viable alternative for households, schools, and public institutions in both rural and urban settings.

The project validated that fundamental mechanical principles – motion transmission through belt drives, rotational brush kinematics, and ergonomic handle design – can be combined effectively to address a genuine daily-life problem. Material selection (mild steel frame, nylon brushes, plastic wheels) proved appropriate for the intended load conditions, with no structural or component failures observed during testing. The total weight of approximately 10–12 kg ensures portability while maintaining structural rigidity.

From a broader engineering perspective, this project reinforces the value of sustainable design by eliminating mandatory electrical infrastructure while still delivering measurable performance improvements over purely manual methods. The hands-on experience gained in CATIA V5 modeling, welding, machining, and electromechanical integration has provided the team with comprehensive exposure to the complete product development cycle. Future iterations of this design, incorporating improved brush geometry, solar charging, and mass-production-ready standardized components, have clear potential for commercialization and wider community impact.

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