AMOGHVARTA

ISSN : 2583-3189

Sustainable Urban Wet Waste Management Through Automated Organic Composters

ORIGINAL ARTICLE

Author
Ar. Neeta Mishra
Associate Professor
Amity School of Architecture and Planning
Amity University
Chhattisgarh, INDIA

Abstract

The swift expansion of urban populations has markedly elevated the production of wet organic waste from residences, eateries, markets, and institutions. Inadequate disposal of biodegradable waste leads to environmental contamination, unpleasant odours, greenhouse gas emissions, and public health risks. Organic waste composters offer an efficient and ecological method for transforming biodegradable garbage into nutrient-dense organic fertiliser via regulated aerobic decomposition. This study introduces an intelligent organic waste management system that use automated composting technology, incorporating sensors, microcontrollers, and environmental monitoring devices. The suggested system effectively regulates moisture, temperature, aeration, and mixing processes to expedite compost production while reducing smell and maintenance needs. The study examines the operational technique, components, advantages, problems, and environmental effects of organic waste composters. The study finds that automated composting systems can significantly diminish reliance on landfills and promote sustainable agriculture practices via environmentally friendly waste recycling.

Key Words

Wet Waste Management, Organic Waste Composters, Composting System, Smart Waste Management, Biodegradable Waste, Organic Fertilizer.

Introduction

Trash management has emerged as a paramount environmental issue globally, attributed to accelerated urbanisation, industrialisation, and population expansion, which have markedly augmented the production of municipal solid trash (Vlaskin et al., 2026; Choudhury et al., 2026). A significant proportion of this garbage comprises biodegradable organic materials, including food remnants, vegetable skins, agricultural byproducts, and garden refuse. Research suggests that approximately 50–60% of domestic garbage produced in poor nations is organic (Rao et al., 2019; Abdul, 2026). Conventional waste disposal techniques, including open dumping and landfilling, result in significant environmental issues such as soil contamination, groundwater pollution, methane emissions, and noxious odours (Colón et al., 2010). The decomposition of wet trash in landfills generates detrimental greenhouse gases that exacerbate climate change and environmental deterioration (Lv and Zhang, 2026). Consequently, the efficient management of organic waste is crucial for environmental sustainability and the safeguarding of public health. Organic waste composting is an environmentally sustainable biological process wherein microorganisms transform biodegradable garbage into stable humus-like substance referred to as compost (Islam et al., 2017). Compost raises soil fertility, augments water retention capacity, and boosts agricultural productivity (Himanshu et al., 2026). Intelligent organic waste composters utilise sensors, controls, IoT-based monitoring systems, and mechanical mixing devices to automate the composting process, hence facilitating accelerated and more efficient decomposition (Morabe et al., 2026; Reddy et al., 2026). Recent innovations in smart waste management technology have implemented automated aeration systems, machine learning-driven compost monitoring, and intelligent airflow optimisation methods to enhance compost quality and operating efficiency (Zou et al., 2026; Saputra and Rahim, 2026). Furthermore, economical smart composting reactors and sophisticated biotechnological methods are extensively investigated for decentralised organic waste management and sustainable circular economy initiatives (Patel et al., 2026; Moharana et al., 2026). This study examines the design, operational analysis, and environmental importance of smart organic waste composters for sustainable treatment of wet waste.

Review of the Literature

Inadequate disposal of biodegradable waste leads to environmental contamination, unpleasant odours, greenhouse gas emissions, and public health risks. Organic waste composters offer an efficient and ecological method for transforming biodegradable garbage into nutrient-dense organic fertiliser via regulated aerobic decomposition. This study introduces an intelligent organic waste management system that use automated composting technology, incorporating sensors, microcontrollers, and environmental monitoring devices. The suggested system effectively regulates moisture, temperature, aeration, and mixing processes to expedite compost production while reducing smell and maintenance needs. The study examines the operational technique, components, advantages, problems, and environmental effects of organic waste composters. The study finds that automated composting systems can significantly decrease reliance on landfills and promote sustainable agriculture practices via environmentally friendly waste recycling.The management of organic waste has emerged as a significant research domain owing to escalating urbanisation, swift population increase, and the environmental repercussions of inadequate garbage disposal. Wet trash produced by households, food companies, marketplaces, and institutions considerably adds to municipal solid garbage. Global researchers have investigated composting technology, intelligent monitoring systems, and sustainable waste management strategies to tackle these difficulties. Rao et al. (2019) created an automated composting system for wet trash, incorporating sensors and microcontrollers to enhance the decomposition of biodegradable materials. Their research highlighted aerobic composting techniques employing moisture monitors, DHT11 sensors, and automated mixing systems to expedite compost development and mitigate unpleasant odours. The research emphasised that automation enhances composting efficiency and reduces manual involvement. Karnchanawong and Suriyanon (2011) examined household composting systems utilising passive aeration methods. Their findings indicated that effective airflow management markedly enhances microbial activity and expedites decomposition. The study demonstrated that composting alleviates landfill pressure and promotes sustainable agriculture via nutrient recycling.

Colón et al. (2010) performed an environmental evaluation of decentralised residential composting systems. The research determined that composting significantly decreases greenhouse gas emissions and transportation expenses related to municipal garbage collection. Their research emphasised the ecological advantages of treating organic waste at the source. Islam et al. (2017) conducted a comparative analysis of vermicomposting and conventional aerobic composting methods utilising urban organic solid waste. The researchers noted greater nutrient quality and increased plant development following the application of compost produced via aerobic composting to agricultural soil. Recent innovations in smart composting technologies have incorporated the Internet of Things (IoT), artificial intelligence, machine learning, and sensor-based monitoring systems. Morabe et al. (2026) introduced an IoT-enabled Smart Organic Waste Composter utilising ESP32 microcontrollers and real-time monitoring sensors. Their research shown enhanced automation and remote surveillance functionalities for organic waste management. Lv and Zhang (2026) reviewed composting challenges at different operational scales and highlighted the role of intelligent monitoring systems, microbial inoculants, and automated aeration techniques in improving compost quality and decomposition efficiency. Zou et al. (2026) utilised machine learning-enhanced hyperspectral imaging for the in-situ assessment of compost maturity. Their research shown that artificial intelligence-driven analysis can enhance compost quality evaluation and optimise decomposition processes. Patel et al. (2026) created an economical open-hardware aerated fermentation reactor for the indoor processing of organic waste. Their research exhibited effective moisture management, temperature regulation, and continuous compost generation utilising low-energy technologies. Reddy et al. (2026) proposed an IoT-enabled smart bin system with automated segregation and composting integration. Their work emphasized the importance of intelligent waste classification and automated processing for sustainable smart city waste management. Overall, the literature indicates that smart composting systems integrated with sensors, automation, and IoT technologies can significantly improve wet waste management efficiency, reduce environmental pollution, and support circular economy practices. Researchers continue to focus on reducing composting time, improving nutrient recovery, and enhancing automation for sustainable waste management applications.

Table 1: Recent Literature Review on Wet Waste Management and Organic Waste Composters

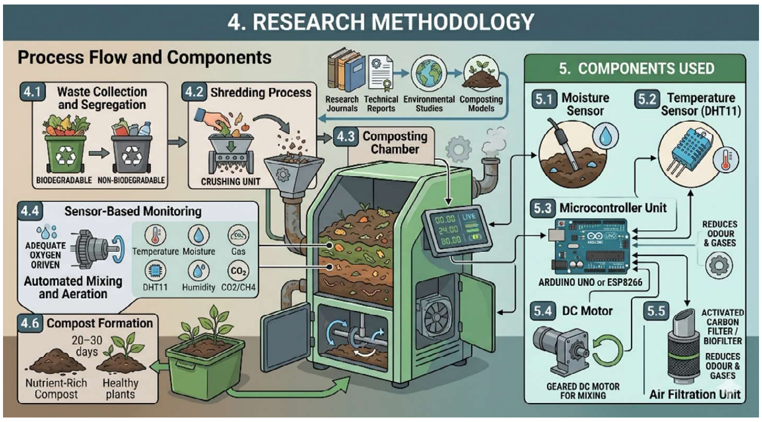
S. No.	Author(s)	Year	Title	Major Contribution
1	Rao et al.	2019	Automated Wet Waste Composting System for Wet Waste Material	Developed automated composting system using sensors and microcontrollers
2	Karnchanawong and Suriyanon	2011	Household Organic Waste Composting Using Passive Aeration	Improved composting efficiency through passive aeration
3	Colón et al.	2010	Environmental Assessment of Home Composting	Reduced greenhouse gas emissions and landfill dependency
4	Islam et al.	2017	Comparison Between Vermicompost and Aerobic Compost	Improved soil fertility and plant growth
5	Morabe et al.	2026	Smart Organic Waste Composter (Automatic Biodegrader)	IoT-based automated composting with real-time monitoring
6	Lv and Zhang	2026	Existing Challenges and Opportunities in Composting	Discussed smart monitoring and automated aeration systems
7	Zou et al.	2026	Machine Learning Assisted Hyperspectral Imaging for Compost Maturity	AI-based compost quality monitoring
8	Patel et al.	2026	Low-Cost Aerated Fermentation Reactor for Indoor Waste Processing	Developed low-cost smart composting reactor
9	Reddy et al.	2026	IoT-Enabled Smart Bin with Automated Waste Segregation	Integrated smart bins with automated composting units
10	Abdul	2026	Environmental Impact of Food Waste	Analysed global food waste and mitigation strategies

11	Moharana et al.	2026	Managing Organic Waste Through Advanced Biotechnological Methods	Focused on biotechnology-based composting systems
12	Himanshu et al.	2026	Vermicomposting for Sustainable Resource Recovery	Integrated smart sensors with vermicomposting technology
13	Saputra and Rahim	2026	Optimization of Compost Mixing Efficiency	Improved airflow and compost mixing efficiency
14	Choudhury et al.	2026	Data Analytics and Smart Technologies in Solid Waste Management	Applied analytics and smart technologies in composting
15	Vlaskin et al.	2026	Smart Municipal Solid Waste Management and Circular Economy	Emphasized circular economy and intelligent waste management

Research Methodology

The research methodology adopted in this study is based on analytical and experimental approaches. Data were collected from research journals, technical reports, environmental studies, and existing composting models as shown in Figure 1.

Figure 1: Multistage Process



The proposed smart composting system includes the following stages:

1. **Waste Collection and Segregation:** Biodegradable waste materials such as vegetable waste, fruit peels, food leftovers, and garden waste are collected separately from non-biodegradable waste.
2. **Shredding Process:** The collected waste is shredded into smaller particles using a crushing unit to increase the surface area for microbial decomposition.
3. **Composting Chamber:** The shredded waste is transferred into a composting chamber where microbial activity decomposes the organic material under controlled environmental conditions.
4. **Sensor-Based Monitoring:** Various sensors are installed inside the composting chamber:
   - Temperature Sensor.
   - Moisture Sensor.
   - Humidity Sensor.
   - Gas Sensor.

   These sensors continuously monitor composting parameters.
5. **Automated Mixing and Aeration:** A DC motor-driven mixing mechanism provides proper aeration and uniform decomposition. Adequate oxygen supply accelerates aerobic composting and reduces foul smell.

6. **Compost Formation:** After 20–30 days, nutrient-rich compost is produced and can be used as organic fertilizer in agriculture and gardening applications.

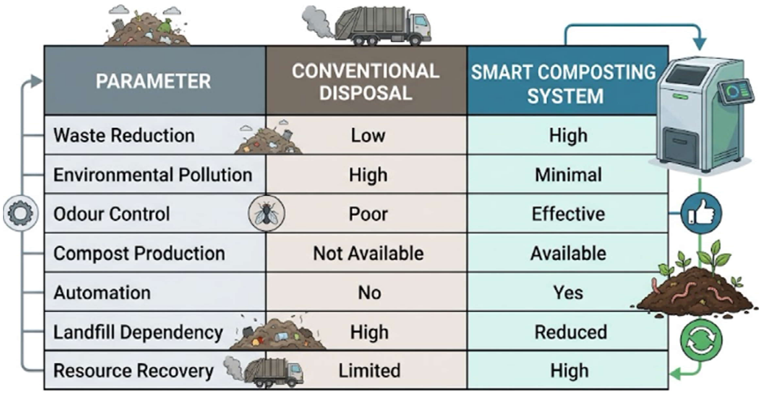
Components Used in Smart Organic Waste Composters

1. **Moisture Sensor:** The moisture sensor measures water content within the composting material and helps maintain optimum moisture levels for microbial activity.
2. **Temperature Sensor (DHT11):** The DHT11 sensor monitors temperature and humidity inside the composting chamber to maintain ideal decomposition conditions.
3. **Microcontroller Unit:** Microcontrollers such as Arduino Uno or ESP8266 control the sensors, motors, and automation processes of the composting system.
4. **DC Motor:** A geared DC motor is used for mixing organic waste materials and ensuring proper aeration.
5. **Air Filtration Unit:** Activated carbon filters or biofilters are used to reduce foul odour and harmful gases generated during decomposition.

Analysis

The analysis of smart organic waste composters indicates significant advantages over conventional waste disposal methods.

Figure 2: Analysis of Conventional Disposal vs Smart Composting System



PARAMETER	CONVENTIONAL DISPOSAL	SMART COMPOSTING SYSTEM
Waste Reduction	Low	High
Environmental Pollution	High	Minimal
Odour Control	Poor	Effective
Compost Production	Not Available	Available
Automation	No	Yes
Landfill Dependency	High	Reduced
Resource Recovery	Limited	High

The automated composting system efficiently converts organic waste into valuable compost while reducing greenhouse gas emissions and waste transportation costs. Sensor-based monitoring improves process efficiency and minimizes operational errors.

Advantages of Organic Waste Composters

- Reduces landfill waste accumulation.
- Produces nutrient-rich organic fertilizer.
- Minimizes greenhouse gas emissions.
- Reduces foul smell and pest infestation.
- Supports sustainable agriculture.
- Encourages waste segregation at source.
- Reduces waste transportation expenses.
- Promotes environmental sustainability.

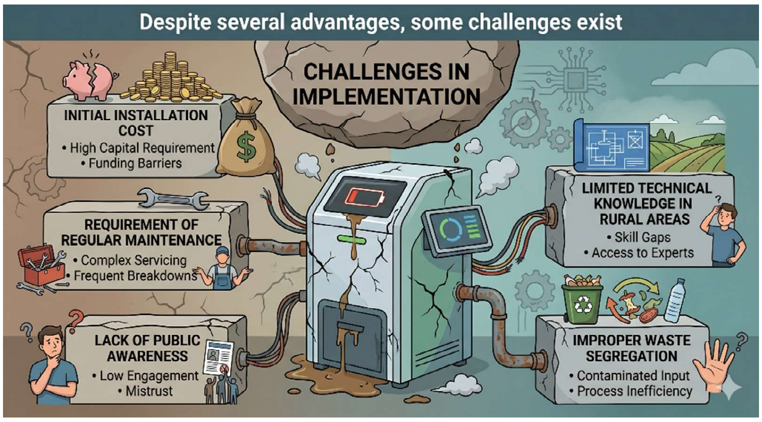
Challenges in Implementation

Despite several advantages, some challenges exist:

- Initial installation cost.
- Requirement of regular maintenance.

- Lack of public awareness.
- Improper waste segregation.
- Limited technical knowledge in rural areas.

Figure 3: Challenges Exits



These challenges can be addressed through awareness programmes, Government support, and technological advancements.

Conclusion

Wet organic waste management has become essential for sustainable urban development and environmental protection. Smart organic waste composters provide an efficient, eco-friendly, and economical solution for managing biodegradable waste. Automated composting systems integrated with sensors and microcontrollers improve decomposition efficiency, reduce environmental pollution, and generate valuable organic manure. The study concludes that widespread adoption of smart composting technology can significantly reduce landfill burden, support organic farming, and contribute toward sustainable waste management practices. Future developments in IoT and artificial intelligence can further enhance composting efficiency and monitoring capabilities.

Bibliography

1. Ahsan, A.; Alamgir, M.; El-Sergany, M.; Shams, S.; Rowshon, M. & Daud, N. (2014) Assessment of municipal solid waste management system in a developing country. *Chinese Journal of Engineering,* 2014, 1–11. https://doi.org/10.1155/2014/561935
2. Al Mamun, M. R.; Hannan, M. A.; Hussain, A. & Basri, H. (2016) Integrated sensing systems and algorithms for solid waste bin state management automation. *IEEE Sensors Journal,* 15(1), 561–567. https://doi.org/10.1109/JSEN.2014.2354462
3. Bharadwaj, B.; Kumari, M. & Chaudhary, S. (2022) Smart waste management using Internet of Things and machine learning approaches. *Sustainable Computing,* 35, Article 100689. https://doi.org/10.1016/j.suscom.2022.100689
4. Carstens, H. (1978) Origin of abnormal formation pressures in central North Sea Lower Tertiary clastics. *The Log Analyst,* 19(1), 24–28.
5. Ferronato, N. & Torretta, V. (2019) Waste mismanagement in developing countries: A review of global issues. *International Journal of Environmental Research and Public Health,* 16(6), Article 1060. https://doi.org/10.3390/ijerph16061060
6. Guerrero, L. A.; Maas, G. & Hogland, W. (2013) Solid waste management challenges for cities in developing countries. *Waste Management,* 33(1), 220–232. https://doi.org/10.1016/j.wasman.2012.09.008

7. Gupta, N.; Yadav, K. & Kumar, V. (2015) A review on current status of municipal solid waste management in India. *Journal of Environmental Sciences,* 37, 206–217. https://doi.org/10.1016/j.jes.2015.01.034
8. Joshi, R. & Ahmed, S. (2016) Status and challenges of municipal solid waste management in India: A review. *Cogent Environmental Science,* 2(1), Article 1139434. https://doi.org/10.1080/23311843.2016.1139434
9. Kaza, S.; Yao, L.; Bhada-Tata, P. & Van Woerden, F. (2018) *What a waste 2.0: A global snapshot of solid waste management to 2050*. World Bank, Washington, D.C. https://doi.org/10.1596/978-1-4648-1329-0
10. Khandelwal, H.; Dhar, P.; Thalla, S. & Kumar, S. (2019) Application of life cycle assessment in municipal solid waste management: A review. *Journal of Cleaner Production,* 209, 630–654. https://doi.org/10.1016/j.jclepro.2018.10.233
11. Kumar, S.; Bhattacharyya, J. K.; Vaidya, A. N.; Chakrabarti, T.; Devotta, S. & Akolkar, A. B. (2009) Assessment of the status of municipal solid waste management in metro cities, state capitals, class I cities, and class II towns in India. *Waste Management,* 29(2), 883–895. https://doi.org/10.1016/j.wasman.2008.04.011
12. Minghua, Z.; Xiumin, L.; Rovetta, T.; Qichang, Q.; Vicentini, H.; Bingkai, A.; Giusti, Z. & Yi, L. (2009) Municipal solid waste management in Pudong New Area, China. *Waste Management,* 29(3), 1227–1233. https://doi.org/10.1016/j.wasman.2008.07.016
13. Navghane, S. S.; Killedar, M. S. & Rohokale, V. M. (2016) IoT based smart garbage and waste collection bin. *International Journal of Advanced Research in Electronics and Communication Engineering,* 5(5), 1576–1578.
14. Pandey, B.; Sharma, R. K. & Tiwari, A. (2023) Artificial intelligence enabled smart waste segregation system for sustainable smart cities. *Environmental Technology & Innovation,* 31, Article 103162. https://doi.org/10.1016/j.eti.2023.103162
15. Patel, R.; Sharma, S. & Gupta, M. (2021) Hydraulic waste compactors for sustainable urban waste management. *International Journal of Environmental Engineering,* 14(3), 145–159. https://doi.org/10.1504/IJEE.2021.10034567
16. Rana, R.; Ganguly, A. & Gupta, P. (2018) Automated waste collection and management system using IoT. *International Journal of Scientific Research in Computer Science Engineering and Information Technology,* 3(1), 670–675.
17. Sharma, P. & Jain, V. (2020) Smart waste segregation systems in modern buildings. *Journal of Environmental Technology,* 25(4), 311–325. https://doi.org/10.1080/09593330.2020.1712458
18. Singh, A. & Sinha, P. (2021) Smart city waste management through sensor-based technologies. *International Journal of Smart Technology and Learning,* 2(3), 211–225. https://doi.org/10.1504/IJSMARTTL.2021.117654
19. Smyth, D. P.; Fredeen, A. & Booth, A. (2010) Reducing solid waste in higher education institutions: The first step toward 'greening' a university campus. *Resources, Conservation and Recycling,* 54(11), 1007–1016. https://doi.org/10.1016/j.resconrec.2010.02.008
20. Wilson, D. C.; Rodic, L.; Scheinberg, A.; Velis, C. & Alabaster, G. (2015) Comparative analysis of solid waste management in modern urban cities. *Waste Management & Research,* 33(12), 1045–1058. https://doi.org/10.1177/0734242X15616024

−−==00==−−