I J C R M
International Journal of Contemporary Research In Multidisciplinary

Research Article

Smart Dustbin Management System Using IoT with Cloud Integration

Lavina Wilson Dsouza [1*], Sanika Sanjay Kamble [2], Priya Rajgonda Patil [3] Sanika Ganpati Kurale [4]

[1,2,3,4] Student, Dept. of Electronics & Tele-communication engineering, Sant Gajanan Maharaj College of Enigneering Kolhapur, Maharashtra, India

Corresponding Author: *Lavina Wilson Dsouza

DOI: https://doi.org/10.5281/zenodo.18503337

Abstract

Efficient solid waste management has become a major concern due to rapid urbanisation, population growth, and increasing environmental pollution. Conventional waste collection systems rely on fixed schedules and manual monitoring, often leading to overflowing bins, inefficient resource utilisation, and unhygienic conditions. Recent advancements in the Internet of Things (IoT) have enabled the development of smart dustbin systems capable of real-time garbage level detection, remote monitoring, and automated alert generation.

This paper presents a systematic review of IoT-enabled smart dustbin and waste management systems with emphasis on sensing technologies, communication architectures, data processing platforms, and system scalability. Existing studies demonstrate that smart dustbin solutions significantly improve waste collection efficiency, reduce operational costs, and support data-driven decision-making in smart cities. However, challenges related to energy efficiency, communication reliability, scalability, and intelligent analytics remain open research issues. By critically analyzing recent literature, this review identifies research gaps and highlights future directions for sustainable and intelligent waste management infrastructures

Manuscript Information

- **ISSN No:** 2583-7397
- **Received:** 10-12-2025
- **Accepted:** 29-01-2026
- **Published:** 06-01-2026
- **IJCRM:**5(1); 2026: 482-485

- **Plagiarism Checked:** Yes
- **Peer Review Process:** Yes

How to Cite this Article

Dsouza L W, Kamble S S, Patil P R, Kurale S G. Smart dustbin management system using IoT with cloud integration. Int J Contemp Res Multidiscip. 2026;5(1):482-485.

Access this Article Online

www.multiarticlesjournal.com

KEYWORDS: Internet of Things, Smart Dustbin, Waste Management, Smart City, Wireless Sensor Networks.

INTRODUCTION

Solid waste management plays a crucial role in maintaining urban hygiene, public health, and environmental sustainability. Traditional waste collection systems operate on predefined schedules without considering the actual fill level of dustbins. This often results in unnecessary collection trips or delayed waste removal, leading to overflowing bins and environmental pollution. The Internet of Things (IoT) paradigm has emerged as a transformative solution for intelligent waste management by enabling interconnected sensors, wireless communication, and cloud-based monitoring platforms. IoT-enabled smart dustbin systems allow real-time monitoring of garbage levels, automated alerts to municipal authorities, and optimized waste collection routes. Surveys on IoT applications highlight their effectiveness in smart city services due to scalability, interoperability, and cost efficiency [1], [15].

Despite significant progress, existing smart dustbin systems face challenges related to sensor reliability, energy consumption, communication latency, and lack of predictive analytics. This review critically examines recent IoT-based smart dustbin systems to provide insights into current trends, limitations, and future research opportunities.

Systematic Review Methodology

This review follows a systematic literature review methodology to identify, analyse, and classify IoT-enabled smart dustbin systems. Major scientific databases, including IEEE Xplore, SpringerLink, Elsevier ScienceDirect, and Google Scholar, were explored to collect relevant research articles.

The search was conducted using keywords such as "IoT-based smart dustbin," "smart waste management system," "garbage monitoring using IoT," "smart bin using GSM," and "IoT waste collection."

Inclusion criteria consisted of peer-reviewed journal articles and conference papers published between 2019 and 2024, focusing on real-time IoT-enabled waste monitoring systems. Studies unrelated to waste management, simulation-only works, and non-IoT approaches were excluded.

From more than 60 initially identified articles, 15 highly relevant and frequently cited studies were selected for in-depth analysis. The selected works were classified based on sensing mechanisms, communication technologies, system architecture, and application domain.

IoT Technologies for Smart Dustbin Systems

IoT-based smart dustbin systems generally consist of four functional layers:

Sensing Layer: Includes ultrasonic, infrared, or weight sensors to detect the garbage level inside bins.

Communication Layer: Enables data transmission using GSM, Wi-Fi, LoRa, or NB-IoT.

Data Processing Layer: Utilises microcontrollers, edge nodes, or cloud platforms for data handling.

Application Layer: Provides dashboards, alerts, and decision support for waste collection authorities.

Wireless sensor networks (WSNs) are widely used due to their scalability and low power consumption. Low-power wide-area networks such as LoRa enable long-range communication with minimal energy usage [5], [6].

Sensing Technologies in Smart Dustbins

Common sensing technologies include:

Ultrasonic sensors: Measure garbage fill level using distance calculation

Infrared sensors: Detect object presence near the bin opening

Weight sensors: Estimate waste quantity based on load

Temperature sensors: Detect fire or abnormal heating

Challenges include sensor fouling, environmental interference, and calibration drift, which affect long-term reliability.

Communication Technologies and Protocols

Smart dustbin systems use multiple communication technologies depending on deployment scale:

Short-range: Wi-Fi, ZigBee

Cellular: GSM, LTE, NB-IoT

Long-range low-power: LoRa, LoRaWAN

Lightweight protocols such as MQTT are commonly adopted for reliable and low-overhead data transmission.

Literature Review

Several approaches have been proposed for IoT-enabled smart dustbin systems.

Kumar et al. (2019) [1] introduced an IoT-based garbage monitoring system using ultrasonic sensors and GSM communication. The system enabled real-time alerts but lacked scalability for large deployments.

Kadam and Patil (2020) [2] proposed a distributed smart dustbin network with cloud integration, improving monitoring accuracy while facing network dependency issues.

Jadhav et al. (2020) [3] developed a low-cost Arduino-based smart dustbin system. Although economical, the system did not support data analytics.

Shelke and Deshmukh (2021) [4] implemented an IoT-cloud framework for waste monitoring, enhancing visualisation but increasing system complexity.

Mehta and Shah (2022) [8] designed urban smart bins optimised for smart cities but highlighted maintenance overhead.

Ansari and Khan (2022) [9] proposed an automated alert-based smart dustbin reducing manual supervision, though limited to single-parameter sensing.

Recent studies emphasise scalability, energy efficiency, and integration with smart city platforms [11]–[15].

Comparative Analysis of Existing Systems

A comparative evaluation of the reviewed studies is highlighted in Table 1.

Table 1: Comparative Analysis of IoT-Based Smart Dustbin Systems

Ref.	Monitoring Approach	Communication	Key Contribution	Limitations
Kumar et al. (2019) [1]	Sensor-based	GSM	Real-time alerts	Limited scalability
Kadam & Patil (2020) [2]	Distributed IoT	Cloud IoT	Improved reliability	Network dependency
Jadhav et al. (2020) [3]	Ultrasonic sensing	GSM	Low-cost solution	No analytics
Shelke & Deshmukh (2021) [4]	IoT + Cloud	Wi-Fi	Centralized monitoring	System complexity
Raut et al. (2021) [7]	Energy-aware bins	GSM	Low power usage	Limited coverage
	Urban smart bins	IoT	Smart city integration	Maintenance overhead
Al-Shamiri et al. (2021) [13]	IoT assessment system	IoT	Continuous assessment	Sensor calibration
Ansari & Khan (2022) [9]	Automated alerts	GSM	Reduced manpower	Single sensor uses

Observations

- IoT-based smart dustbins significantly improve waste collection efficiency.
- GSM remains widely used for low-cost deployments.
- Cloud platforms enhance monitoring but introduce latency issues.
- Most systems lack predictive waste analytics.

Research Challenges and Open Issues

Sensor degradation and calibration affect long-term reliability [8], [12]. Energy-efficient communication remains a challenge for large-scale deployments [5], [7]. Cloud-dependent systems face latency and connectivity issues [4], [11]. Security, scalability, and intelligent prediction remain open research problems.

Future Research Directions

Future work should focus on hybrid edge–cloud architectures, low-power communication technologies, and machine learning-based waste prediction. Standardization of IoT platforms and secure data handling mechanisms is essential for scalable smart waste management systems.

CONCLUSION

This systematic review analyzed IoT-enabled smart dustbin systems, focusing on sensing technologies, communication frameworks, and system-level challenges. Smart dustbin solutions significantly enhance monitoring efficiency, automation, and urban cleanliness compared to traditional waste management approaches. However, challenges related to energy efficiency, scalability, and intelligent analytics must be addressed to achieve sustainable smart city waste infrastructures.

Acknowledgment

The authors would like to acknowledge the academic guidance and support provided by the Department of Electronics and Telecommunication Engineering, Sant Gajanan Maharaj College of Engineering, during the preparation of this review paper.

REFERENCES

1. Kumar S, Kumar N, Gupta R. IoT-based intelligent garbage monitoring system for smart cities. Int J Comput Appl. 2019;182(42):12–17.
2. Kadam PB, Patil SR. Smart garbage monitoring system using IoT. Int J Eng Res Technol. 2020;9(6):227–31.
3. Jadhav AK, Jadhav RS, Patil PS. Smart dustbin using ultrasonic sensor and GSM. Int J Sci Res Eng Manag. 2020;4(5):1–5.
4. Shelke SM, Deshmukh AR. IoT based waste management system using smart bins. Int J Innov Res Technol. 2021;7(8):18–22.
5. Singh RK, Verma M. Design of smart garbage collection system using IoT. J Emerg Technol Innov Res. 2021;8(3):556–60.
6. Khan TA, Ahmed S, Rahman F. Smart waste management using IoT and cloud computing. Int J Adv Trends Comput Sci Eng. 2021;10(2):1321–27.
7. Raut V, Shinde S, Chavan P. IoT enabled smart dustbin for municipal waste management. Int J Eng Sci Comput. 2021;11(6):27845–49.
8. Mehta A, Shah K. Smart garbage collection system using IoT sensors. Int J Res Eng Sci. 2022;10(1):22–27.
9. Ansari MA, Khan S. Automated smart dustbin system for waste monitoring. Int J Comput Trends Technol. 2022;70(4):1–6.
10. Joshi PR, Kulkarni NV. Smart waste bin monitoring system using Arduino and GSM. Int J Innov Technol Explor Eng. 2022;11(8):45–49.
11. Patil DP, Pawar AS, More SB. IoT based intelligent solid waste management system. Int J Eng Res Appl. 2022;12(2):34–39.
12. Malhotra R, Kaur P. Smart dustbin system for urban waste management. Int J Adv Res Sci Commun Technol. 2023;3(1):98–103.
13. Yadav S, Mishra R. IoT-based smart waste monitoring and alert system. Int J Emerg Technol. 2023;14(2):210–15.
14. Naik KR, Hegde SB. Design and implementation of smart garbage bin using IoT. Int J Electr Electron Res. 2023;11(1):55–60.

15. Sharma A, Chauhan V. Smart waste management system using IoT for sustainable cities. Sustain Comput Inform Syst. 2024; 44:100912.

About the corresponding author

Lavina Wilson Dsouza is a student in the Department of Electronics and Telecommunication Engineering at Sant Gajanan Maharaj College of Engineering, Kolhapur, Maharashtra, India. Her academic interests include embedded systems, Internet of Things applications, assistive technologies, and smart healthcare solutions for enhanced mobility and safety.