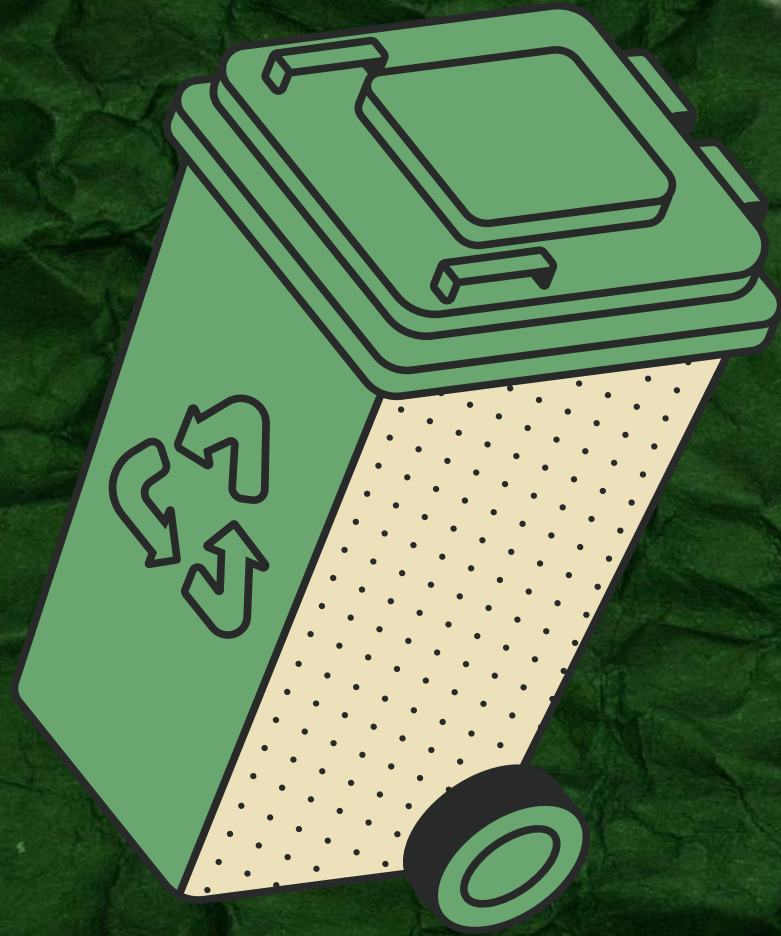




Smart Waste Management System



R26-IT-126

FINAL PRESENTATION

October 2026

Project Team

Supervision



Mr. Uditha Dharmakeerthi

Supervisor



Mr. Kanishka Prajeewa Yapa

Co-supervisor

Group members



Hemsara K.D.S

IT22548528 · C1

IoT-Based Environmental
Sensing Smart Bin



Gamaariya C.C

IT22202772 · C2

Smart Fill-Level and
Occupancy Monitoring



Jayawardhane K.G.M.S

IT22213358 · C3

ML-Based Municipal Waste
Prediction, Composition
Estimation and Circular
Economy Revenue Hub



Wijesiri A.M

IT22088482 · C4

Mobile Application for Real-
Time Bin Detection, Adaptive
Route Optimization and
Resident-Driven Coordination

PP2 Panel Comments and Responses

Member	PP2 panel comment	How it is addressed
IT22213358 Jayawardhane K.G.M.S ML-Based Municipal Waste Prediction	<i>Good improvement. Need to do an expert evaluation for the final evaluation</i>	<i>The developed system were demonstrated to the Chairman of the Bandaragama Pradeshiya Sabha, and his feedback was obtained as part of the final expert evaluation.</i>
IT22088482 Wijesiri A.M Mobile Application for Real-Time Bin Detection and Coordination	<i>Good progress. Try to do an expert evaluation for the final. Add a notification about the waste collection schedule for the user</i>	<i>Drivers can now post a collection announcement for each ward. Residents of that ward automatically receive it as a push notification at a fixed time, 6:00 PM the day before collection. The complete workflow was tested end to end on real phones with a moving driver (12 of 12 scenarios passed) and recorded as a demo video.</i>
IT22548528 Hemsara K.D.S IoT-Based Environmental Sensing Smart Bin	<i>Change the dashboard in a way that the user can select the bins' critical levels, and only show them through the dashboard (In a particular root)</i>	<i>Updated the dashboard to allow users to select critical bin levels and display only the selected bins under a specific root.</i>
IT22202772 Gamaariya C.C Smart Fill-Level and Occupancy Monitoring	<i>Need to improve the response time. Need to do the expert evaluation</i>	<i>Improved system response time by optimising data processing and transmission. Conducted expert evaluation and incorporated the feedback received.</i>

Research Problem

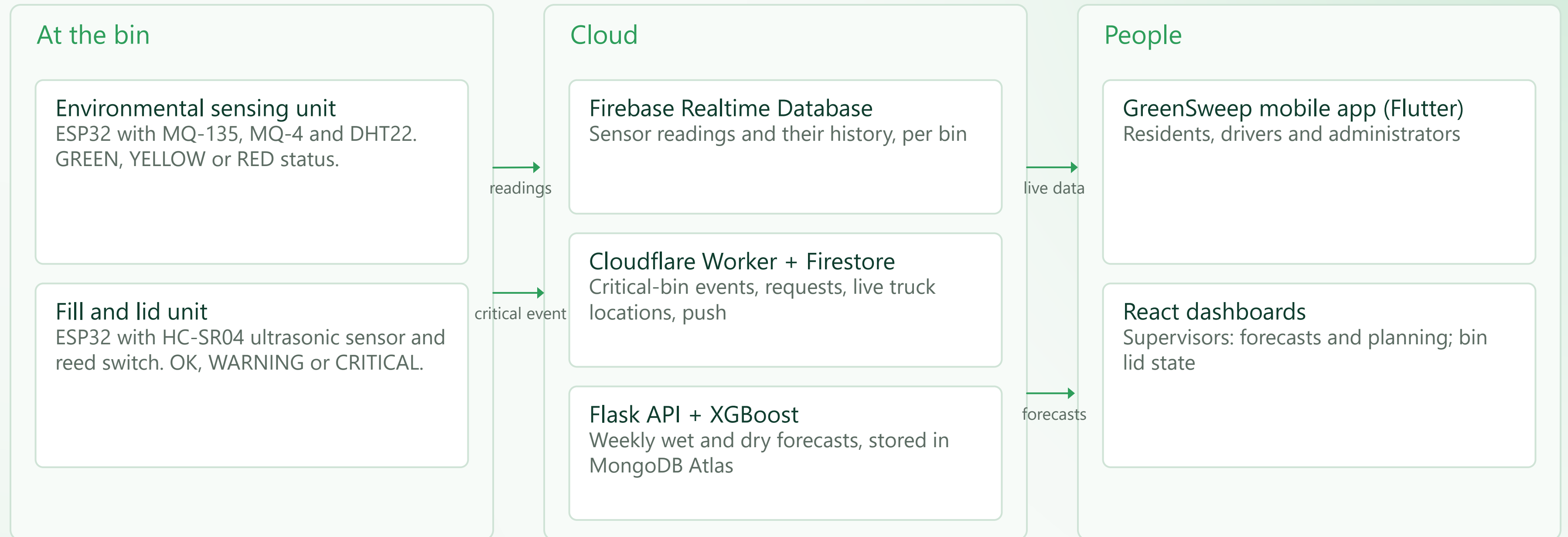
Research question

Waste collection is still mostly reactive: fixed schedules, no live view of what is happening inside bins, no advance estimate of demand, and little coordination between residents and collection drivers. How can sensing, forecasting and mobile coordination be combined so collection becomes proactive?

Key challenges

- | | | |
|----|-------------------------|--|
| C1 | Bin conditions | Fill-only monitoring misses gases, heat and humidity inside a bin, and manual inspection is only occasional. |
| C2 | Fill and lid state | Overflow is noticed late, and the lid activity that explains it is not recorded. |
| C3 | Future demand | Weekly wet and dry waste is known only after collection, too late to plan trips and recycling. |
| C4 | Collection coordination | Residents cannot see when a truck is coming, and drivers lack one view of critical bins and resident requests. |

Solution Overview



Four components

C1 Environmental Sensing Smart Bin

C2 Fill-Level and Occupancy Monitoring

C3 Waste Prediction and Revenue Hub

C4 Mobile App for Bins and Coordination



IoT-Based Environmental Sensing Smart Bin

How it works



What it does

- Watches the condition inside the bin, not only how full it is: air quality, methane, temperature and humidity.
- Thresholds: MQ-135 at 35 and 100 ppm, MQ-4 at 1,000 and 5,000 ppm, temperature at 45 and 60 °C. The worst reading sets the status.
- Watchdog and reconnect logic keep it running unattended.

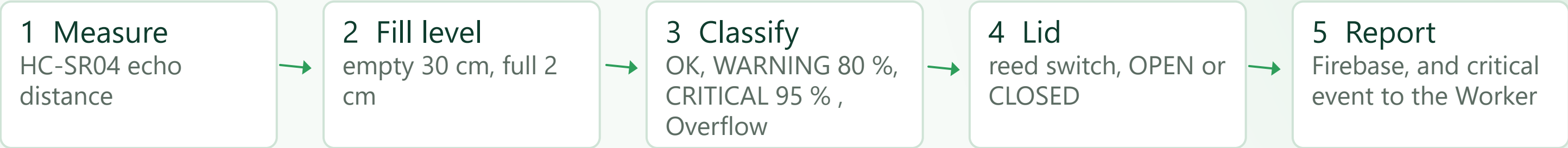
Evaluation

Payload delivery	99.4 %
Mean cloud latency	1.84 s
Temperature and humidity error (RMSE)	0.82 °C and 2.74 pp
Alert classification accuracy	96.7 % (target 97 %)



Smart Fill-Level and Occupancy Monitoring

How it works



What it does

- Turns the distance to the waste surface into a fill percentage, shown on green, yellow and red LEDs at the bin.
- Records lid state and specifies five patterns, such as a sudden rise without a lid event or a lid left open.
- A critical bin is sent to the collection Worker, so it appears straight away on the driver's map (C4).

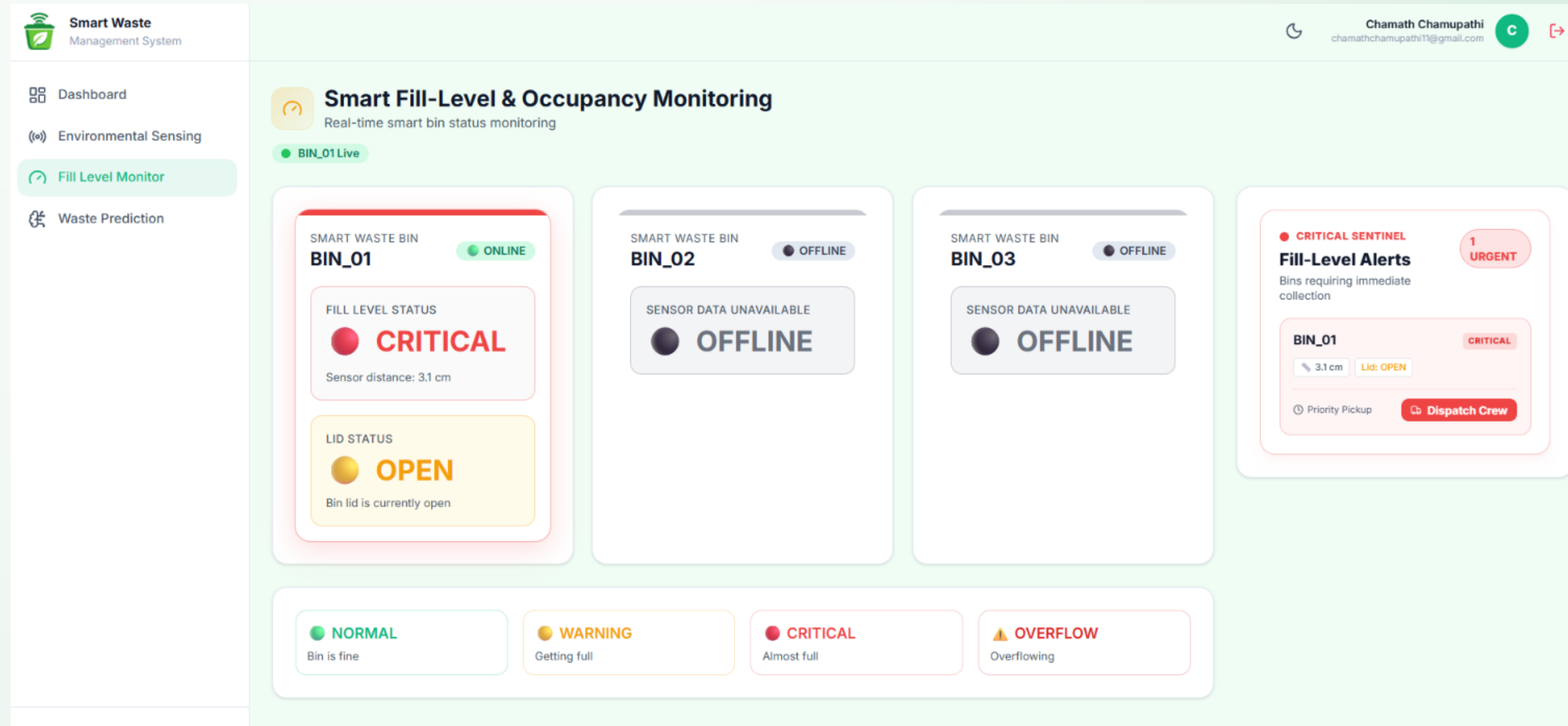
Evaluation

Fill class at the 79, 80, 94 and 95 % boundaries	Expected class every time
Lid state on the web page	OPEN and CLOSED shown
Critical bin reaches the driver map	Shown in red (with C4)
Bins in the study	3



IT22202772 | Gamaariya C.C

Smart Fill-Level and Occupancy Monitoring - Web Application

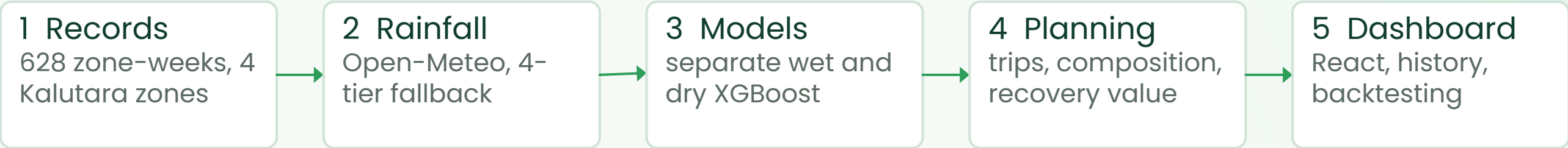


IT22213358 | Jayawardhane K.G.M.S



ML-Based Municipal Waste Prediction, Composition Estimation and Circular Economy Revenue Hub

How it works



What it does

- Forecasts next week's wet and dry waste for Kalutara North, Kalutara South, Katukurunda 1 and Katukurunda 2.
- Turns the forecast into five-tonne truck trips, material composition and an indicative recovery value.
- A Flask service stores every run in MongoDB Atlas; the dashboard compares predictions with actual tonnage.

Evaluation

Dry waste: R ² and MAE (RMSE)	0.949 and 1.52 t (2.27 t)
Wet waste: R ² and MAE (RMSE)	0.804 and 3.28 t (4.83 t)
Test split	chronological, 502 train / 126 test

Waste Prediction Dashboard



Smart Waste
Management System

Dashboard

Environmental Sensing

Fill Level Monitor

Waste Prediction

 Predict

 Results

 Revenue

 Recommendations

 History

Inputs:

Week: Oct 25 – Oct 31, 2026

Normal Week

 115.5mm (Open-Meteo (Live Forecast))

October



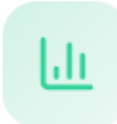
WET WASTE

114.9 tons



DRY WASTE

80.31 tons



TOTAL WASTE

195.21 tons



TRUCK LOADS

40 loads

Total collection loads this week

Truck Load Allocation by Zone

Standard compactor truck capacity: 5 tons per load



KalutaraMC
kalutaramc2@gmail.com

K



< Collapse



Mobile Application for Real-Time Bin Detection, Adaptive Route Optimization and Resident-Driven Coordination

How it works

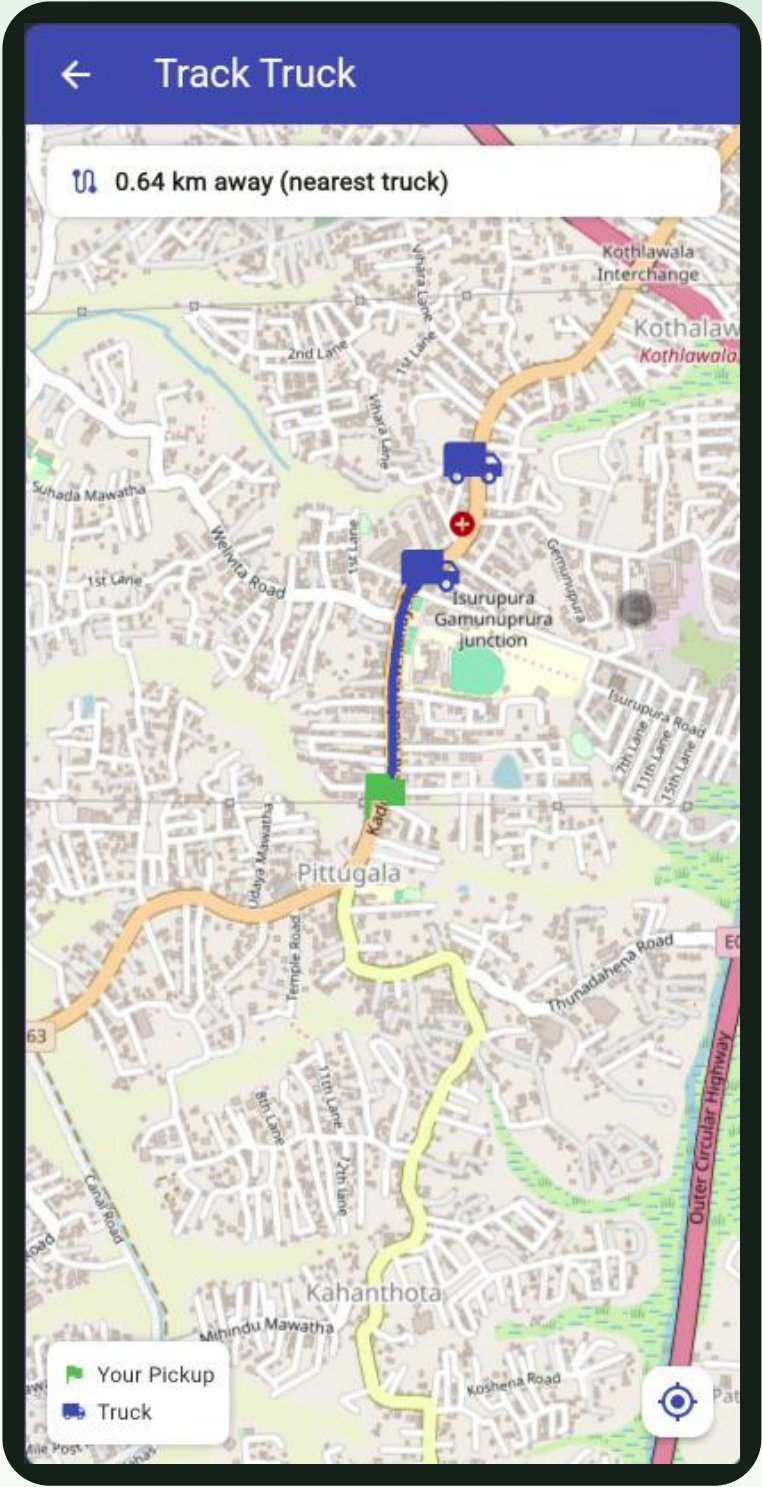


What it does

- One Flutter app for residents, drivers and administrators, built on Firebase and a Cloudflare Worker.
- Residents request a pickup and watch the nearest truck come, with its road route and distance.
- Drivers see critical IoT bins and resident requests on one map, with a suggested order.
- Missed pickups are rescheduled for 3 hours or closed with a reason; ward announcements go out at 6 PM the day before.

Evaluation

End-to-end scenarios, two phones and a moving driver	12 of 12 passed
Automated unit and widget tests (CI on every pull request)	64 passing
IoT critical bin reaches the driver map	Shown in red
Nearest truck as positions change	Switched correctly

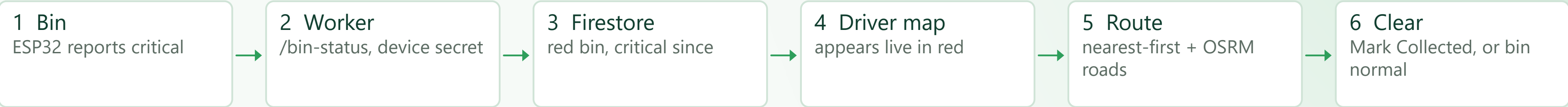


Two trucks: the nearest one is tracked



Mobile Application for Real-Time Bin Detection, Adaptive Route Optimization and Resident-Driven Coordination

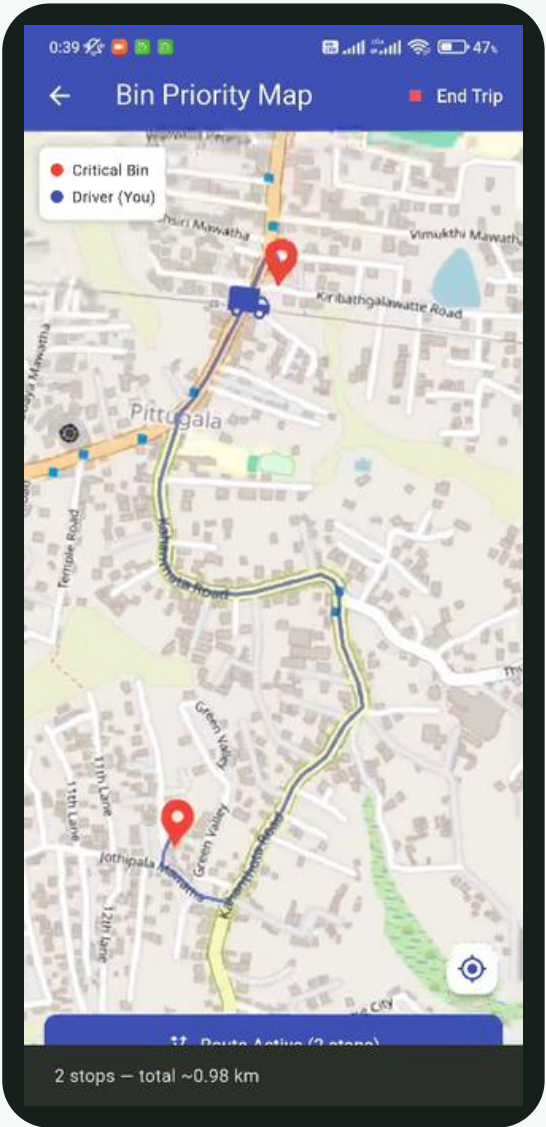
Critical bins and route support



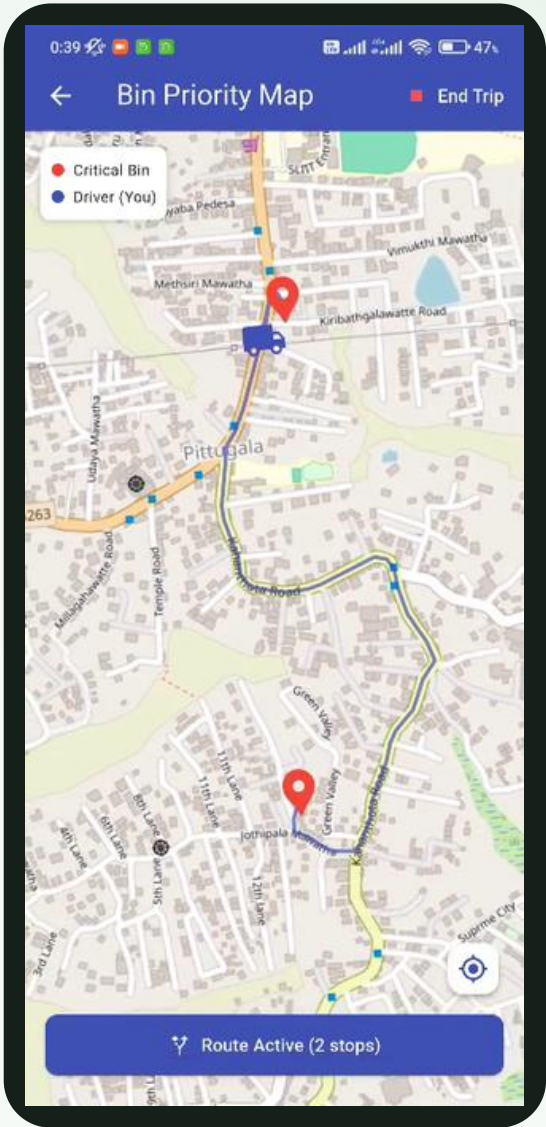
Real-time rules

Driver location upload	every 3 s
Arrival detected	within 300 m
Route redrawn	150 m off route, 15 s apart
Switch to a nearer truck	100 m closer, 15 s apart
Truck hidden if silent	after 60 s
Missed if no response	after 15 min

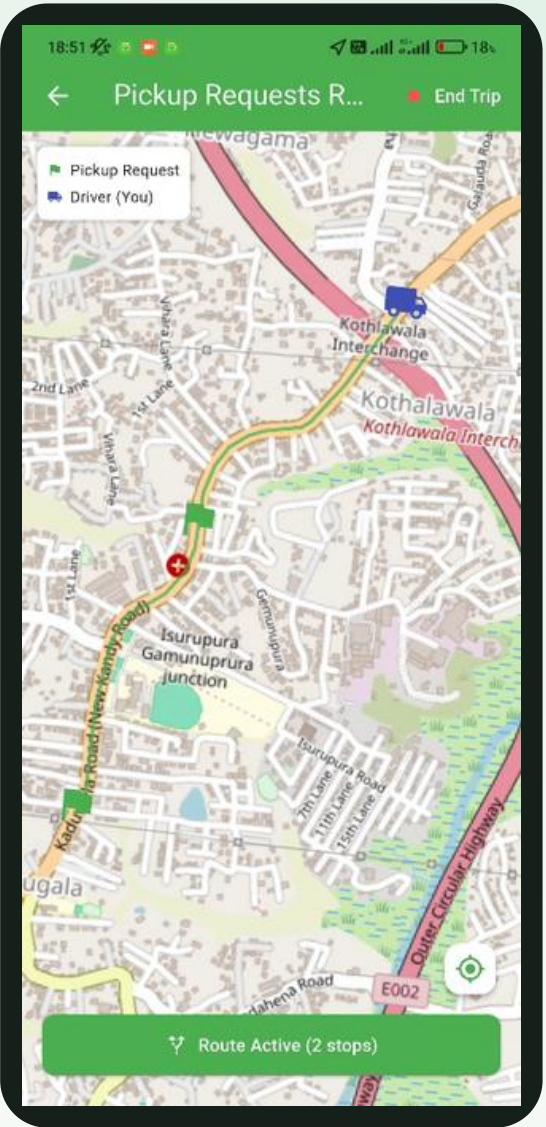
Every time limit is also checked by Firestore rules on the server clock.



Critical bins, route active



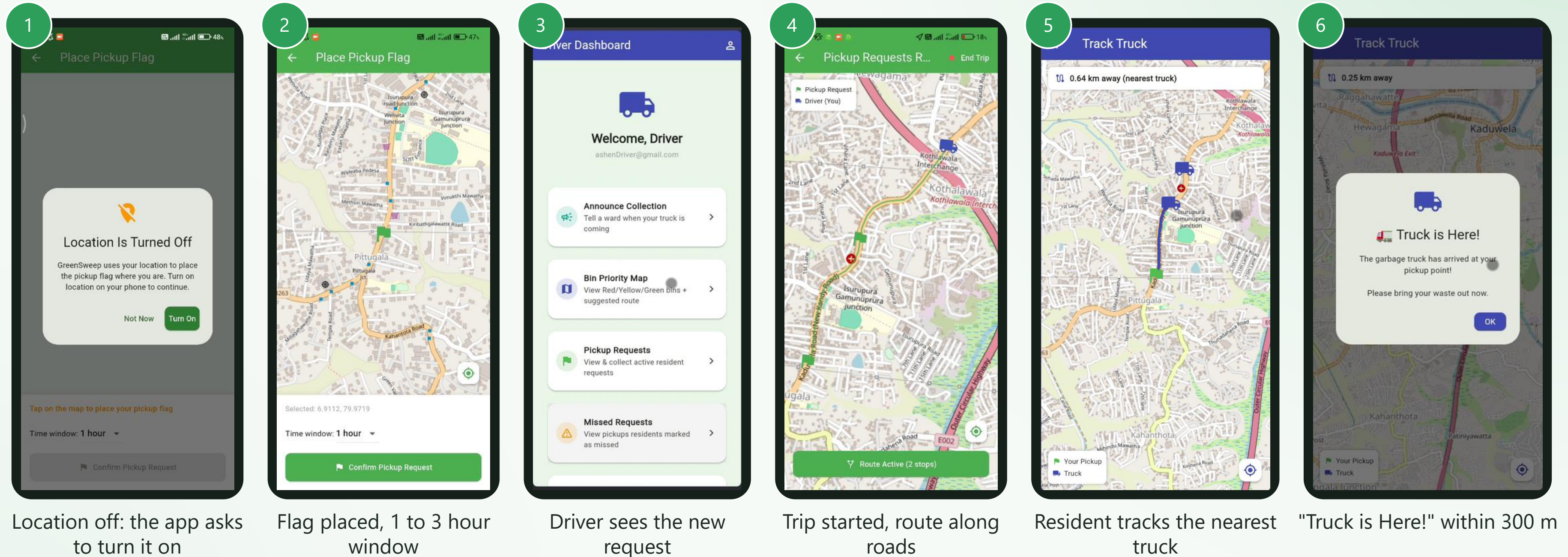
Bin needs collection



Pickup route, 2 stops



Resident and driver pickup flow

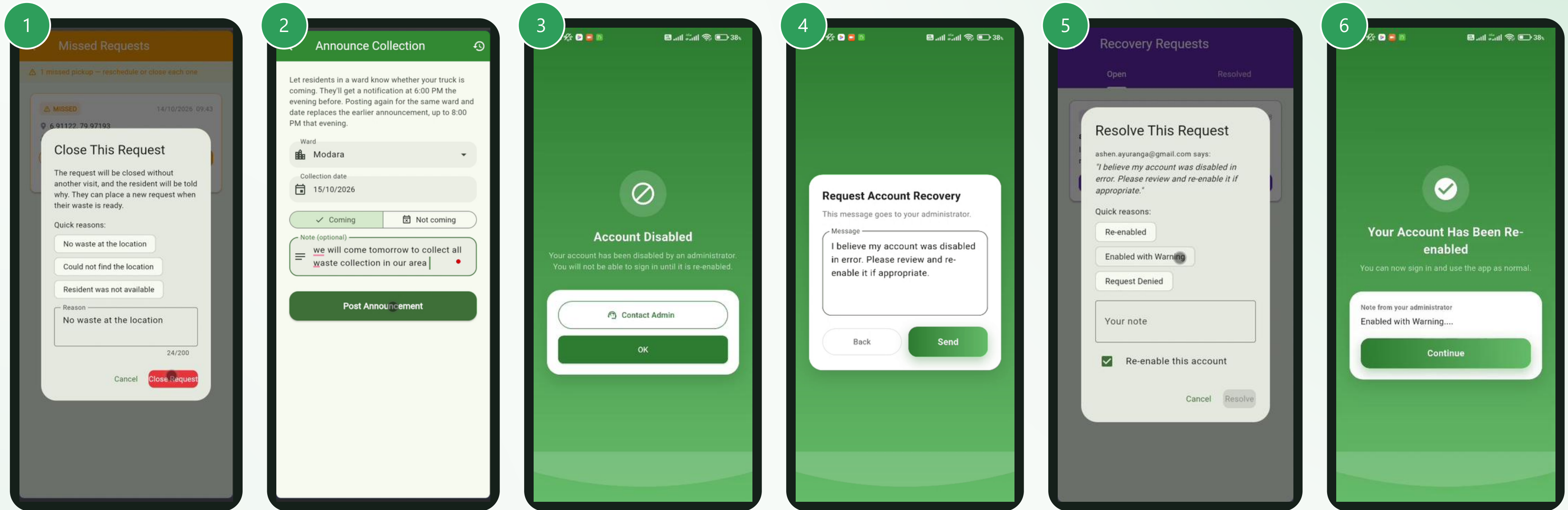


IT22088482 | Wijesiri A.M



Mobile Application for Real-Time Bin Detection, Adaptive Route Optimization and Resident-Driven Coordination

Missed pickups, announcements and account recovery



Close a missed request with a reason

Driver announces a ward's collection

Disabled account sees why

Sends a recovery request

Admin resolves and re-enables

Resident is told, with the note

Test Results

Component	What was tested	Data	Result
C1 Environmental	Payload delivery and cloud latency	Prototype telemetry	99.4 % delivered, 1.84 s mean
C1 Environmental	Alert classification	Prototype tests	96.7 % (target 97 %)
C2 Fill and lid	Fill class at the 79, 80, 94, 95 % boundaries	3 bins	Expected class every time
C3 Prediction	Dry waste forecast	126 held-out zone-weeks	R² 0.949, MAE 1.52 t
C3 Prediction	Wet waste forecast	126 held-out zone-weeks	R² 0.804, MAE 3.28 t
C4 Mobile	End-to-end workflows	12 scenarios, 2 phones, moving driver	12 of 12 passed
C4 Mobile	Automated unit and widget tests	64 tests	All passing, on every pull request
C2 + C4	Critical bin to the driver map	Live bin unit and app	Shown in red

Forecasts are scored on a chronological hold-out. Sensor and mobile results are from controlled prototype tests, not a city-wide deployment.

Cost and Commercialisation

Prototype cost, as reported by each component

Item	Cost
Environmental sensing unit, prototype hardware (C1)	LKR 12,400
Fill and lid unit, electronics and supporting items (C2)	LKR 7,400
Mobile app backend: Firebase and Cloudflare Worker (C4)	Free tiers at prototype scale
Forecast service hosting: Flask and MongoDB Atlas (C3)	<i>Free tiers at prototype scale</i>

Running cost grows with the number of bins, users and update frequency.

For municipal councils and private collection operators, their drivers, and residents in urban service areas.

How it earns

Subscription per council or operator
Hosting, app updates, maintenance and calibration support

Hardware supply or leasing
Sensor units for the bins that need them most

Staged adoption
Start with one service area, measure, then expand



THANK
YOU