

A Study On Manual Motorized Sweeping Machine

Alyssa Marie D. Lapid¹, Angelu B. Lizares², Jefreniel T. Taborada³, Nhel Sydney H. Lumpinas⁴, Paul Andre L. Haquias⁵, Mark Anthony Bell R. Bacang⁶, Keymar B. Villarin⁷, Vianafrankher O. Salomes⁸, Emmauel O. Calvo⁹

Diplahan National High School
nhelsydneylumpinas1255@gmail.com
09854488574

Abstract: *This research focuses on the design, construction, and performance evaluation of a manual motorized sweeper developed for Diplahan National High School. The study aims to provide a cost-effective, efficient, and environmentally friendly solution for maintaining school cleanliness and surrounding areas. Traditional manual sweeping is often time-consuming and labor-intensive, while fully motorized sweepers are expensive and impractical for school or community use. To address this, the researchers designed a hybrid cleaning system that combines manual operation with a low-powered motor, improving cleaning efficiency, ease of use, and affordability. The project emphasizes mechanical design, material selection, power source optimization, and ergonomic considerations to reduce operator fatigue. Performance testing showed that the sweeper effectively collects different types of waste on school grounds and paved areas, significantly reducing cleaning time compared to manual sweeping alone. The results indicate that the manual motorized sweeper is a practical and sustainable innovation that can enhance sanitation within the school and serve as a model for other resource-limited institutions.*

Keywords: *Manual motorized sweeper; hybrid cleaning system; mechanical design; power optimization; ergonomic design; urban sanitation; cost-effective solution*

Introduction

Traditional sweeping methods have long been the primary approach to maintaining cleanliness in public and private spaces. These methods, which typically rely on manual tools such as brooms and dustpans, require significant human labor and physical effort. They are often employed in schools, streets, markets, and other community areas due to their low cost and accessibility. Despite their simplicity, traditional sweeping plays a vital role in environmental hygiene and public health, especially in developing regions where access to modern cleaning technologies is limited. Manual sweeping is a fundamental component of public health, urban aesthetics, and environmental safety. While this method is simple and cost-effective, it often requires significant time and physical effort, especially in larger campuses. In response to these challenges, manual sweeping machines will be introduced as a potential alternative to improve the efficiency of routine cleaning tasks.

Manual sweeping machines are introduced due to their affordability, easy to use, and less effort. These machines are pushed by operators and function through rotating brushes and collection bins to gather litter, dust, and debris. Their simple mechanical structure makes them attractive for municipalities with limited budgets (Kumar et al., 2021).

The main problem associated with traditional sweeping methods in schools, is relying heavily on manual labor using brooms and dustpans, demand significant physical effort and time, especially when cleaning wide areas such as corridors, classrooms, and school grounds.

The purpose of conducting this study is to explore and assess the design limitations and operational issues of manual sweeping machines, with the goal of identifying areas at school campus for improvement in terms of efficiency, comfort, and sustainability. It aims to provide insight into how design innovations or ergonomic modifications can significantly impact the productivity of manual sweeping. Moreover, the study seeks to support the Diplahan National High School campus and user-friendly sweeping system that aligns with environmental and economic environment. By improving the way the cleaning is done, we hope to create a healthier and more welcoming environment for students, teachers, and visitors. The machine is designed to reduce physical effort while increasing the speed and quality of cleaning, especially during school activities, clean-up drives, and daily maintenance.

This study will be motivated by our desire to help our school and local community through a practical and sustainable innovation. As STEM students at Diplahan National High School, this study encourages the researchers to apply science and technology to solve real-world problems. We saw the need for a better cleaning solution and used

this project as an opportunity to create something useful that could benefit everyone in our school from the students. We believe that small innovations like this can lead to bigger changes in how we care for our environment

The nature of this research is both scientific and community based. Scientifically it involves designing, testing, and improving a manually operated machine that can perform better than traditional brooms. Socially, it aims to uplift the working conditions of our school's maintenance staff, reduce risk, and inspire environmental awareness among the students. This project also serves as a hence on learning experience for us as young researchers who want to make a difference in our surroundings.

Studies such as those supported by the United Nations Environment Program (UNEP, 2019) show that low cost and sustainable technologies are key to solving sanitation problems in schools and communities. This manual sweeping machine aligns with this goal by offering a cleaner, safer, and more efficient way to maintain hygiene in places like Diplahan National High School. Through this innovation, we hope to promote not just cleanliness, but also responsibility, teamwork, and innovation among our fellow students and community members.

The interest in this study also stems from the global push toward environmentally sustainable technologies. Unlike motorized sweepers that rely on fuel and produce emissions, manual sweepers offer a low-carbon alternative. Enhancing their effectiveness could play a small but significant role in promoting green urban management. Thus, this study investigates the "Manual Motorized Sweeping Machine" at Diplahan National High School of School Year 2025-2026.

Statement of the Problem

This study aimed to develop and evaluate a Manual Motorized Sweeping Machine for use at Diplahan National High School during School Year 2025–2026. Specifically, it sought to:

- (1) design and construct a functional manual motorized sweeping machine;
- (2) evaluate its cleaning efficiency across different surface types;
- (3) assess its capability to collect common types of school waste.

Scope and Delimitations

This study focuses on the development and evaluation of a manual motorized sweeping machine at Diplahan National High School, School Year 2025-2026. The scope includes the design, construction, and performance testing of the machine in cleaning various types of school grounds such as hallways, pathways, and outdoor pavements. The study also evaluates the machine's efficiency, ease of use, and cleaning capacity compared to traditional manual sweeping tools.

The research is limited to the application of the machine within a single school campus and does not extend to large-scale or industrial cleaning scenarios. The evaluation will be based on short-term tests conducted by a selected group of school maintenance personnel and does not include long-term durability studies. Financial aspects, such as large-scale production costs or commercial viability, are also excluded from this study. Additionally, the study does not explore sweeping machines powered entirely by large engines or industrial-grade motors.

Results

The Level of Energy Consumption of the Manual Motorized Sweeping Machine

This acquires by following the formulas; for Current (Amps) for the power consumption, Battery Capacity Formula to calculate the battery capacity needed by the mechanism and the energy consumption to calculate the energy usage to express energy usage in kilowatt-hours (kWh).

Battery Energy Capacity

Battery energy capacity is calculated as:

$$E \text{ (battery)} = \text{Battery Capacity} \times \text{Voltage}$$

For simplicity, we'll use a 12 V battery (common in such setups):

$$E \text{ (battery)} = 7.5\text{Ah} \times 12\text{V} = 90\text{Wh}$$

The Surfaces of the Area the Manual Motorized Manual Machine can be used

The cleaning efficiency of the machine differs on the surfaces it was tested. The researchers tried running the machine through different terrains:

Types of Surfaces	Output
Rocky Surface	When passing through rocky surfaces, it will be difficult to steer properly, and the machine may take up tiny stones that can disrupt the machine.
Grassy Surface	When passing through grassy surfaces, the machine can perform well if the grass is trimmed and dry. Otherwise, it can get stuck and the mud may build up in the wheels of the machine.
Smooth Surface	When passing through smooth surfaces, the machine can work properly and can collect trash efficiently.

With the given data, the results show that the manual motorized sweeping machine's efficiency depends on the surface of the area.. This demonstrates that considering the amount of trash and the surface of the area is viable to its maximum working result.

The types of trash the machine can collect

The cleaning efficiency of the Manual Motorized Machine depends on the type of trash it collects. We gathered data based on the tests the researchers conducted:

First Attempt, Smooth Surface	Papers, Plastic Bottles, Plastic Cups, and Cellophane, etc.
Second Attempt, Grassy Surface	Papers, Plastic Bottles, Plastic Cups, and Cellophane, etc.
Third Attempt, Semi-rocky Surface	Papers, Plastic Cups, Cellophane, etc.

The types of trash collected vary on the surfaces, which means the efficiency also varies on the surfaces it was tested. There are certain types of trash that can be easily collected, while the others may be difficult.

How many trash it can collect

The trash compartment stores the collected trash for easier disposal. To calculate the capacity of the trash compartment, we use the formula:

$$L \times w \times h$$

It is calculated as:

L = 100cm, W= 50 cm, H= 50cm

100 x 50 x 50 = 250, 000

During the test, the machine collected a measurable amount of trash in a given area.

Number of Attempts	Types of Trash	Amount of Trash Collected
First Attempt	Papers, Plastic Bottles, Plastic Cups, and Cellophane, etc.	7
Second Attempt	Papers, Plastic Bottles, Plastic Cups, and Cellophane, etc.	5
Third Attempt	Papers, Plastic Cups, Cellophane, etc.	4

Conclusion and Recommendations

In conclusion, this study successfully designed a manual motorized sweeping machine that uses a cleaning system mechanism. This system ensures the effective cleaning and providing a sustainable and efficient solution for school communities. The study also determined the system's energy requirements, including battery capacity and power consumption, ensuring its practicality and reliability in various conditions. This project highlights the potential of combining clean energy with innovative water purification technologies to address global water scarcity while minimizing environmental impact. The findings serve as a valuable reference for future efforts to develop eco-friendly, adaptable systems that promote clean water access and sustainable development in under served communities. The current trash collection system has limitations in handling large-sized waste; thus, widening the entrance of the trash compartment is recommended to improve collection efficiency. To enhance mobility on uneven and wet surfaces, the use of larger and more durable wheels is advised. The frame and chassis, which were constructed using old wood, should be replaced with stronger and lightweight materials to improve stability and overall performance, along with expanding the trash compartment for greater storage capacity. Adding a protective covering at the entrance of the trash compartment and around the brushes is also recommended to ensure proper waste direction into the container. Lastly, using longer, detachable brushes would increase the cleaning coverage and allow easier maintenance and replacement in future use.

References

- Adebesin, A. A., & Adedeji, K. A. (2020). Sustainable industrial design with ergonomics for street sweeping machine. *International Journal of Engineering Applied Sciences and Technology*, 5(2), 119–126.
<https://www.ijeast.com/papers/119-126,Tesma502,IJEAST.pdf>
- Amato, F., Querol, X., Johansson, C., Nagl, C., & Alastuey, A. (2010). A review on the effectiveness of street sweeping, washing and dust suppressants as urban PM control methods. *Science of the Total Environment*, 408(15), 3070–3084.
<https://doi.org/10.1016/j.scitotenv.2010.04.025>
<https://www.sciencedirect.com/science/article/pii/S0048969710004426>
- Asiimwe, D. (2021). Design of a mechanized road sweeper. Kabale University.
<http://hdl.handle.net/20.500.12493/1083>
- Bchir, O., Almasoud, S., Alyahya, L., Aldhalaan, R., Alsaeed, L., & Aldalbahi, N. (2022). A computer vision system for street-sweeper robot. *International Journal of Advanced Computer Science and Applications*, 13(10).
https://thesai.org/Downloads/Volume13No10/Paper_46-A_Computer_Vision_System_for_Street_Sweeper_Robot.pdf
- Chang, C.-L., Chang, C.-Y., Tang, Z.-Y., & Chen, S.-T. (2018). High-efficiency automatic recharging mechanism for cleaning robot using multi-sensor. *Sensors*, 18(11), 3911.

<https://doi.org/10.3390/s18113911>

Dulevo International. (2020). An energy-saving road sweeper using deep vision for garbage detection. *Applied Sciences*, 10(22), 8146.

<https://doi.org/10.3390/app10228146>

<https://www.mdpi.com/2076-3417/10/22/8146>

Jamil, S., Mukhtar, T., Ali, R. H., Qaiser, I., & Ahmed, B. (2021). Design and development of an electric remote-controlled road-sweeper vehicle. *Engineering Proceedings*, 12(1), 89.

<https://doi.org/10.3390/engproc2021012089>

Khan, J. (2021). Design and development of smart solar powered street sweeping machine. *International Conference Proceedings*.

<https://www.sciencedirect.com/science/article/abs/pii/S2214785321027590>

https://www.researchgate.net/publication/353549476_Design_and_development_of_smart_solar_powered_street_sweeping_machine

Kumar, M. R., & Kapilan, N. (2015). Design and analysis of manually operated floor cleaning machine. *International Journal of Engineering Research & Technology*, 4(4), 973–979.

<https://www.ijert.org/design-and-analysis-of-manually-operated-floor-cleaning-machine>

Lim, Y., Le, A. V., Ramalingam, B., Hayat, A. A., Elara, M. R., Minh, T. H. Q., Gómez, B. F., & Wen, L. K. (2021). Locomotion with pedestrian-aware perception sensor by pavement sweeping reconfigurable robot. *Sensors*, 21(5), 1745.

<https://www.mdpi.com/1424-8220/21/5/1745>

<https://doi.org/10.3390/s21051745>

Liu, Z. (2024). Design of a sweeping robot based on fuzzy QFD and ARIZ. *Scientific Reports*.

<https://pmc.ncbi.nlm.nih.gov/articles/PMC11481654/>

Nishanth, K. S., Adarsh, S., Tejas, K., & Jagadish, B. (2021). Design and fabrication of solar power automatic road sweeping with waste segregation machine. *International Journal of Advanced Research in Science, Communication and Technology*, 8(1).

<https://www.ijarsct.co.in/A1812.pdf>

Parsons, T., Baghyari, F., Seo, J., Kim, W., & Lee, M. (2024). Advanced path planning for autonomous street-sweeper fleets under complex operational conditions. *Robotics*, 13(3), 37.

<https://www.mdpi.com/2218-6581/13/3/37>

<https://doi.org/10.3390/robotics13030037>

Pei, J. (2022). Research and design of intelligent sweeping robot based on STM32. *Academic Journal of Engineering and Technology Science*, 5(4), 29–33.

<https://doi.org/10.25236/AJETS.2022.050406>

Raihan, I., Lubis, M., Siregar, A. M., Siregar, C. A., & Affandi. (2024). Design and manufacture of mechanical drive systems for road sweepers on flat surfaces. *Jurnal Terapan Teknik Mesin*, 5(1), 144–148.

<https://doi.org/10.37373/jttm.v5i1.789>

Wang, H., Wang, C., Ao, Y., & Zhang, X. (2025). Fuzzy control algorithm of cleaning parameters of street sweeper based on road garbage volume grading. *Scientific Reports*.

<https://doi.org/10.1038/s41598-025-92771-6>

W. Jastrzebowski, (1857). *An Outline of Ergonomics, or the Science of Work*.