EcoVision: A Cloud-Based Waste Management System With RPA Automation

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Abstract- *Urban waste management systems face challenges such as inefficient route planning, delayed monitoring, high operational costs, and increased carbon emissions. EcoVision is an intelligent waste management platform designed to optimize urban sanitation workflows using cloud infrastructure and automation technologies. The system enables real-time data access and cross-regional scalability, ensuring efficient monitoring and management of waste collection activities. The core innovation lies in the integration of Robotic Process Automation (RPA), which automates repetitive administrative tasks, including route scheduling, bin-level monitoring alerts, and billing processes, without human intervention. By reducing manual.for, optimizing resource utilization, EcoVision minimizeesoperatio nal costs and decreases fuel consumption of collection vehicles, thereby reducing carbon emissions. The proposed system contributes to building a responsive, scalable, and sustainable waste management ecosystem that supports smart city initiatives and cleaner urban environments.*

Keywords: Intelligent Waste Management, Cloud Computing, Robotic Process Automation (RPA), Smart City, Route Optimization, Real-Time Monitoring, and Sustainable Urban Development.

I. INTRODUCTION

Rapid urbanization has significantly increased the burden on municipal waste management systems, particularly in densely populated cities where daily waste generation continues to rise. Traditional approaches based on fixed collection schedules, manual complaint handling, and limited real-time monitoring often result in inefficient operations, delayed issue resolution, increased operational costs, and environmental concerns caused by unnecessary fuel consumption.

To overcome these limitations, modern cities require intelligent, scalable, and technology-driven solutions aligned with smart city initiatives. EcoVision is a cloud-based waste management platform that integrates robotics. Process Automation (RPA) to enhance and automate sanitation workflows. The system facilitates digital complaint registration, real-time monitoring, and automated task routing, thereby reducing manual intervention and improving operational transparency.
By optimizing resource utilization and minimizing redundant vehicle movement, EcoVision promotes a more efficient, sustainable, and responsive urban waste management ecosystem.

1.1 PROBLEM STATEMENT

In many cities, waste management operations still depend heavily on manual processes and fixed schedules. Complaints from citizens are often recorded and routed manually, which can cause delays and reduce transparency in the overall system. Without proper real-time monitoring, authorities may not have clear visibility into the status of waste collection activities.

These limitations lead to inefficient resource utilization, increased operational costs, and inconsistent service quality. As urban populations continue to grow, the absence of an automated and integrated waste management system becomes a significant challenge for municipal authorities. Therefore, there is a clear need for a smarter and more responsive solution that can improve efficiency, accountability, and sustainability.

1.2. LITERATURE REVIEW

Several studies have explored job recommendation, skill gap identification, and career guidance using machine learning and data-driven techniques. The following works are closely related to the proposed system.

In paper [1] H. Mao, “Urban Planning Management Information Integration Platform System Based on Big Data Analysis,” Proc. International Conference, July 29–31, 2023.

In paper [2] D. Cao, H. Yin, and J. Xu, “Research on Digital Urban Management System of Gulou District of Nanjing,” Proc. Conference on Urban Planning Systems, Dec. 26–28, 2009. .

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[5] "Exploring the Use of Robotic Process Automation in Smart Cities," *Proc. 2024 IEEE MSCC*, May 2–4, 2024, doi: 10.1109/MSCC62288.2024.10696992.

II. PROPOSED SYSTEM

EcoVision is a cloud-based intelligent waste management platform developed to modernize and automate municipal sanitation processes. The system combines a user-friendly web interface, centralized cloud storage, and robotic process automation Citizens can register waste-related complaints digitally through the platform, ensuring quick and convenient issue reporting. Once a complaint is submitted, the system automatically analyzes the details and routes it to the appropriate department or field worker based on predefined rules such as location, category, and urgency. The integration of RPA minimizes manual intervention and reduces processing delays. In addition, the platform provides real-time status updates and analytics dashboards that enable authorities to monitor performance, track response times, and improve overall service efficiency. This structured and automated approach enhances transparency, accountability, and operational effectiveness in urban waste management.

III. METHODOLOGY

The methodology of EcoVision is designed as a structured and automated workflow to ensure efficient complaint handling, monitoring, and citizen engagement. The process begins with digital complaint registration, where citizens submit waste-related issues through a web interface or AI-based chatbot by providing details such as location, category, and description of the problem. Once submitted, the complaint data is securely stored in a centralized cloud database with a unique identification number and timestamp to ensure traceability.

An RPA bot continuously monitors the database for newly registered complaints. Upon detection, the bot extracts relevant details and applies predefined routing rules based on factors such as location, complaint type, and urgency level. The system then automatically assigns the complaint to the appropriate municipal department or field worker, reducing manual delays. Throughout the resolution process, the complaint status is updated dynamically through stages such as Assigned, In Progress and Resolved. Real-time tracking ensures transparency for both authorities and citizens. The system records response times and generates analytical reports to evaluate operational efficiency and departmental performance. To encourage active citizen participation and improve accountability, the platform incorporates a reward and recognition mechanism. Citizens who consistently report valid issues or provide constructive feedback may earn digital reward points or recognition badges. Similarly, departments or field workers demonstrating efficient resolution performance can be recognized through performance metrics and acknowledgment dashboards. This mechanism promotes community involvement and motivates service providers to maintain high service standards. Finally, once the complaint is resolved, the system initiates a feedback collection process. The collected feedback is analyzed to support continuous improvement in service delivery.

IV. RPA INTEGRATION WORKFLOW

Thecomplaint..registration, Complaint Registration, is where citizens report waste-related issues through an AI-powered chatbot or web interface by providing details such as location, complaint type, and description. All complaints are securely stored in a centralized cloud database with a unique complaint ID and timestamp for tracking. An RPA bot continuously monitors the database for new complaints and automatically assigns them to the appropriate municipal department or field worker based on predefined rules like location, category, and urgency. The system tracks the complaint status through diffe progress.

Additionally, analytics and reporting tools evaluate response times and performance metrics to measure efficiency and identify areas for improvement. Once the issue is resolved, citizens can submit feedback and ratings, which are stored for continuous service quality enhancement. The results confirm that the system can reliably detect multiple types of hazards and provide early warning signals to prevent potential accidents. The developed system functions as a multi-hazard detection platform by combining gas, temperature, humidity, and

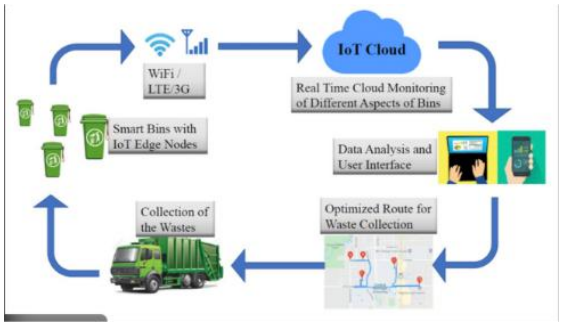
V. TECHNOLOGY STACK

A cutting-edge and effective technology stack was used in the construction of the EcoVision system to guarantee scalability, automation, and user-friendliness. A responsive user interface and interactive dashboards for both citizens and administrators are made possible by the frontend's

development using HTML, CSS, JavaScript, and React.js. TypeScript powers the backend, which effectively manages client-server communication through RESTful APIs. To ensure scalability and dependability, all complaint data is safely stored in a MySQL database with cloud-based storage. Routing and complaint monitoring procedures are automated by RPA tools like Automation Anywhere and UiPath. An NLP-based chatbot for filing complaints and a Response Time Analytics engine for monitoring performance are integrated into the AI and analytics layer. An NLP-based chatbot that uses natural language processing to streamline complaint registration is part of the AI and analytics module, and a Response Time Analytics engine assesses operational effectiveness and performance. Utilizing services like EC2, RDS, and Cloud Storage for hosting, database administration, and safe data handling, the system is set up on the AWS Cloud platform.

EcoVision is a powerful and cutting-edge environmental management solution since it also uses Postman for API testing and Git/GitHub for version control, continuous integration, and collaborative software development.

VI. SYSTEM ARCHITECTURE



The EcoVision system architecture is built as a modern, cloud-based framework that brings together automation, analytics, and smart decision-making to make urban waste management more efficient. The frontend interface, like the one shown in the login screen, is created using React.js, HTML, CSS, and JavaScript to provide a clean, responsive, and easy-to-use experience. It includes role-based login, so Citizens, authority officers, and departments can each access features meant for them. For example, citizens can easily report waste-related issues, upload photos, and track the status of their complaints. Authority officers can review and assign those complaints, while departments can update progress and mark tasks as completed. The design focuses on being simple, accessible, and mobile-friendly, ensuring that users can interact with the system smoothly and in real time, no matter what device they're using.

VII. RESULT

The proposed RPA-based Municipal Task Assignment System was successfully implemented and tested in a simulated smart city environment. The system consists of user authentication, automated task routing, SLA monitoring, and escalation mechanisms. accidents, reduce operational risks, and support proactive maintenance in high-risk environments.

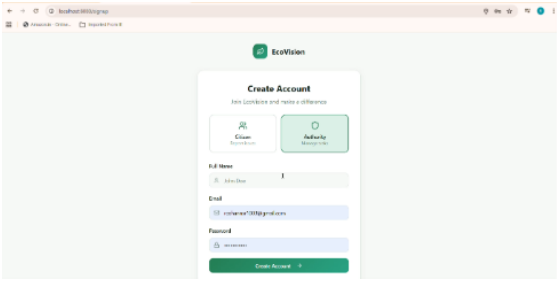


Fig. 1. Login Page of the Proposed System

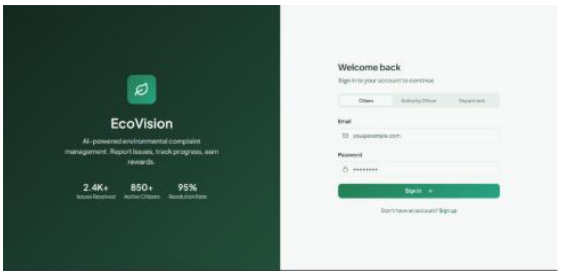


Fig. 2. Signup Page of the Proposed System

The login interface ensures secure access to the system by validating authorized users before granting access to administrative functionalities.

The authentication module verifies user credentials and restricts unauthorized access, thereby enhancing system security and data integrity. The login system is designed with role-based access control to differentiate between administrative authorities and operational departments.

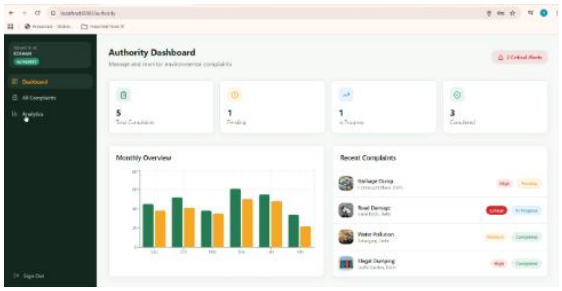


Fig. 6. Authority Dashboard Showing Task Assignment and SLA Status

After successful login, the authority dashboard provides a centralized interface for monitoring complaint assignments, SLA status, and escalation actions.

The implemented RPA logic automatically assigns tasks to appropriate departments based on predefined rules. If the SLA time exceeds the defined threshold, the system triggers an escalation process and sends automated notifications.

VIII. ALGORITHM

The EcoVision complaint management algorithm begins when a citizen registers a complaint through an AI-powered chatbot or web portal by providing essential details such as location, complaint type, and description. Once submitted, the system validates the information, generates a unique complaint ID along with a timestamp, and securely stores the record in a centralized cloud database with an initial status marked as "Registered." A Robotic Process Automation (RPA) bot continuously monitors the database for new complaints. When a new entry is detected, the bot retrieves its details and applies auto-routing logic to assign the complaint to the appropriate municipal department or field worker based on factors such as location, category, and urgency. The system then updates the complaint status to "Assigned" and notifies the citizen automatically. As the issue progresses, the status transitions through various stages—Assigned → In Progress → Resolved—with each update triggering a real-time notification to keep citizens informed. Meanwhile, the analytics module collects performance data, including response times and completion rates, to evaluate operational efficiency. After resolution, the citizen receives a feedback form to rate the service and provide comments. This feedback is stored and analyzed to enhance future performance, improve accountability, and ensure a transparent, data-driven waste management process.

IX. CONCLUSION

EcoVision demonstrates how RPA and SLA-based automation can significantly improve municipal complaint management. By automating routing, monitoring, and notification processes, the system enhances operational efficiency and supports digital governance initiatives. The proposed architecture is scalable and adaptable to smart city environments.

EcoVision demonstrates that integrating RPA with SLA-driven governance mechanisms significantly enhances municipal service efficiency. Automation reduces human errors, improves transparency, and enforces accountability. The modular system design ensures adaptability for smart city ecosystems and scalable deployment.

10.Future Implementation

Future enhancements may include:

- AI-based complaint prioritization
- SMS integration
- GIS-based complaint mapping
- Mobile application support
- Cloud deployment for scalability
- Integration with IoT-based smart sensors

REFERENCES

[1] H. Mao, "Urban Planning Management Information Integration Platform System Based on Big Data Analysis," Proc. International Conference, July 29–31, 2023.

[2] D. Cao, H. Yin, and J. Xu, "Research on Digital Urban Management System of Gulou District of Nanjing," Proc. Conference on Urban Planning Systems, Dec. 26–28, 2009.

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