COMMUNITY

INFORMATICS

Prepared by

Group 18

GROUP DETAILS

22020901	A.U.Savindu
22020322	Herath H.M.K.M
22021035	H.R.D.L.M.Thilakarathne
22020853	Sajidha M.S.F

TABLE OF CONTENT

IDENTIFICATION AND ANALYSIS OF THE PROBLEM

PROBLEM OVERVIEW

Sri Lanka's urban areas are struggling with a severe waste management crisis, driven by poor disposal habits, inefficient collection systems, and illegal dumping. Citizens often discard waste in unauthorized areas due to a lack of awareness and accessible disposal facilities. The waste collection process is inefficient, leading to irregular service, overflowing bins, and unoptimized routes. Additionally, illegal dumping worsens pollution, affecting the environment and public health.

These issues result in unhygienic living conditions, environmental degradation, and declining urban aesthetics. Without immediate intervention, the situation will continue to deteriorate, affecting economic growth, public health, and overall city cleanliness.

ANALYSIS

- **Poor Waste Disposal Practices** - The majority of the urban areas in Sri Lanka experience the issue of indiscriminate dumping of waste, with people and commercial entities dumping garbage in open spaces, roads, or water sources instead of using the provided disposal systems. Lack of awareness and segregation of waste makes it worse, recycling and processing of the waste becoming more and more complex.

- **Inefficient Collection Systems -** Waste collection infrastructure in most municipalities is deplorable, featuring irregular collection of garbage, lack of disposal sites, and outdated waste management infrastructure. Municipal councils and waste management authorities are plagued by logistical problems, limited funding, and inadequate resource allocation, leading to the piling up of waste along streets and public areas.

- **Illegal Dumping -** Illegal dumping of waste, particularly in urban and semi-urban areas, is increasing. Construction material, plastic waste, and hazardous materials are regularly dumped in unauthorized places such as wetlands, forests, and rivers, leading to severe pollution and environmental damage.

- **Impact on Public Health -** Improper waste disposal creates breeding grounds for mosquitoes, rodents, and other pathogens that cause diseases, thus making dengue, respiratory diseases, and gastrointestinal diseases more possible. Air pollution from the burning of waste also exacerbates urban air quality, creating long-term health risks.

- **Environmental Consequences -** Illegal dumping and absence of controlled waste disposal are to blame for soil, air, and water pollution. Drainage systems are choked by plastic trash, leading to regular urban flooding. Toxins from landfills and dumpsites leach into the groundwater, affecting drinking water quality and harming aquatic life.

- **City Cleanliness & Aesthetic Issues -** llegal dumpsites and uncollected trash disfigure the aesthetic appeal of urban environments, affecting tourism, property values, and overall quality of life. A poorly maintained urban environment also dampens public morale and investment in the cities' economy.

Addressing these concerns requires comprehensive waste management reforms, public sensitization campaigns, policy enforcement, and adoption of sustainable waste disposal methods such as recycling, composting, and proper landfilling.

PROBLEMS IDENTIFIED

- Citizens face multiple challenges in waste management. Many people are unaware of proper waste disposal methods, leading to garbage being discarded in unauthorized locations. Additionally, they struggle to find designated bins in their neighborhoods, making it difficult to dispose of waste responsibly. A major issue is the absence of a simple and accessible way to report waste management problems such as overflowing bins or missed collections.

- Waste collectors also encounter several operational difficulties. Collection teams often follow inefficient routes, which results in delays and inconsistent service across different areas. They frequently deal with overflowing bins due to irregular pickup schedules, making their work more challenging. Moreover, the reliance on manual data logging slows down operations and reduces overall transparency in waste collection processes.

- Waste centers face significant limitations in tracking and managing waste collection. There is no efficient system to monitor how much waste is collected, where it originates, or how effectively disposal sites are managed. Without access to real-time data, decision-making is slow, leading to inefficient resource allocation and poor waste management outcomes.

Addressing these challenges requires an integrated approach that combines public awareness, technological solutions, and improved waste collection strategies. By focusing on data-driven waste tracking, citizen engagement, and optimized logistics, Sri Lanka can move towards a cleaner and more sustainable urban environment.

PROPOSED ICT BASED SOLUTION

SOLUTION OVERVIEW

Our proposed Smart Waste Management System (SWMS) is a progressive, mobile and Internet of Things (IoT)-based system that seeks to make waste collection easier and increase sustainability. The system unites all the interested parties in the waste management value chain—citizens, collectors, and centers—using technology to optimize the monitoring, collecting, and dumping of waste processes in real time.

The SWMS is designed to provide an improved, efficient, responsive, and environmentally friendly solution to waste management using smart sensors, mobile apps, AI, and data analytics. The solution is targeted towards improving the efficiency of waste collection, reducing expenses, enhancing recycling operations, and reducing environmental degradation.

HOW IT WORKS

Citizens

The SWMS mobile app gives power to citizens, providing them with tools to help them play a role in effective waste management:

- Waste Reporting: Citizens can report issues such as overflowing bins, littering, or hazardous waste through the app, allowing waste collectors to detect and resolve issues in a timely manner.

- Smart Bin Locator: The app uses geolocation to allow citizens to locate nearby smart bins, encouraging the disposal of waste in available and convenient bins.

- Collection Schedule Tracking: The app allows users to view collection schedules, receive notifications when the next collection is near, and obtain updates in case of changes in the schedule due to unforeseen circumstances.

IoT-Sensored Bins

IoT-sensored bins are the centerpiece of the SWMS, and they are equipped with advanced sensors that monitor waste levels continuously. The bins are placed strategically throughout urban areas, and they relay real-time data that enhances the efficiency of waste management in general:

- Real-Time Waste Monitoring: : Each smart bin is equipped with sensors that monitor the fill level, temperature, and even the type of waste disposed of. The system automatically sends data to waste collectors and waste centers, allowing real-time monitoring of waste levels and conditions in the bins.

- Route Optimization of Collection: Based on the data received from the IoT-sensored bins, the system plans bin collection based on fullness, preventing overflows and ensuring timely garbage collection. This removes unnecessary pickups, optimizing the routes for garbage collectors and reducing fuel usage and emissions.
- Smart Scheduling: Data from these bins can be used to predict the optimal time for pickups so that waste collectors operate on the basis of actual demand rather than being on rigid schedules, improving overall collection efficiency.

Waste Collectors

Waste collectors benefit from the SWMS through a series of features designed to make their jobs easier:

- Optimized Routes: AI algorithms calculate the most efficient collection routes based on data from the IoT-sensored bins, reducing travel time, fuel consumption, and operational costs.

- Real-Time Bin Monitoring: Waste collectors can view real-time data from the IoT sensors to see which bins are approaching full and need to be collected urgently. This allows them to plan collections in priority order and respond dynamically to changing waste levels.

- Collection Tracking: Collectors can log their progress, report any problems, and ensure all scheduled collections are completed on time. This ensures accountability and allows waste centers to track performance in real time.

Waste Centers

Within the waste centers, the SWMS uses data analytics and IoT integration to optimize waste management operations:

- Real-Time Monitoring and Data Analytics: The waste centers receive real-time information from the IoT-sensored waste bins and collection trucks, providing a bird's-eye view of the waste management process. The data is used for tracking trends, optimizing operations, and resource allocation.

- Operational Optimization: The data analysis from the IoT sensors and AI provide waste centers with the ability to optimize staffing, plan effective waste sorting schedules, and ensure compliance with environmental regulations. The waste centers can also optimize their waste disposal and recycling processes based on the trends identified from data analysis.

By integrating IoT-sensored bins with the entirety of the waste management ecosystem, the SWMS facilitates real-time data collection and intelligent decision-making in such a way that waste collection and disposal are as efficient, timely, and green as possible. The system reduces unnecessary collection trips, prevents bin overflow, and allows cities to reach sustainability goals.

ANALYSIS OF THE PROPOSED SOLUTION

IMPACT OF THE SOLUTION

Smart Waste Management System (SWMS) is to benefit multiple stakeholders with various added benefits through maximizing efficiency and sustainability of waste collection and disposal.

For Citizens:

- More convenient and easy waste disposal through the mobile application and intelligent bin finders.
- Increased waste management practice awareness through real-time updates and messages.
- Healthier surroundings due to maximum waste collection, reducing littering and overflowing issues.

For Waste Collectors:

- Increased collection frequencies for households.
- Reduced operating costs by limiting manual calls.
- Improved routes to optimize driving patterns.
- Reduced fuel costs and optimized waste collection routes according to real-time bin information.
- Enhanced schedules of collection with fewer wasted collections and lower workload.
- Enhanced reliability of the service, with on-time waste collection and increased resource utilization.

For Waste Centers:

- Enhanced waste management through real-time and predictive analysis data.
- Enhanced tracking of waste patterns to inform wiser recycling and disposal activities.
- Enhanced operational effectiveness through minimized waste spillover and optimized resource assignment.

SUSTAINABILITY & SCALABILITY

The SWMS is designed to be sustainable and scalable, becoming feasible in the long term as well as elastic enough to operate in different regions and waste management needs.

Scalability:

- The system has the ability to scale up from urban to rural and suburban cities.
- Integration capability with municipal solid waste management systems for mass installation.
- Possibility of expansion to industrial and business waste management operations.

Sustainability:

- Generation of revenue through public-private partnerships (PPP), where governments and private entities are encouraged to collaborate together to share expenses and benefits.
- Advertising revenues generated through digital displays or QR code promotional advertising on smart bins to finance maintenance and operational costs.
- Reduced environmental impact through lowered fuel usage, efficient refuse collection, and recycling behavior.

CHALLENGES & SOLUTIONS

Challenge	Proposed Solution
High cost of IoT-based bins	Seek government-private funding, implement a phased rollout strategy to deploy bins gradually, and encourage local manufacturing to reduce costs.
Limited Internet Access in Rural Areas	Use low-cost, low-bandwidth communication technologies such as LoRaWAN (Long Range Wide Area Network) to transmit data in areas with poor internet connectivity.
Resistance to adoption	Conduct awareness campaigns to educate citizens and stakeholders, introduce incentive-based programs such as rewards or discounts for participation.
Data Privacy & Security	Implement robust encryption protocols and secure data storage practices to protect citizens' personal information. Ensure compliance with data protection regulations like GDPR.
Bin Vandalism or Theft	Use tamper-resistant bins and integrate GPS tracking on bins to prevent theft or damage. Engage the community with education and awareness programs to reduce vandalism.
Low digital literacy of collectors	Training programs, user-friendly app interface with multilingual support, visual guides.

PROTOTYPE

EcoTrack Prototype

VIDEO LINK

EcoTrack Video

REFERENCES

- http://www.ncas.ac.lk/journal/journal_2019_1/article%20_06_NCAS%20journal2019.pdf
- https://www.researchgate.net/publication/228501236_Environmental_impacts_with_waste_disposal_practices_in_a_suburban_municipality_in_Sri_Lanka#:~:text=Disposal%20of%20solid%20waste%20is,Bandara%20and%20Hettiaratchi%2C%202010)%20.
- https://www.linkedin.com/pulse/waste-management-challenges-sri-lankas-colombo-kandy-paving/
- https://journals.sjp.ac.lk/index.php/fesympo/article/view/6951
- https://bine.world/
- https://www.rts.com/blog/what-is-a-smart-waste-bin/