International Journal of Maritime and Interdisciplinary Research
©2026 IJMIR/Volume 8(2) January-June | ISSN: 2734-3286.

Journal homepage: www.ijmir.edu.ng

DESIGN AND FABRICATION OF A MECHANICALLY OPERATED FLOOR SWEEPING MACHINE

By

Kpina B. Charles,[1] Idubor Fabian. I,[2]

Department of Mechanical Engineering, Nigeria Maritime University, Okerenkoko, Delta State, Nigeria[1]

Department of Marine Engineering, Federal University of Petroleum Resources, Effurun, Delta State, Nigeria[2]

Charles.kpina@nmu.edu.ng

ABSTRACT

This mechanically operated floor cleaning machine has been designed to operate with the use of chain drive. It can be utilised in cleaning of road, school, house, bus stand, mall, airport and other commercial places. This machine does not require any type of external source of energy for its operation. The aim of present work is to design and develop process for cleaning the floor manually. In designing this mechanically operated floor cleaning machine, the following components or parts were used; steel bar, Chain Sprockets, Sweeping Roller, spur gear, wheel, bearing, shaft. The construction consists of simple fabrication processes and It is designed by taking the following into consideration; cost reduction, minimal efforts in use, environment friendly, and easy to handle. The machine will work without electricity. Testing the sweeping machine in different conditions on different types of trash, confirms the sweeper's ability to clean adequately. This work can be very useful to improve the life style of mankind.

Keywords: Mechanically operated, Sweeping, floor cleaning machine, Design.

1. Introduction

Cleaning is a fundamental necessity in today's world, and cleaning machines play a crucial role in maintaining cleanliness in various settings such as hospitals, homes, auditoriums, bus stations, and public areas etc. (kumar, et. al., 2022). Sweeping which is part of cleaning is essential in a house,

to keep the environment clean and neat. In early days a floor is clean by using a broom which is operated by human hand, in this a continuous movement of human hand is required which create fatigue and time consuming. Traditional sweeping which are in different methods involves huge cost of labor and wastes time. Also, Sweeping is a physically demanding and labor-intensive job. Sweepers frequently use heavy powered tools (e.g., buffing machines/floor polishing machines, wet and dry vacuums) in addition to a variety of physically demanding tasks such as wiping surfaces, polishing, and heavy material handling (e.g. moving furniture, carrying and emptying rubbish,), often under time constraints (Kru¨ger, et al, 1997). Many researchers have dedicated extensive efforts to improve the design of cleaning machines to enhance their performance. However, a significant number of these researchers relied on electrical energy to power their machines. In contrast, this particular machine has been cleverly designed to function by manual power without the need for electricity or any other external energy source (kumar, et. al., 2022).

The machine, describes a system which operates partially on its own, with some degree of automation, but still requires human input or control for certain aspects of its operation. To achieve this, manual power is transferred from a chain sprocket to a spur gear attached to the sweeping roller through a chain mechanism. Subsequently, this power is further transmitted to a spur gear, resulting in the rotation of the machine's wheels, facilitating floor cleaning. What sets this machine apart from others is its ability to operate without any reliance on external energy sources, making it a cost-effective and dependable option for a wide range of users. It is suitable at cleaning dry floors, and it is portable due to its lightweight and uncomplicated design. Therefore, it can be easily transfer from one place to another. Worthy of note is its eco-friendly characteristics.

One of the key benefits of the mechanically operated floor sweeping machine is its simplicity and ease of use. It requires no electricity or special training to operate, making it ideal for use in homes, small businesses, and other low-traffic areas where a more complex machine may not be necessary. Another advantage of a floor sweeping machine is its flexibility. It can be used on a variety of flooring types, including tile, hardwood, concrete, and carpet, and can be adjusted to accommodate different levels of debris and dirt. In summary, the machine is a reliable and cost-effective solution for maintaining cleanliness in small to medium-sized spaces. Its simplicity, flexibility, and ease of use make it an ideal choice for a wide range of applications.

Therefore, this work deals with design and fabrication of a mechanically operated sweeping machine which is carried out to overcome the traditional method of sweeping that is

physiologically stressful. This machine reduces the time it takes to sweep, thereby reducing the human effort to make the environment clean.

The objectives of the study are to:

- design a mechanically operated floor sweeping machine
- select appropriate materials needed for the construction.
- make the machine economical.
- reduce human effort, cost and time

1. Literature Review

Various researchers have worked on floor cleaning machines and related work in the past. Consequently, a review of various work done by different scholars on the floor cleaning machine has been studied and a summary of their contribution is presented. Abdulrahman et al, (2024) presented the design and construction of an innovative mechanical sweeper from locally sourced materials to handle street and walkway cleaning challenges. By utilizing simple technique and employing locally available materials, the sweeper collects debris and eliminates negative effects of gasoline powered sweeper on the environment. Sturdy features include a mop function for thorough particle removal, an adjustable lever mechanism for agility, and a flexible brush configuration for cleaning various variety of surfaces. Their result shown that the designed sweeper with a single 24v battery and 0.5 hp electric motor gave a cleaning efficiency above 58%. In the work of Arjun et al. (2017), they work on floor cleaning machine. Their aim is to develop and modernized process for cleaning the floor with wet and dry. At first dust was collected from vacuum cleaner. After that Water was sprayed from water tank and floor cleaning was done by rotating press which is coupled to the DC motor. Fan was used to dry the water which was fitted to the Back side of the vehicle. Rameshkumar et al. (2018) designed and fabricated a multipurpose floor cleaning machine. In their work, modelling and analysis of the floor cleaning machine was done using suitable commercially available software. From the finite element analysis, they observe that the stress level in the manually operated floor cleaning machine is within the safe limit.

In the research of Gaikwad et al. (2019), they work on the design and development of multifunctional floor scrubber and cleaner. It was intended to substantially reduce the cleaning time and cost of the machine. At the same time, the floor cleaning machine should be capable of cleaning rough as well as smooth floors and inaccessible corners effectively. Aesthetic and

ergonomic considerations were taken into account in their design. Khade (2017), worked on multi-use floor cleaning machine. He developed machine which is capable of performing cleaning of floor and corners effectively, semiautomatic water spray, cleaning of byre, dry as well as wet cleaning tasks. This floor cleaning machine is designed by keeping the basic considerations for machine and operational cost reduction, efforts reduction, environment friendly and easy handling.

Abarna et al (2018) worked on Design and fabrication of automatic floor cleaning machine. Their system enables cleaning of the floor by the help of highly stabilized and rapidly functionalized electronic and mechanical control system. Current project work targets to use automatic floor cleaner for large floor in household purposes and office floors. The cleaning purpose is specifically carried out by continuous relative motion between a scrubber and the floor surface.

Antapurkar (2018), works on Arduino based dry and wet automatic floor cleaner. He aimed at constructing a floor cleaner which will be fully automatic providing dry and wet cleaning as well as UV sterilization. The cleaner will be a step for providing comfortable life by resolving problems in traditional floor cleaning methods. Himani and Mahima (2019), worked on wireless multipurpose floor cleaning machine. They focused on the problems of long wires, to overcome this problem they used battery system which can be rechargeable when electricity is available and work as required. Meshram and Mehta (2016) developed a tricycle-operated street cleaning machine aimed at improving efficiency and reducing human effort.

Yadav et al., (2022) Designed and Fabricated an automatic Sweeping Machine. Their floor cleaning machine was designed by keeping the basic considerations for reduction in cost and efforts while being environmentally friendly and easy to handle. Their machine worked on electricity. Nighot et al, (2019) presented the design and development of mechanically operated sweeping machine that can be an alternative for small space cleaning.

From the review of literature, it is found that most of the existing street cleaning machines uses petrol and diesel. It can cause pollution and also the vibration produced in the machine causes noise pollution. Therefore, the design and fabrication of a mechanically operated sweeping machine seems an alternative concept for avoiding these problems.

3. Materials and Methods

The procedures used in this study are as follows: Design conceptualization, material selection, cost assessment, calculation of component parts, fabrication and testing. The design considerations for the mechanical sweeper include simplicity of manufacturing, operator's safety, material availability, cost of construction, quality of working life, and functional needs

3.1 Material Selection

The selection of material has been carefully chosen based on some specific criteria such as weight, surface finish, stiffness, chemical resistance, service life and dependability, local material availability, mechanical strength, durability, availability and cost. The sweeper frame was constructed mainly with steel, most especially mild steel with inherent advantage of being easy to weld and containing low carbon content (Meng et al., 2021). The machine is made up of the following components: steel bar, Chain Sprockets, Sweeping Roller, spur gear, wheel, bearing, shaft. The machine components are subdivided into four parts as given below.

Roller

The main bristle mechanism is the central component responsible for the primary sweeping function. It consists of sturdy bristles designed to efficiently collect debris and dust. In our project a bristle is connected to a roller (brush) which is operated with the help of a chain sprocket. The rolling force help the dust particles to move to the collector. The force is generated from the tyre, through the contact the tyre has with the ground, and transfer it to the gear shaft, and the gear shaft connect it to the pinion which then propel the brush and make it to sweep. The roller is shown in Figure 1



Figure 1: Sweeping Roller

Collection Bin

The collection bin is an integral part of the sweeping machine, responsible for temporarily storing collected debris until it can be properly disposed of.



Figure 2: Collection Bin

Frame

The chassis and frame provide the structural support for the sweeping machine. They house the various components and ensure the machine's stability and manoeuvrability. Frame is a basic structure of sweeping machine and made up of mild steel with the help of arc welding. The dimension of frame is 680 × 530mm. The Frame help in supporting the chain sprocket and it also help in absorption of shock and vibration. The sweeping roller is also attached with the frame

which help in providing the strength to the machine. The frame also helps to hold the wheel. The frame is shown in Figure 3.



Figure 3: frame

Chain Sprocket

This machine uses chain mechanism to drive the sweeping machine. A chain is a series of links connected by pin joints. The total length of the chain used is 640mm with 82 links. A chain mechanism is a way of transmitting mechanical power from one shaft to another shaft. The sprocket used in the chain mechanism is shown in Figure 4, it is used to give power to the sweeping roller. The emphasis is conveyed by a roller chain, known as the drive chain or transmission chain (Micheal, 2013).



Figure 4: Chain Sprocket

Table 1: Components and their specification

Components	Engineering standards/Materials	Specifications/Dimension
Chain Sprockets	Mild Steel	Diameter = 640mm, Thickness = 15mm
Sweeping Roller	Wood	Length = 400mm
Bristle	Polypropylene or nylon	length = 50mm
Wheel	Plastic	Rear tryre = 180mm, front tyre = 140mm
Frame	Mild steel	The dimension of frame is 680 × 530 mm
Large Spur gear	Cast iron	No of teeth= 30
Small spur gear	Cast iron	No of teeth = 15

3.2 Fabrication procedure

Cutting Metal

cutting is a manufacturing process in which a larger piece of material is separated into smaller pieces or parts. There are numerous metal cutting method available, each of which offers distinct benefits and limitations that make it suitable for different manufacturing projects.

Arc welding

Arc welding is a type of welding process using an electric arc to create heat to melt and join metals. A power supply creates an electric arc between a consumable or non-consumable electrode and the base material using either direct (DC) or alternating (AC) currents. The arc can be either manually or mechanically guided along the line of the join, while the electrode either simply carries the current or conducts the current and melts into the weld pool at the same time to supply filler metal to the join.

Grinding

Grinding is an abrasive machining process that uses a grinding wheel or grinder as the cutting tool. Grinding is a subset of cutting, as grinding is a true metal-cutting process. Grinding is very common in mineral processing plants and the cement industry.

3.3 Design Calculations

1. Determination of the velocity ratio of the chain drive

V = Velocity of humans = 1.4m/s

N_1 = rpm of large Sprocket

N_2 = rpm of small sprocket

T_1 = no. of teeth in large sprocket = 30

T_2 = no. of teeth in small sprocket = 15

$$V = \frac{\pi DN}{60} 1.4 = \frac{\pi \times 0.174 \times N_1}{60}$$

$$N_1 = 154\ rpm$$

But,

VR (Velocity Ratio of Chain Drives) = $\frac{N_1}{N_2} = \frac{T_2}{T_1} = \frac{15}{30}$

$$\frac{T_2}{T_1} = \frac{15}{30} = 0.5$$

$$\therefore\ N_2 = \frac{N_1 T_1}{T_2} = 308 \text{ rpm}$$

Therefore, N_2 is the speed of the brush which clean the surface.

V.R = $\frac{N_2}{N_1} = \frac{308}{154}$ = 2 say 2 (from standard smaller sprocket table)

2. Selecting the minimum number of teeth on the smaller sprocket or pinion

Taking T_1 = 15

$$\therefore \quad T_1 = 15$$

3. Solving for the number of teeth on the larger sprocket.

Number of teeth on the larger sprocket or gear,

$$T_2 = T_1 \times \frac{N1}{N2} = 15 \times \frac{308}{154} = 30$$

4. Solving for the design power by using the service factor

   We know that the design power

   = Rated power × Service factor (KS)

   The service factor (KS) is the product of various factors K_1, K_2 and K_3. The values of these factors are taken as follows:

   Load factor (K_1) for constant load

   = 1

   Lubrication factor (K_2) for drop lubrication

   = 1.5

   Rating factor (K_3) for 8 hours per day

   = 1.5

   ∴ Service factor,

   $KS = K_1.K_2.K_3 = 1.5 \times 1.5 \times 1 = 2.25$

Also, Design power = 2.6 × 2.25 = 5.85

4.0 Results and discussion

The system is assembled with a pair of existing wheels that rotates with the help of a shaft. The shaft and wheels are joined together with the help of nut and washer. The wheels provide power to the spur gear through the chain mechanism, and the spur gears are connected perpendicularly. The help of chain gear rotates the brush. The revolutions start to move when we exert forces on this machine manually. As the wheel starts spinning, it becomes straightforward to move it forward or backward, and as the lower end of the machine is installed with a brush, the brush starts operating, cleaning the surface where it is interacting. The assembled mechanically operated sweeping machine is presented in Figure 5.



Figure 5: Assembled mechanically operated sweeping machine

In order to avoid slipping as in belt drives; steel chains are used. The chains are made up of number of rigid links which are hinged together by pin joints in order to provide the necessary flexibility for wrapping round the driving and driven wheels (sprockets). The sprockets and the chain are thus constrained to move together without slipping and ensures perfect velocity ratio.

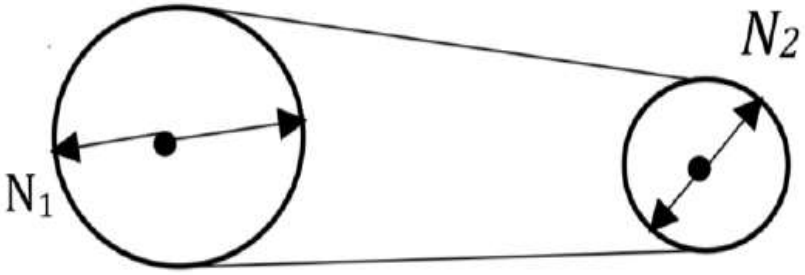


Figure 6: Sprocket chain mechanism

5. Conclusion

In this study, we have designed and constructed a mechanically operated floor sweeping machine with the help of Chain drive. This machine is designed to enable easy operation and to reduce human effort when sweeping. One of the key benefits of the mechanically operated floor sweeping machine is its simplicity and ease of use. It requires no electricity or special training to operate, making it ideal for use in homes, small businesses, and other low-traffic areas where a more complex machine may not be necessary. Another advantage of this floor sweeping machine is its flexibility. It can be used on a variety of flooring types, including tile, hardwood, concrete, and carpet, and can be adjusted to accommodate different levels of debris and dirt. In summary, the machine is a reliable and cost-effective solution for maintaining cleanliness in small to medium-

sized spaces. Its simplicity, flexibility, and ease of use make it an ideal choice for a wide range of applications

Acknowledgments

The authors wish to acknowledge the manager and technologists of the mechanical engineering workshop at the Federal University of Petroleum Resources Effurun, for their assistance in the construction work of this machine.

REFERENCES

Abarna, R., Devadharshini, S. Dhileep, (2018). Design and Fabrication of Automatic Floor Cleaning Machine, International Journal of Science and Engineering Research, (p)-2230-235, 3221 5687, (P) 3221 568X, Volume 6 Issue 4 April -2018.

Abdulrahman, K. O., Oghenetega, S. P., Ogunwoye, F. O., Shopeyin, O. J., Sayodun, A. O., and Yahaya, S. A. (2024). Design and Fabrication of a Mechanical Sweeper, Nigerian Journal of Technological Development, Vol. 21, (4), *doi:* http://dx.doi.org/10.4314/njtd.v21i4.2781

Antapurkar, S., Vyas, A., Chourasia, S., & Prasad, R. (2018). Arduino based dry & wet automatic floor cleaner. *International Journal of Engineering Technologies and Management Research*, 5(2), 14–18. https://doi.org/10.29121/ijetmr.v5.i2.2018.607

Arjun, V. M., Amal, R., AnandhuJayaram (2017). Floor Cleaning Machine, International Journal of Advanced Engineering and Global Technology, ISSN No: 2309-4893, Volume 5, Issue-03

Gaikwad, S. G., Kulkarni, S. S., Patil, V. P., and Nagargoje, A. S. (2019). Design and development of multi-functional floor scrubber and cleaner. *International Journal of Scientific & Technology Research*, 8(12), 3638–3644

Himani, P. and Mahima, P. (2019). Wireless Multi -Purpose Floor Cleaning Machine, International Journal of Latest Technology in Engineering, Management & Applied Science, ISSN 2278-2540, Volume 8, Issue 4,16-19.

Khade, S. (2017). Multi-use floor cleaning machine. International Journal of Mechanical Engineering and Technology (IJMET), 8(5), 656–664

Kumar, R., Quadri, M. A., Prasad, G., Upadhyay, G., Kumar, A., Singh, R., and Kumar, G. (2022). Design of mechanically operated floor cleaning machine. International Journal of Research in Engineering and Innovation Vol-6, Issue-3 (2022), 199-203

Kru¨ger, D., Louhevaara, V., Nielsen, J., Schneider, T., (1997). Risk Assessment and Preventative Strategies in Cleaning Work. Wirtschaftsverlag NW, Bremerhaven.

Meng, X., Huang, Y., Cao, J., Shen, J., & Santos, J. F. dos. (2021). Recent progress on control strategies for inherent issues in friction stir welding. *Progress in Materials Science*, *115*.

Meshram, S. J., & Mehta, G. D. (2016). Design and development of tricycle operated street cleaning machine. International Journal for Scientific Research & Development (IJSRD), *4(2), 1356–1359.*

Michael R. L (2013). Mechanical Engineering Manual for sprocket and pinion, Page 6-60.

Nighot, A., Jadhav, Y., Jagadale, P., Jadhav, I., Bharate, A. (2019). Design & Developmemt of low Cost Manually Operated Sweeping Machine, International Research Journal of Engineering and Technology (IRJET), Volume: 06 Issue: 06

Rameshkumar, S., Selvakumar, M., Senthilkumar, S., Surya, P., and Thilagavathi, I. (2018). Design Fabrication of Multipurpose Floor Cleaning Machine, International Journal of Advanced Science and Engineering Research.

Yadav, A. K., Singh, O. N., Rai, A., Singh, R. K., Singh, K., Maurya, C. G. (2022). Design and Fabrication of Automatic Sweeping Machine, International Journal of Scientific Development and Research (IJSDR), volume 7 issue 5, www.ijsdr.org