EcoBin Sync

Smart Waste Management System Using IoT

Project Duration: 1 July 2025 – 31 December 2025
Project Manager: Rakhshanda
Software Process Model Used: Agile (Scrum)

1. Business Statement

Urban municipalities in Pakistan face persistent challenges in waste collection, especially in densely populated zones. Overflowing garbage bins create hygiene concerns, attract pests, and degrade urban cleanliness. Traditional systems rely on fixed schedules and manual monitoring, leading to inefficiencies.

Problem: The waste collection process lacks real-time data, resulting in delayed and inefficient pickups.

Opportunity: Deploy an IoT-enabled smart waste management system that tracks bin levels in real time, notifies waste collectors when bins are full, and optimizes routes, thus improving urban hygiene and operational efficiency.

2. Project Team

Role	No: of People	Justification
Project Manager	1	Oversee planning, scheduling, risk, and team coordination
Hardware Engineers	2	To build, test, and deploy sensor-based IoT device
Backend Developers	2	API development, cloud integration, and database management

Frontend/Mobile Developers	2	UI for dashboard and mobile app for waste collectors
QA Tester	2	To perform testing across hardware and software components.
Business Analyst	1	Liaison with the municipality and gather feedback.

Team Structure

Project Manager (Rakhshanda)
├── Hardware Team (2 Engineers)
├── Software Team
│ ├── Backend Developers
│ ├── Frontend/Mobile Developers
│ └── QA Tester
└── Business Analyst

3. Feasibility Analysis

Feasibility type	**rating(1-10)**	**Justification**
Technical	9/10	Affordable and widely available hardware (NodeMCU, ultrasonic sensors); real-time cloud platforms are accessible.
Economic	7/10	Moderate initial investment with long-term cost savings in fuel, labor, and route optimization.
Operational	8/10	Easily integrable into existing municipal workflows with minor training.
Schedule/legal	6/10	No major restrictions; needs collaboration with local governments for public deployment.

Critical Success Factors (CSFs)

CSF	**Why its critical**	**Measure taken**
Sensor accuracy	Prevent false alerts and missed pickups	Use calibrated and tested sensors.

Dashboard uptime	Ensure 24/7 monitoring	Host on reliable cloud server (AWS)
User Engagement	Adoption by municipal workers	Training and hands-on demo sessions.
Stakeholder Engagement	Critical for approvals and support	Weekly reports and regular feedback meetings.

4. Project Goal

Aim

To build and deploy a smart waste management solution using IoT-enabled bins and real-time dashboards to optimize collection efforts.

Goals

- Deploy IoT sensors to monitor public bin levels
- Create a cloud-based dashboard and mobile app
- Notify collectors based on bin fullness
- Pilot in one district and scale city-wide

Benefits

- Reduced health risks due to timely waste collection
- Route optimization leads to fuel and time savings
- Transparency and accountability in waste collection
- Enhanced citizen satisfaction and urban cleanliness

5. Project Deliverables

Deliverable	Linked Objective	Success Criteria
IoT sensor devices	Monitor bin fill levels	Accurate real-time reading <5% false readings.
Backend System	Process and store in-data	Real-time API responses, minimal downtime.
Web Dashboard	Municipal monitoring	Visual bin map with live updates.
Mobile App	Collector routing and alerts	Real-time alert delivery and GPS integration.
Training Materials	Staff onboarding	All users complete training and demonstrate usage.

6. Project Scope

In-Scope

- Bin-level monitoring via sensors
- Real-time dashboard
- Mobile application for collectors
- Notification system (push, SMS, email)
- Pilot deployment in one district

Out-of-Scope

- Private/commercial waste systems
- Integration with garbage truck sensors
- Full city rollout in initial phase

Phases of the Project

1. Initiation & Planning
2. Design (Hardware + Software)
3. Development
4. Testing
5. Deployment & Monitoring
6. Project Closure

Success Criteria

- 90% accuracy in bin level detection
- System uptime ≥ 95%
- At least one district covered by pilot phase
- Stakeholder satisfaction post-deployment

7. Agile User Stories

Admin (Municipality Officer)

- As an admin, I want to see the fill levels of all public bins on a map so I can track which need collection.
- As an admin, I want to generate reports on bin collection so I can evaluate system performance.

Waste Collector

- As a collector, I want to receive real-time alerts for full bins so I can prioritize collection.

- As a collector, I want to see optimized routes so I can save fuel and time.

System

- As a system, I want to trigger alerts when bin levels cross thresholds so actions can be taken on time.
- As a system, I want to log all sensor data with timestamps for auditing and analytics.

8. Assumptions, Constraints & Dependencies

Assumptions

- Municipality agrees to pilot in one district
- Basic infrastructure (Wi-Fi/mobile data) is available
- End-users (collectors/admins) are willing to use the system

Constraints

- Budget limitations for large-scale deployment
- Limited access to certain public areas
- Device maintenance during monsoon or harsh weather

Dependencies

- Sensor availability and shipment timelines
- Third-party cloud service reliability
- Timely feedback from municipality stakeholders

9. Stakeholders

Stakeholder	Role	Responsibilities
Project Manager	Lead	Planning, coordination, quality check.
Municipality Admin	Client	Approve pilot, provide access to bins.
Hardware Engineers	Development	Build and calibrate sensors
Software Team	Development	Build backend, dashboard and app.
QA Tester	Quality Control	Validate system functionality
Waste Collectors	End users	Use a mobile app for collections.

10. Expert

Name: Ubaid Aftab Chawla

Domain: IoT Solutions & Embedded Systems

Job Title: Senior Embedded Systems Engineer

Why This Expert?

Ubaid has hands-on experience with deploying IoT devices in smart city applications, including waste and utility management systems.

Past Experience

- Led the hardware team for “CleanCity IoT Project” in Lahore
- Published papers on low-power IoT for urban infrastructure
- Worked with public sector for scalable deployments

Role in the Project

Ubaid will validate sensor selection, guide calibration, and troubleshoot integration between hardware and cloud systemS.

11. Risk Management

Below are **five critical risks** identified for your Smart Waste Management System project, with mitigation strategies and expert insights:

Risk Task	Why it's a Risk	Risk Type	Mitigation strategy
Sensor Calibration in Real Conditions	Environmental factors (heat, dust, bin shape) may impact sensor accuracy.	Technical	Conduct extensive lab and fielding tests, use adjustable threshold levels in code.
Cloud Service Downtime	If AWS or Firebase services go down, real-time monitoring halts.	Operational	Setup fallback mechanisms like local caching and backup API's.
Integration of Frontend & Backend	APIs may not align with frontend data expectations, causing data rendering issues.	Development	Use swagger for API contracts and regular sprint reviews with frontend and backend teams.
Lack of User Adoption by Municipality	Stakeholders may resist new systems or apps.	Human/Stakeholder	Conduct hands-on training, get early feedback from users and simplify dashboard UX
Resource Constraints (Mobile Dev)	Limited mobile app developers may delay delivery of app features.	Resource	Outsource if required or use close platform tools to reduce load.

Expert Consultation Summary:

- **Expert Name**: Engr. Faizan Ahmed

- **Expertise**: IoT Architect with 6+ years of experience in Smart City Systems
- **Role in Risk Management**: Helped assess technical feasibility, recommended sensor models, and API fail-safe architecture.
- **Contribution**: Suggested redundancy in sensor logic and using Firebase for real-time alerts due to its low latency.

Budget Summary & Justification:

- **Human Resources** are the major cost factor due to skilled developers and engineers.
- **Hardware is purchased** only once in July for the pilot and full deployment.
- **Contingency** (10%) added to cover unforeseen costs such as repair, extra development time.
- **Cloud services** are recurring for real-time data sync and alerts.