Format for

Submission of Proposals under the AICTE Research Promotion Scheme (RPS)

(An applicant must complete only as per the proforma relevant to his project. Proposals with either section missing or incomplete will be rejected without further consideration.) General Information: Section A:

i. Name of Institution / Univ. Department of Applicant

ii. Address:

iii. Phone / Mobile No. : _____ Fax: _____ STD Code: _____

iv. Type of Institution: Govt./Govt. Aided/Self-financing/Institute Deemed to be University

v. Name of the Partner Institute/Institutions

vi. Name of the Industry Partner

Research Proposal Details: Section B

1 Title of the Proposal:

2 Major Area (refer list or state otherwise):

3 Detailed Research Proposal:

3.1 Abstract (in 500 words)

3.2 Objectives of the research proposal (in 100 words)

3.3 Justification of the problem statement with respect to the Department/Institution Needs:

3.4 Relevance of the research proposal with the Academic & Research Activities:

3.5 International Development in the Area of Project

3.5.1 Please Carry out a Literature and Patent search for novel research problems

3.5.2 International Status (in 500 words)

3.5.3 National Status (in 500 words)

3.5.4 Significance of Undertaking the proposed problem in the Context of Current Status (in 100 words)

3.6 Does the research problem have any Commercial Application or Patentability? (in 200 words)

3.7 Impact of Project:

3.8 Social Significance

3.9 Any other information related to the Project proposal/execution of the project:

1. Title of the Proposal

Design and Development of Smart Dustbin with Capacity Alert and Automated Cleaner Allocation using IoT, LoRa, and GSM Technologies.

3. Detailed Research Proposal

3.1 Abstract

The increasing burden of urban waste, particularly in tourist destinations and densely populated public areas, demands intelligent solutions that are both scalable and efficient. Overflowing dustbins not only create an unhygienic environment but also reflect poorly on public infrastructure, especially in areas intended to attract visitors. In response to this need, the proposed project focuses on an advanced Smart Dustbin Capacity Alert System enhanced with dual communication technologies — GSM and LoRa — to provide timely, reliable, and centralized waste management.

The system begins with the integration of ultrasonic sensors installed within each smart dustbin to continuously monitor the fill level of garbage. These sensors detect the distance from the top of the bin to the waste surface and estimate the percentage filled. This data is processed in real-time using a microcontroller unit (MCU) embedded within each dustbin node. When the garbage reaches a predefined threshold (e.g., 80% full), the MCU triggers an alert mechanism.

To ensure immediate local action, the GSM module sends an SMS alert directly to the assigned cleaning personnel or municipal staff, prompting urgent cleaning of the specific dustbin. Simultaneously, the same data is transmitted using LoRa (Long Range) communication protocol to a LoRa Gateway, which acts as the central receiver for multiple dustbins in a zone.

This LoRa Gateway then uses GSM or Wi-Fi connectivity to forward the aggregated data from all bins to a cloud-based server. On the cloud server, data from each dustbin is organized and visualized through a web-based dashboard or mobile app interface accessible to municipal authorities. This interface displays parameters such as fill level, location, last cleaned timestamp, and alert status — enabling administrators to make informed decisions about cleaning schedules, route optimization, and resource allocation.

The combination of GSM and LoRa in a hybrid communication model offers robust reliability. GSM provides direct peer-to-peer alerting, ensuring that immediate cleaning actions are triggered even if internet connectivity is unavailable. Meanwhile, LoRa enables low-power, long-range communication for centralized real-time monitoring across a wide area, making it especially suitable for large campuses, tourist zones, or smart city environments.

This system not only helps prevent the overflow of waste but also ensures smart allocation of manpower, reduced response time, and improved public hygiene. The automation of alerts and remote monitoring minimizes human dependency for routine checks, enhances accountability, and increases the overall efficiency of waste management operations.

Additional features such as QR-code-based reward systems, contactless lids using servo motors and PIR sensors, and solar power integration can be added to improve sustainability, encourage user participation, and support environmental awareness.

Overall, the proposed Smart Dustbin Capacity Alert System contributes significantly to the goals of Swachh Bharat Abhiyan and Smart City Mission, offering a scalable, efficient, and hygienic solution for modern waste management challenges.

3.2 Objectives

- To design a smart dustbin system integrating ultrasonic, IR, PIR sensors, servo motor, LoRa, and GSM modules.
- To develop automated waste capacity monitoring and cleaner allocation software.
- To prototype and test the system's feasibility, reliability, and scalability in real-world scenarios.
- To analyse the social, economic, and environmental impacts of smart waste management in public areas.

3.3 Justification of the Problem Statement

This research aligns with the Department's focus on IoT, Embedded Systems, and Smart City solutions, providing students and faculty with practical exposure to real-life societal challenges. It strengthens the department's research output, industrial relevance, and contribution to national initiatives like Digital India and Swachh Bharat Abhiyan while creating interdisciplinary project opportunities.

3.4 Relevance

The proposed project integrates embedded systems design, wireless communication (LoRa, GSM), automation, and data analytics, covering major academic modules and laboratory practicals. It enhances research activities by fostering innovation, prototyping, field testing, and publishing opportunities, thus enriching the academic environment and industry-readiness of students.

3.5 International Development

3.5.1 Literature

US20240378571A1 – "Waste management system and method" proposes IoT sensors communicating via short-range wireless technologies (e.g. Bluetooth, ZigBee) or GSM, with cluster-based data forwarding. No LoRa mesh network or reward mechanisms are included

WO2017175244A1 – "A smart bin" describes a bin with RFID or camera-based user recognition to capture and share photos or reward users. While engaging, it depends on Wi-Fi and social media sharing—without Li-Ra or GSM level alerts

US11961054B1 – "Waste management system" includes multi-sensor (fill, air quality, temperature) visualization dashboards and alerting via WSN and cloud platforms, yet doesn't integrate reward algorithms or contactless lid automation

CN209097482U details a smart home dustbin with ultrasonic detection and servo-driven lid, but limited to stand-alone functionality and without remote alerts, mesh networking, or public incentives

US11702280B1 outlines ultrasonic fill sensors, environmental sensors, and cloud-based monitoring via GSM/Wi-Fi, but lacks features like automated cleaner dispatching, LoRa fallback, or user rewards

3.5.2 International Status

Globally, the problem of waste overflow and inefficient garbage collection has been addressed through several advanced smart waste bin systems, with varying levels of success and affordability. One of the most prominent international examples is Bigbelly Solar, a U.S.-based solution that integrates solar-powered compaction units with wireless communication to notify authorities when bins are full. These bins can hold more waste due to internal compactors and send notifications to central servers for route optimization and data analytics. While highly effective in cities like New York, London, and Toronto, these systems are extremely cost-prohibitive, with each unit costing approximately INR 1.5 to 2 lakh. This makes them inaccessible for mass deployment in developing nations like India, especially in semi-urban or rural tourist zones.

Furthermore, most internationally available smart bin systems are dependent on high-speed internet infrastructure, typically using Wi-Fi or LTE for real-time communication. These technologies assume consistent network availability, which is not always feasible in developing regions, especially at remote tourist spots or public parks in India. In contrast, Indian deployment requires low-power, long-range, and internet-independent communication protocols to maintain functionality in low-connectivity zones. This is where existing international models fall short — their scalability is limited not only by their price but also by their dependency on infrastructure that isn't always present in the Indian context.

Another major limitation of many global smart bin solutions is the lack of user engagement mechanisms. Current systems primarily serve municipal or waste management authorities and offer no direct user-facing features to influence public behavior. In contrast, the Indian

context demands systems that not only work efficiently but also actively promote citizen participation in cleanliness efforts. The absence of motivational or reward-based frameworks in most global smart bin systems represents a significant gap in leveraging public cooperation.

Moreover, international systems typically operate in centralized architectures, which are vulnerable to single-point failures and do not scale well across uneven or widely distributed terrain. There is little to no adoption of self-healing mesh networks using LoRaWAN or similar technologies in such commercial solutions.

In comparison, the proposed Smart Dustbin Capacity Alert System is designed to address all of these limitations. It integrates low-cost components (approximately INR 2500 per unit) using ultrasonic and IR sensors, a contactless lid mechanism, and a QR-code-based reward system that incentivizes users for proper waste disposal. The system leverages LoRa communication to build a self-healing mesh network, ensuring reliable data transmission across a large area without requiring internet at every node. For added reliability and emergency alerting, it also incorporates GSM modules for direct communication with cleaning personnel via SMS.

This dual-mode communication system (LoRa + GSM) combined with user participation strategies offers a unique, context-sensitive, and scalable solution for countries like India. Unlike global systems, this model is built to be affordable, resilient, and socially inclusive, making it more applicable to the challenges faced in Indian public infrastructure — particularly in tourist destinations, smart cities, railway stations, and urban local bodies.

3.5.3 National Status

India has been progressively adopting smart solutions in the waste management sector, driven by government initiatives like the Swachh Bharat Abhiyan and the Smart Cities Mission. However, the deployment of smart dustbin systems in India remains largely at a pilot or experimental stage, with most projects focusing on basic ultrasonic sensing and GSM-based alert systems. These early implementations were aimed at detecting the garbage level within bins and sending SMS alerts to municipal workers once the bin reached a specified threshold. While useful, these systems lack integration with modern communication technologies or user engagement mechanisms.

Several municipal corporations such as those in Indore, Pune, and Ahmedabad have initiated smart bin projects, incorporating ultrasonic sensors with GSM modules. However, these implementations often function as standalone units with no centralized data monitoring or network-based communication. They depend on individual SIM cards for each dustbin, making them costly and difficult to maintain at scale. Furthermore, these systems do not support contactless operation, which has become increasingly important in the post-pandemic era for maintaining public hygiene.

In the academic and innovation sector, several engineering institutions and startups have developed working prototypes of smart dustbins using microcontrollers, ultrasonic sensors, and GSM modules. Examples include student projects at IIT Madras, VIT Vellore, and BITS Pilani, which demonstrated real-time waste level monitoring and alert transmission. However,

most of these innovations have remained limited to lab environments or exhibitions and have not transitioned to large-scale deployment due to a lack of industrial collaboration, funding, or integration with public infrastructure.

Attempts to implement LoRa-based smart bin networks are relatively new in India. Some smart city pilot programs, like those in Pune and Bhopal, have tested LoRaWAN for communication between various smart city assets, including smart lighting and bins. However, these initiatives are still in the proof-of-concept stage and do not yet include features such as automated cleaner allocation, reward-based user engagement, or self-healing mesh networking.

A key gap in nearly all existing Indian implementations is the lack of behavioral incentives. Most systems are designed solely for monitoring and alerting, without any mechanism to motivate citizens to actively participate in maintaining cleanliness. Moreover, there is little focus on integrating QR-code reward systems, which could be effective in promoting responsible waste disposal behavior, particularly in high-traffic areas like tourist destinations.

Our proposed system addresses all these limitations., a dual-communication model that leverages LoRa for long-range, low-power communication and GSM for direct SMS-based alerting. The system also includes a centralized cloud dashboard for administrators and an automated algorithm for cleaner allocation based on real-time data.

3.5.4 Significance

Overflowing dustbins in public areas and tourist destinations not only create unhygienic conditions but also damage the aesthetic appeal and reputation of these locations. Existing systems lack real-time monitoring, behavioral incentives, and reliable communication, leading to inefficient waste management. The proposed smart dustbin system addresses these gaps through automated fill-level detection, contactless operation, QR-based reward mechanisms, and dual communication (LoRa and GSM). This ensures timely cleaning, promotes hygienic practices, and encourages public participation. By bridging technological and behavioral deficiencies, the project supports Smart City goals and contributes to a cleaner, healthier, and more sustainable urban environment.

3.6 Commercial Application

The proposed Smart Dustbin Capacity Alert System holds strong commercial potential across multiple sectors, including municipal corporations, smart city initiatives, educational institutions, malls, industrial parks, railway stations, and tourist destinations. With the rising demand for automation, hygiene, and efficient urban infrastructure, this system addresses a critical gap in waste management by offering a cost-effective and scalable solution.

The project supports a subscription-based business model, wherein customers can subscribe for hardware maintenance, real-time data monitoring, cloud analytics, and automated cleaner allocation dashboards. This approach ensures sustained service delivery and offers a recurring revenue model for potential commercialization through startups or industry partnerships.

The system’s unique combination of features—including dual communication (LoRa for mesh networking and GSM for direct alerts), contactless lid operation, and a QR code-based reward mechanism to promote public participation—makes it highly innovative and patentable. Intellectual Property Rights (IPR) may be claimed for the system architecture, reward integration framework, and cleaner allocation algorithm.

This innovation aligns with AICTE's vision of fostering research-driven entrepreneurship, with high potential for startup incubation, licensing, and support under schemes like Startup India, MSME innovation funding, and AICTE IDEA Lab commercialization tracks.

3.7 Impact of Project

- Social: Promotes hygienic disposal and public participation in waste management.
- Economic: Generates revenue through QR rewards partnerships with local stores; reduces municipal operational costs.
- Environmental: Prevents overflow and pollution, enhancing public health and urban aesthetics.
- Academic: Creates hands-on research and interdisciplinary learning opportunities for students and faculty.

3.8 Social Significance

Clean, hygienic, and well-managed public spaces are essential for improving the quality of life, ensuring community well-being, and preserving the visual and environmental appeal of cities, especially in tourist destinations. Overflowing dustbins and uncollected waste not only pose health risks but also create negative perceptions among visitors, impacting tourism, local pride, and urban aesthetics.

The proposed smart dustbin system directly addresses these issues by enabling real-time waste monitoring, automated cleaning alerts, and hygienic contactless disposal, which collectively foster cleaner surroundings. By incorporating QR-based rewards, the system also encourages citizens—especially youth and tourists—to actively participate in cleanliness drives, thereby reinforcing positive behavioral change at the grassroots level.

The project supports the goals of national initiatives like Swachh Bharat Abhiyan, Smart Cities Mission, and Digital India by promoting technology-driven cleanliness, citizen engagement, and efficient resource utilization. Cleaner environments reduce the spread of diseases, improve air and water quality, and contribute to mental well-being and civic responsibility.

Overall, the project creates a socially inclusive and environmentally conscious ecosystem, empowering both authorities and citizens to collaborate toward a cleaner, healthier, and more sustainable future.

3.9 Other Information Related to the Project

The proposed project is closely aligned with AICTE's vision of promoting research-driven innovation that leads to tangible societal impact. It fits well within the objectives of programs like the AICTE IDEA Lab, Smart India Hackathon (SIH), and Atal Innovation Mission, offering significant potential for prototype development, validation, and commercialization.

The team has already completed the initial system design, hardware selection, and bill of materials (BoM). A functional prototype is partially built, and core modules—including the sensor integration, LoRa communication, and QR reward mechanism—have been tested in a controlled environment. The core research team comprises skilled faculty and students with expertise in embedded systems, IoT, and software development.

The project also holds potential for startup incubation and licensing, especially under Startup India and Make in India initiatives. With appropriate funding, the solution can be refined into a commercial-grade product deployable by municipal corporations and facility managers.

Collaboration with local municipal bodies is already being explored to facilitate real-world pilot deployment. Additionally, support from industry partners is being sought for mass manufacturing and cloud infrastructure hosting.

The project is execution-ready, with the next steps involving component procurement, field integration, pilot deployment, performance evaluation, and final optimization for real-world conditions.

4 Duration of Project

Sr. No.	Activity Block	Time Required (in months)
1	Finalization of design, BoM, and procurement	1
2	Hardware assembly integration and coding	2
3	Testing and debugging	1
4	Pilot deployment in field conditions (3 zones)	2
5	Data collection, refinement, and optimization	1
6	Final reporting, publishing, IP filing	1
	Total Time: _____8_____ months	

5 Budget Estimate

5.1 Recurring Expenditure (Consumable, Contingencies etc.)

Sr. No.		Total Proposed Cost in Lakhs (₹)
1.	Manpower (Only Research Staff)	5.0
2.	Field Work/ Travel	2.0
3.	Stationary	1.0
4.	Cloud hosting,Sms Gateway,Servers	2.0
5.	Contingency	0.45
	Total	10.45

5.2 Non-Recurring Expenditure

Sr. No.	Name of Equipment/ Facilities to be Procured	Make and Model of the Equipment	Total Proposed Cost in lakh	Justification for Procurement	Whether the Proposed Equipment Already Exist in the Department (Yes/No)
1.	Bin	Plastic	0.4	Required for the physical collection of waste. Two bins support segregation (wet/dry) or expand capacity.	No
2.	Microcontroller	Arduino uno	1.0	For multi-sensor handling and data processing	No
3.	Ultrasonic Sensor	HC-SR04 ultrasonic module	0.5	Measures the garbage level inside the bin to detect fullness	No
4.	Charger and Cable	micro USB-5V	0.2	Required for recharging the battery and powering the system during development and maintenance	No
5.	PIR Sensor	HC-SR501 human IR motion detector	0.3	Detects human presence to automate lid operation or track usage	No
6.	Servo Motor	SG90 micro servo	0.3	Operates the bin lid automatically upon sensing motion or proximity	No
7.	Male Header	40 pin	0.4	Essential for making modular and reliable sensor connections on the PCB or breadboard	NO
8.	Box	ABS plastic project box	0.2	Protects the electronics from environmental	N0

				damage and ensures safe installation	
9.	PCB Hscr	custom PCB for integration	0.65	Custom-designed printed circuit board for integrating sensors and microcontrollers neatly	No
10.	LoRa Module	Ra-02 SX1278 433 MHz	1.0	Enables long-range wireless communication for smart monitoring via LoRaWAN gateways	No
11.	Flow Solder	40X1 Flow Solder	0.4	Used for soldering connections on the PCB for robust component attachment	No
12.	Charging Modules	TP4056 charging module	0.4	Safely manages charging of Li-ion batteries in the system.	N0
13.	Battery	Battery 18650 3,7v	0.3	Provides portable power supply for off-grid or solar-powered usage.	N0
14,	Solar Panel	5v 1A	1.0	Enables green energy harvesting for sustainable operation of the smart bin	N0
15.	Bin 02	Plastic dustbin	0.4	For internal wiring between components, ensuring flexible and durable connections	No

16.	Multistand Wire	26 AWG	0.3	Enhances the signal range and stability of LoRa communication	No
17.	LORA Antenna	433Mhz SMA	1.0	A powerful microcontroller with built-in Wi-Fi and Bluetooth for advanced features like web dashboard or app control	No
18.	Microcontroller	ESP32/Gsm	1.0	General-purpose board for soldering and mounting small circuits, sensor headers, and connectors.	No
19.	Dot PCB green	General purpose	0.5		No
	Total =9.5				

Total Budget Estimate (A + B) = ₹ _____2000000_____

It is understood and undertaken that Non-Recurring expenditure should not exceed 15% of the proposed project cost. AICTE support is only at a reasonable level to enable faculty members and research scholars in the project. AICTE expects that this support will result in a multiplier effect leading to major projects for support from other agencies. AICTE does not encourage hiring of secretarial manpower for the project.

_____ _____

Signature of the Applicant Head of the Institution
Signature & Seal

Place: _____

Date: _____