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Role-Based Waste Pickup Scheduling Platform with Resident Notification Optimization System Civic Services

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ABSTRACT

Rapid urbanization and continuous population growth have significantly increased the complexity of Municipal Solid Waste (MSW) management in residential communities. Conventional waste collection systems primarily rely on fixed collection schedules and manual planning, making them inefficient in handling the varying waste generation patterns of modern urban environments. These traditional approaches often result in delayed waste collection, overflowing garbage bins, inefficient route planning, excessive fuel consumption, increased operational costs, environmental pollution, and potential public health risks. Furthermore, the absence of real-time coordination among residents, sanitation workers, and municipal authorities limits effective communication, making it difficult to respond promptly to collection requests, service complaints, and emergency situations. To address these challenges, the proposed Resident Clean Scheduler Organized Waste Collection System (RCS-OWCS) introduces a centralized web-based platform that automates and optimizes residential waste management operations. The system enables residents to schedule waste pickups, report sanitation-related issues, and monitor collection status in real time. Sanitation workers receive optimized collection schedules and intelligent route guidance to improve operational efficiency, while municipal administrators can supervise collection activities, allocate resources, monitor workforce performance, and generate analytical reports for data-driven decision-making. By integrating automated scheduling, centralized data management, and real-time communication, the proposed system enhances service transparency, minimizes operational expenses, improves resource utilization, and reduces environmental impact. The platform supports sustainable Smart City (SC) development by promoting efficient waste collection, cleaner residential environments, improved civic participation, and technology-driven municipal service management.

Key words: Municipal Solid Waste Management, Smart City, Waste Collection Scheduling, Route Optimization, Real-Time Monitoring, Sustainable Urban Management.

1. INTRODUCTION

Municipal waste management is currently a crucial topic related to a variety of processes, such as waste generation, storage, collection, transport, recovery and disposal in accordance with public health, sustainable development and economic policies [1]. The rapid growth of the global population and urbanization have increased the production of municipal solid waste (MSW) with critical socioeconomic and environmental consequences [2]. In order to find optimal solutions for both the problem of material resources and the effectiveness of MSW management systems, the concept of Circular Economy (CE) was introduced, based on five principles waste prevention, reuse, recycling, energy recovery, and waste disposal [3].

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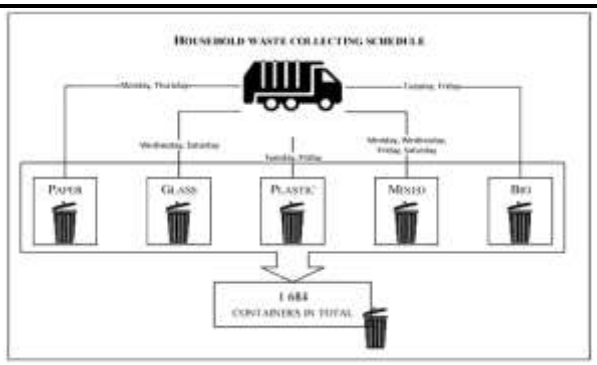

Fig. 1: Resident clean scheduler organized waste collection

In Italy, multiple organizations (such as companies, municipalities, foundations, associations, research centres and universities) have been involved in the transition to the CE policy, and among the five principles of CE, recycling has proven to be the most favourable practice to be adopted for more sustainable MSW management in terms of ecology and health safety [4]. On average, European countries produce about 482 kg of waste annually per capita; however, differences in MSW generation have been reported. The countries with the highest waste generation rates are Denmark, Cyprus, Malta and Germany, while the lowest rates are in Romania, Poland, Czech Republic and Slovakia [5]. The level of MSW generation has mainly been affected by the national economic development, so that the richer the country, the more waste that is generated.

2. LITERATURE SURVEY

Manikantan R, et al. [6] proposed a smart waste collection system based on IoT sensors and the TOPSIS multi-criteria decision support method for route optimization with criteria such as toxicity, volume, and time duration. With multiple influencing variables compared to using one parameter, the system proposed here achieved a reduction of 14% in the overall collection distance. Likewise, it addressed the application of IoT for real-time medical waste monitoring in smart cities. Mr. Adithya Sampath, et al. [7] proposed a system that could be applied to smart city waste management, enabling proactive decision-making and efficient resource allocation. By integrating real-time traffic data, bin fill levels, and vehicle capacity constraints, the system adapted dynamically to changing conditions in the urban landscape. Reshma K.J., et al. [8] suggested a system that maximized waste collection by reducing travel distances without compromising efficiency, especially for high-waste-generating households. Initially, it prioritized target households based on estimated waste accumulation and ranked them in decreasing order of waste generation.

Sivapriya K, et al. [9] developed an IoT-powered waste management system that inherently supported circular economy principles by making efficient segregation, recovery, and recycling of wastes possible. The practices saved resources, minimized environmental pollution, and promoted sustainable material flows. Consistency with international sustainable urban development objectives enabled waste systems not only to contribute to environmental protection but also to economic resilience and social wellbeing. Rakesh U, et al. [10] introduced an innovation for a smart garbage bin with a real-time monitoring system that incorporated numerous technologies. This study proposed a Medical Waste Collection Management (MWCM) system for hospitals and clinics in smart cities through IoT to keep the city clean and monitor waste bins in real-time. Merve Erçin, et al. [11] developed that waste collection was an operational process that needed to be done regularly in settlements. A poorly managed waste system created unhygienic conditions and costs. With the rapid development of technology, the concept of the smart city entered our lives and the processes in cities were supported by technologies. As cities moved towards becoming smart, it became possible to improve waste collection systems.

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D. Varghese, et al. [12] developed a waste collection model including route optimization. The proposed route optimization model suggested an optimal route to the waste collection system using the system's variables, parameters, and the constraints created by the relationship between variables. This model was proposed for initial use of the system in a region. In time, it was anticipated that improvements in route optimization by using AI and machine learning, and thus improvements in the generated algorithm, could be made by obtaining historical data in waste bins. As the data of the filling times of the waste bins accumulated over time, the determination of the routes was improved by using machine learning. Tamas Banyai, et al. [13] proposed a waste collection process that was described, which incorporated routing, assignment, and scheduling problems. V. Ruiz, et al. [14] developed a system that represented a prime instance of how machine learning approaches and route optimization could potentially improve the urban waste aggregation process. Through the use of these comprehensive methods, the system overcame the inadequacies in traditional approaches for managing waste. Maurizio Faccio, et al. [15] proposed the idea that knowing the real-time data of each vehicle and the real-time replenishment level at each bin made it possible to decide, as a function of the waste generation pattern, which bin should be emptied and which should not be, optimizing different aspects like the total covered distance, the necessary number of vehicles, and the environmental impact.

3. PROPOSED METHODOLOGY

The workflow of the proposed resident clean scheduler system is designed to introduce a structured, data driven approach to residential waste collection and monitoring. The process begins with residents interacting through a web-based interface to schedule waste pickups or report collection-related issues, ensuring direct and timely communication. These requests are centrally processed and stored in a database, enabling administrators to monitor service demand and manage access control efficiently. Based on collected schedules and service data, optimized routes and task assignments are generated and communicated to sanitation workers. Field level activities are continuously logged, allowing real time tracking of collection progress and issue resolution. The integrated workflow ensures seamless coordination among residents, administrators, and sanitation workers while maintaining transparency, operational efficiency, and reliable service delivery.

Fig. 2: System architecture for proposed resident clean schedule

The proposed methodology as demonstrated in Fig. 2gm focuses on establishing a structured, technology driven workflow to improve the efficiency and transparency of residential waste collection operations. The system follows a role-based interaction model involving residents, administrators, and sanitation workers, supported by a centralized digital platform. All activities are coordinated through a web-based interface to ensure real-time communication, monitoring, and data consistency. The methodology begins with residents accessing the system through a web interface to schedule waste pickups or report

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collection-related issues. These inputs are securely transmitted to the backend server, where they are processed and stored in a centralized My Structured Query Language (MySQL) database.

Workflow

The workflow of the resident clean scheduler system as shown in Fig. 3 is designed to ensure systematic coordination among residents, administrators, and sanitation workers through a centralized digital platform. The process begins when residents interact with the system to schedule waste pickups or report service-related issues using a web-based interface. These inputs are securely transmitted to the backend server and stored in a centralized database for further processing. Administrators continuously monitor incoming requests, manage schedules, and oversee operational activities through a dedicated control panel. Based on the collected data, optimized task assignments and routes are generated for sanitation workers to improve collection efficiency. Field-level execution updates are logged in real time, and status notifications are shared with all relevant stakeholders, completing a transparent and closed-loop workflow.

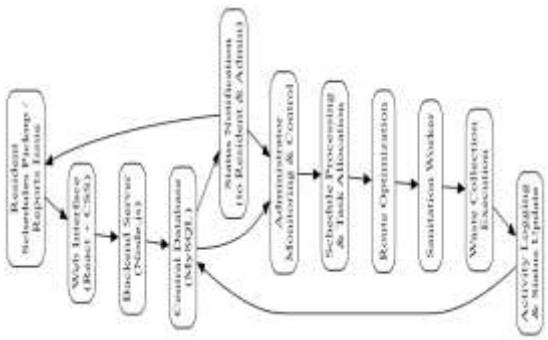

Fig. 3: System workflow for proposed resident clean schedule

4. RESULTS AND DISCUSSION

The implementation of the Resident Clean Scheduler system is realized as a full-stack web application designed to automate and organize residential waste collection processes. The system integrates a responsive frontend, a scalable backend, and a centralized database to enable real-time scheduling, monitoring, and coordination among residents, administrators, and sanitation workers. The implementation emphasizes modularity, data consistency, and efficient workflow execution to ensure reliable civic service delivery.

Fig. 4: Supervisor Dashboard for OWCSRORTIR

The Fig. 4 shows the supervisor dashboard of the waste management system. This page allows the supervisor to monitor incoming service requests from residents and assign workers for waste collection and related tasks. The dashboard displays details such as resident name, type of request, assigned worker, action status, and rating with feedback. Completed tasks and performance feedback help in evaluating worker efficiency. The left-side menu provides options to manage residents, workers, and approval requests.

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Fig. 5: Resident Management Page for OWCSRORTIR

The Fig. 5 shows the resident management page of the waste management system. This page allows the supervisor to view the list of registered residents along with their phone numbers and addresses. The supervisor can manage resident records and remove users when required using the “Remove” option. The left-side menu provides easy navigation to other modules such as workers, approvals, and the dashboard.

Fig. 6: Worker Management Page for OWCSRORTIR

The Fig. 6 shows the worker management page of the waste management system. This page allows the supervisor to view the list of registered workers along with their phone numbers and performance scores. The supervisor can manage worker records and remove workers when required using the “Remove” option. The left-side menu provides navigation to other sections such as dashboard, residents, and approvals.

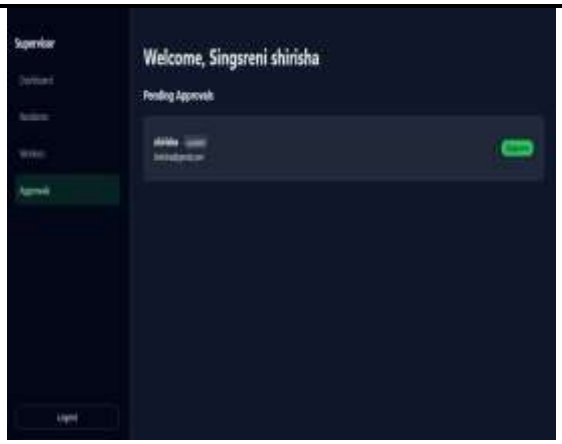

Fig. 7: User Approval Page for OWCSRORTIR

The Fig. 7 shows the pending approvals page of the waste management system. This page allows the supervisor to review and approve newly registered users. The system displays the user’s name, role (resident), and email address. The supervisor can grant access by clicking the “Approve” button. This page ensures that only verified users are allowed to access the system, maintaining security and controlled user management.

Fig. 8: Worker Dashboard and Complaint Management for OWCSRORTIR

The image as shown in the Fig. 8, displays Worker Dashboard serves as the central hub for field staff to manage service requests, featuring a personalized greeting for the authenticated user, such as "Ramya". The interface displays critical task details, including specific complaints like "work is not done in block 5" and "trash is not collected,"

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alongside essential field data like the location "Medchal" and a contact phone number. To facilitate real-time operational tracking, the system utilizes status indicators to mark tasks as "Completed" and provides functional controls such as a "Raise Complaint" button and a "Logout" option.

Fig. 9: Resident Dashboard for OWCSRORTIR

The image as shown in the Fig. 9, Supervisor Dashboard provides an administrative overview of the system's operational status, allowing the supervisor, such as "Dilip," to manage high-level activities and community requests. The interface features a personalized header and a navigation sidebar that includes a Logout option for secure session termination. Central to this dashboard is the Complaints and Requests section, which displays active issues reported by residents, such as "work is not done in block 5" and "trash is not collected". Each entry includes vital metadata such as the specific location ("Medchal"), a contact phone number, and a progress bar or status indicator to track resolution. This centralized view enables the supervisor to efficiently monitor worker performance and ensure that all community waste management needs are being addressed in a timely manner.

5. CONCLUSION

The resident clean scheduler organized waste collection system successfully addresses key operational challenges associated with traditional residential waste management practices. The project demonstrates how a structured, web-based approach can improve coordination among residents, administrators, and sanitation workers through centralized scheduling, monitoring, and communication. By replacing manual processes with digital workflows, the system enhances service transparency, reduces inefficiencies, and supports more reliable waste collection operations.

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