

Sri Lanka Institute of Information Technology - Malabe



SE3070 – Case Studies in Software Engineering

Group ID : Y3S2_WE_01.02_26

Assignment 01

Case Study 2 - Smart Waste Management System for Urban Areas

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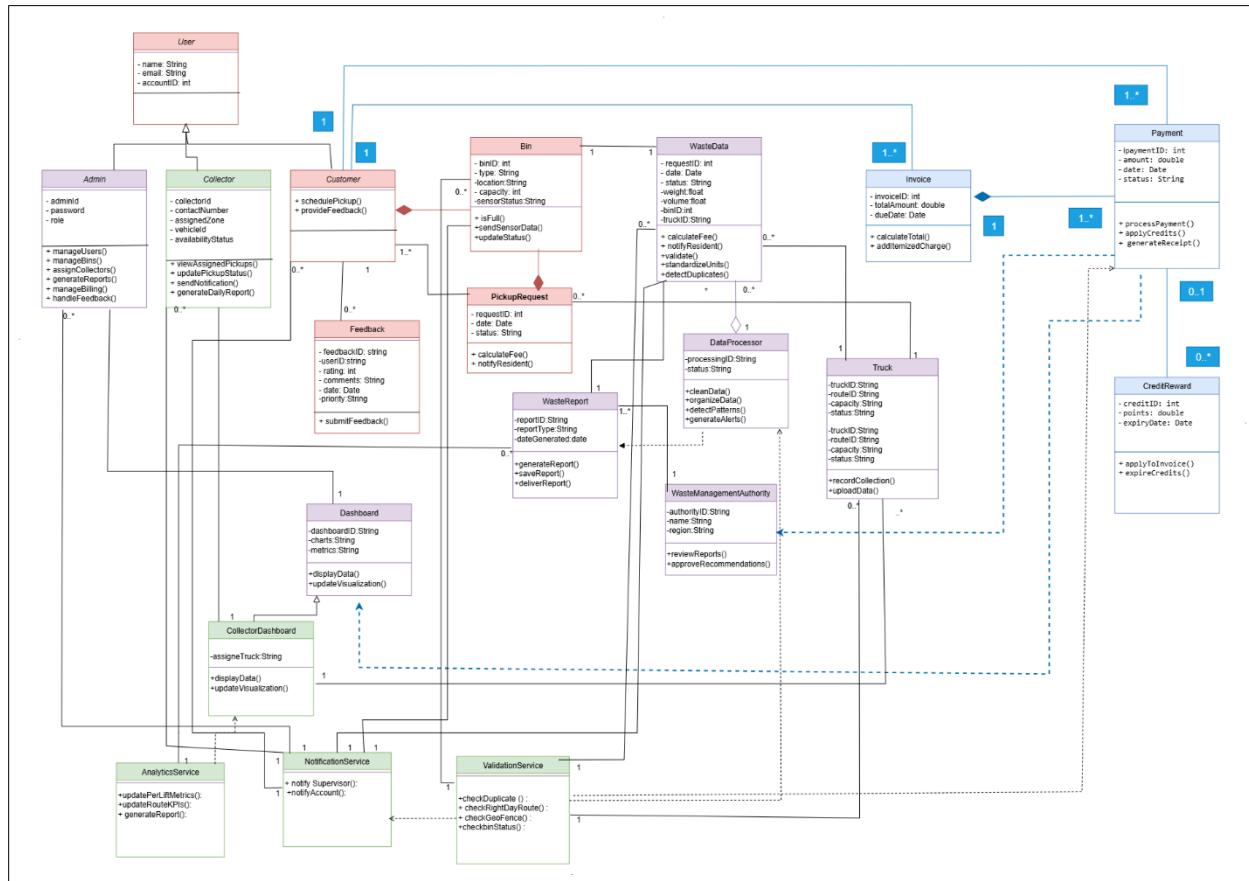
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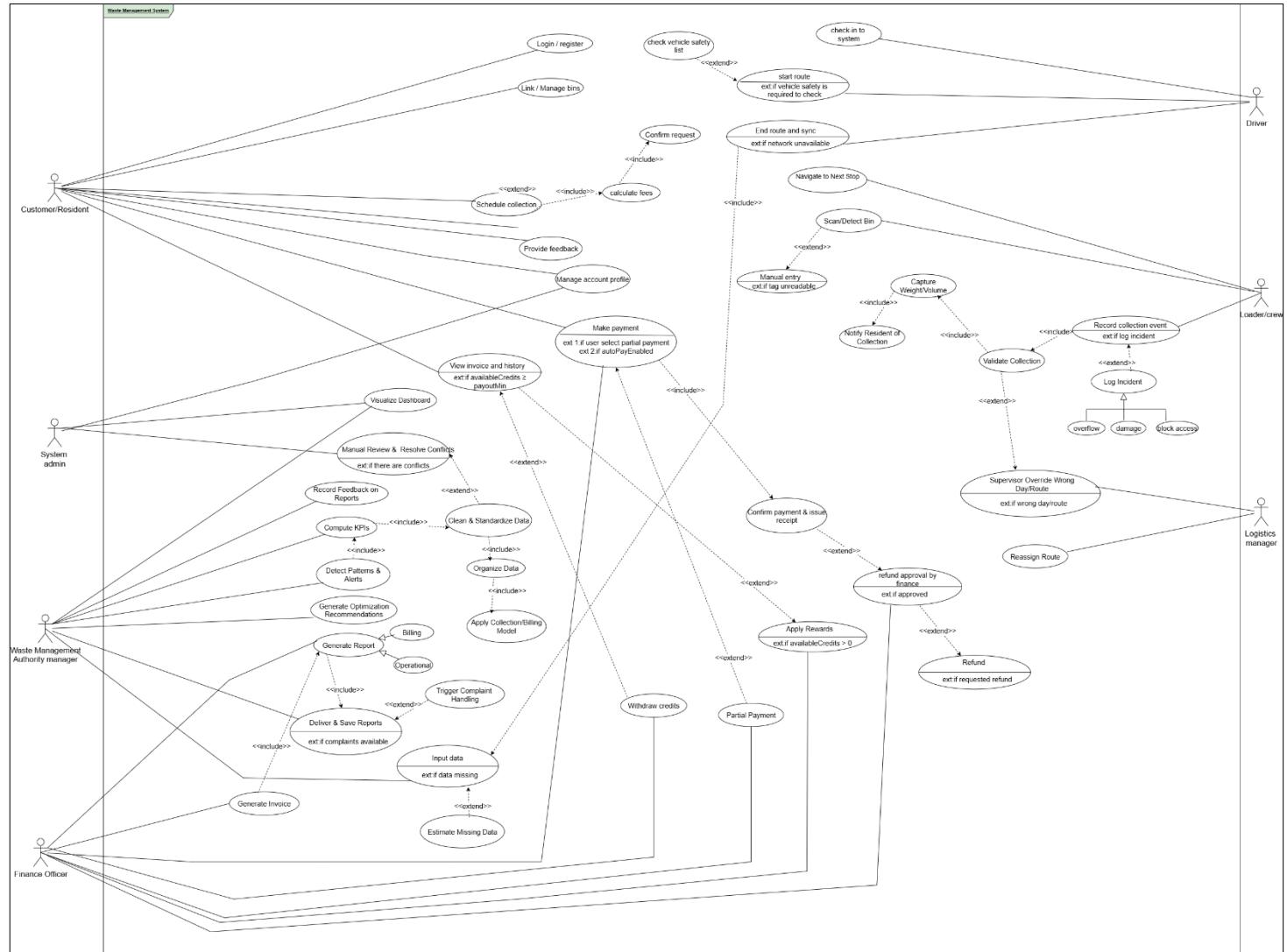
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Group Diagrams

1. Class diagram - [link](#)



2. Use case diagram - link



Individual Diagrams

1.Bin & Collection Management (IT22124708- Gunawardhana J C A)

Use case scenario

Use Case Scenario: Perform Scheduled Bin Collection and Recording

Description:

This use case scenario describes how waste collection crews record bin collections digitally. Each bin is uniquely identified by barcode, QR code, RFID, NFC, or sensor. During pickup, the bin is scanned or detected, and the event is logged with time, crew, vehicle, GPS, and waste stream. The system validates the event, prevents duplicates, and supports exceptions such as blocked access, contamination, bulky or e-waste, and unregistered bins.

Preconditions:

- Each bin is registered with ID, tag or sensor serial, capacity, and GPS coordinates.
- Bin is linked to a valid household or business account.
- Bin status is Active (not lost, damaged, or decommissioned).
- Bin is assigned to today's collection route.
- Crew and vehicle are checked in with roles, vehicle ID, and odometer.
- Field app or truck UI is operational with GPS (online or offline).
- City fee model and waste streams (general, recyclable, organic, bulky, e-waste) are configured.
- Daily safety checklist is completed by the crew.

Main Flow:

- Driver starts the route.
- System logs crew, vehicle ID, odometer, and time.
- App guides the crew to the next bin stop.
- Loader scans the bin tag or sensor.
- System displays bin and account details with audio or visual confirmation.
- System validates the scan to prevent duplicates, wrong day or route, or out-of-geofence collection.
- Crew empties the bin.
- Weight or volume is auto-captured from sensors or entered manually by the crew.
- System records the collection event with timestamp, bin ID, account, route, crew, truck, GPS, waste stream, and dwell time.
- System confirms the event to the crew.
- Resident may receive a notification of collection.
- KPIs are updated for route progress and SLA adherence.
- App guides crew to the next stop.

- Driver ends the route.
- All events are synced and route KPIs are finalized.

Alternate Flows:

- Multiple bins at one address:
 - System lists all bins linked to the account.
 - Crew scans each bin and separate events are created.
- Sensor-only auto collection:
 - Bin sensor detects the lift.
 - App displays an auto-record.
 - Crew confirms or edits details.
- Bulky or e-waste pickup:
 - Bin flagged for bulky or e-waste.
 - Crew records the special pickup and may capture photo evidence.
- Contamination detected:
 - Crew flags contamination in recyclables.
 - System logs the contamination event and allows optional photo.
- Overflow or blackspot:
 - Crew records overflow or illegal dumping.
 - System flags the site for hotspot analytics.
- Wrong day or route overridden:
 - System displays a warning.
 - Supervisor override allows collection with reason code.
- Duplicate scan attempt:
 - Crew scans the same bin within a restricted time window.
 - System blocks the event and shows the previous record.
- Offline mode:
 - Network unavailable during collection.
 - Events stored locally and synced automatically later.
- Unreadable tag:
 - Tag damaged or not scannable.
 - Crew manually enters bin ID or retries scan.
- Unregistered bin:
 - System cannot match scanned ID.
 - App creates a service incident with photos for admin review.
- Damaged bin or tag:
 - Crew logs bin or tag damage.
 - System creates an incident and collection continues or is deferred.
- Backup truck takeover:
 - Dispatcher reassigns remaining stops to another truck.
 - Route updates on both apps.

Postconditions:

- A validated collection event exists for each bin lifted.
- Events are available for analytics such as KPIs and hotspot detection.
- Events are available for billing such as flat, PAYT, or hybrid charges, and credits for recyclable or e-

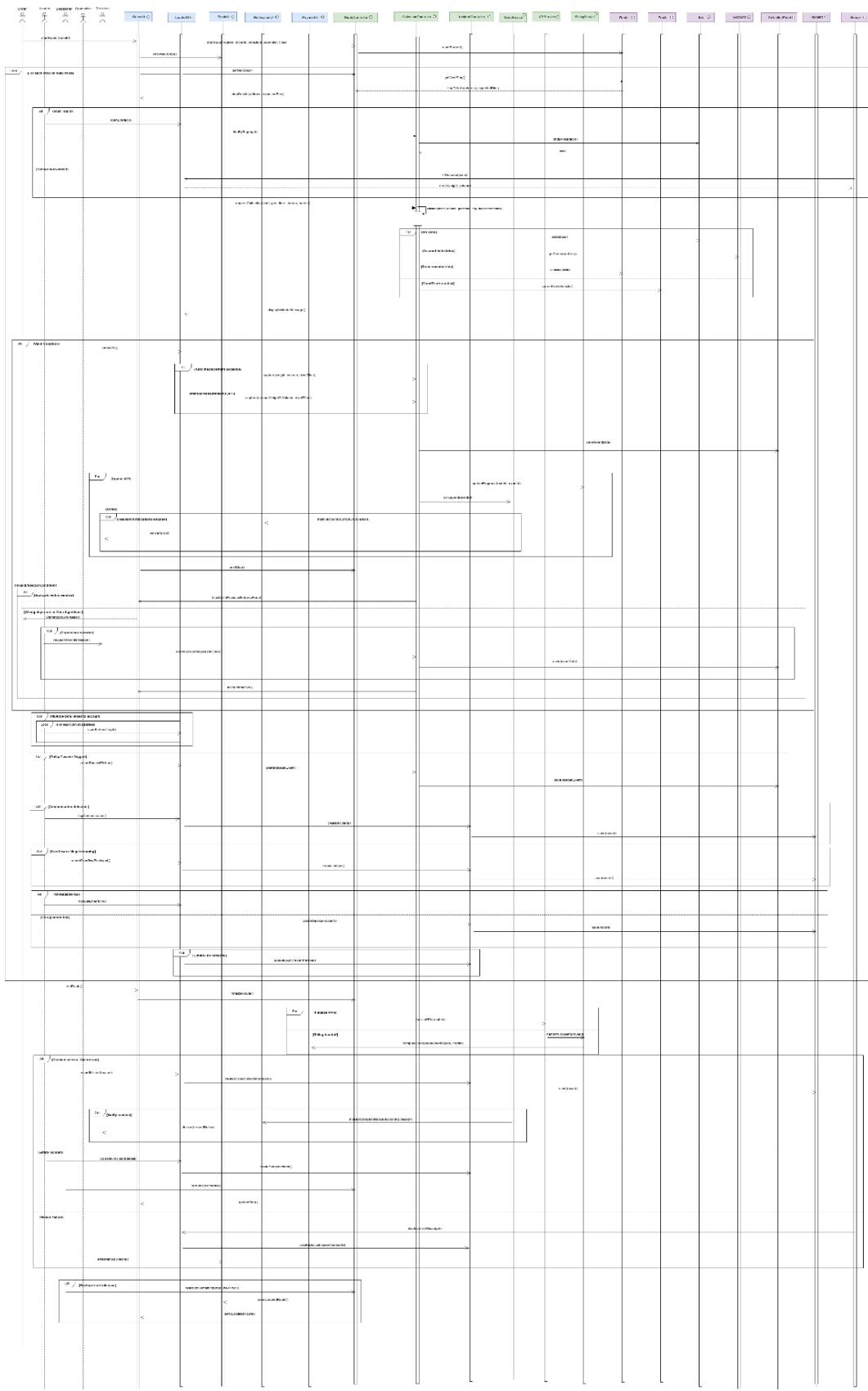
waste.

- Residents may receive proof of collection notifications by SMS, app, or email.
- All incidents such as overflow, contamination, and damaged or unregistered bins are logged with reason codes and evidence.

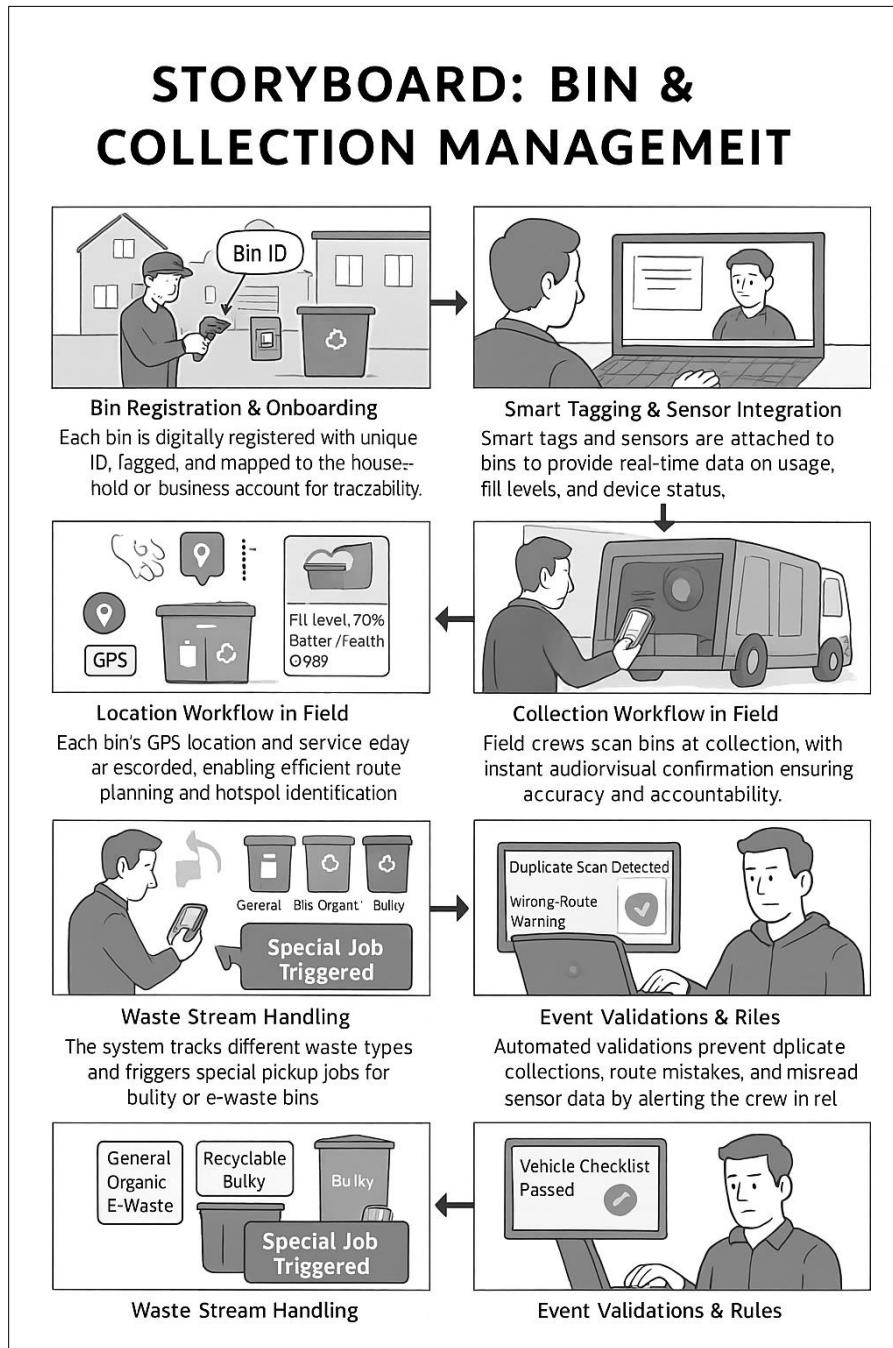
Exception Flows:

- Bin not out or blocked access:
 - Crew records reason such as locked gate or obstruction.
 - System logs a missed collection event and notifies the resident.
- Safety incident:
 - Hazard detected such as spill, animal, or unsafe conditions.
 - Crew logs the incident and dispatcher reroutes or reschedules.
- Device or app failure:
 - Mobile app crashes or device battery dies.
 - Crew switches to a backup device or performs manual entry at depot.
- Sensor failure:
 - Bin sensor heartbeat lost or battery dead.
 - System logs device incident and crew records collection manually.
- Account closed or on hold:
 - System detects suspended or closed account.
 - Collection is blocked or logged as “no service – account inactive.”

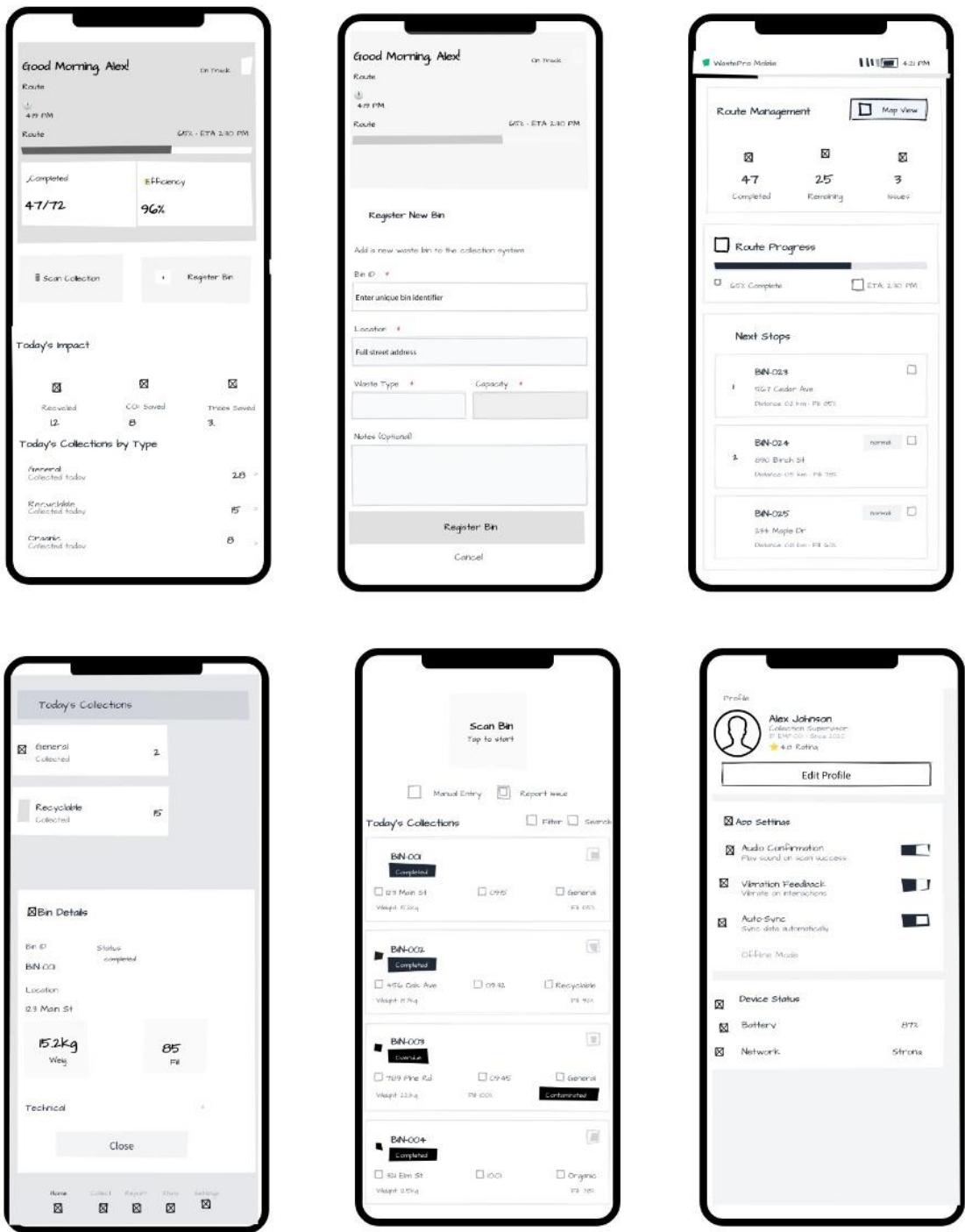
Sequence diagram - Link



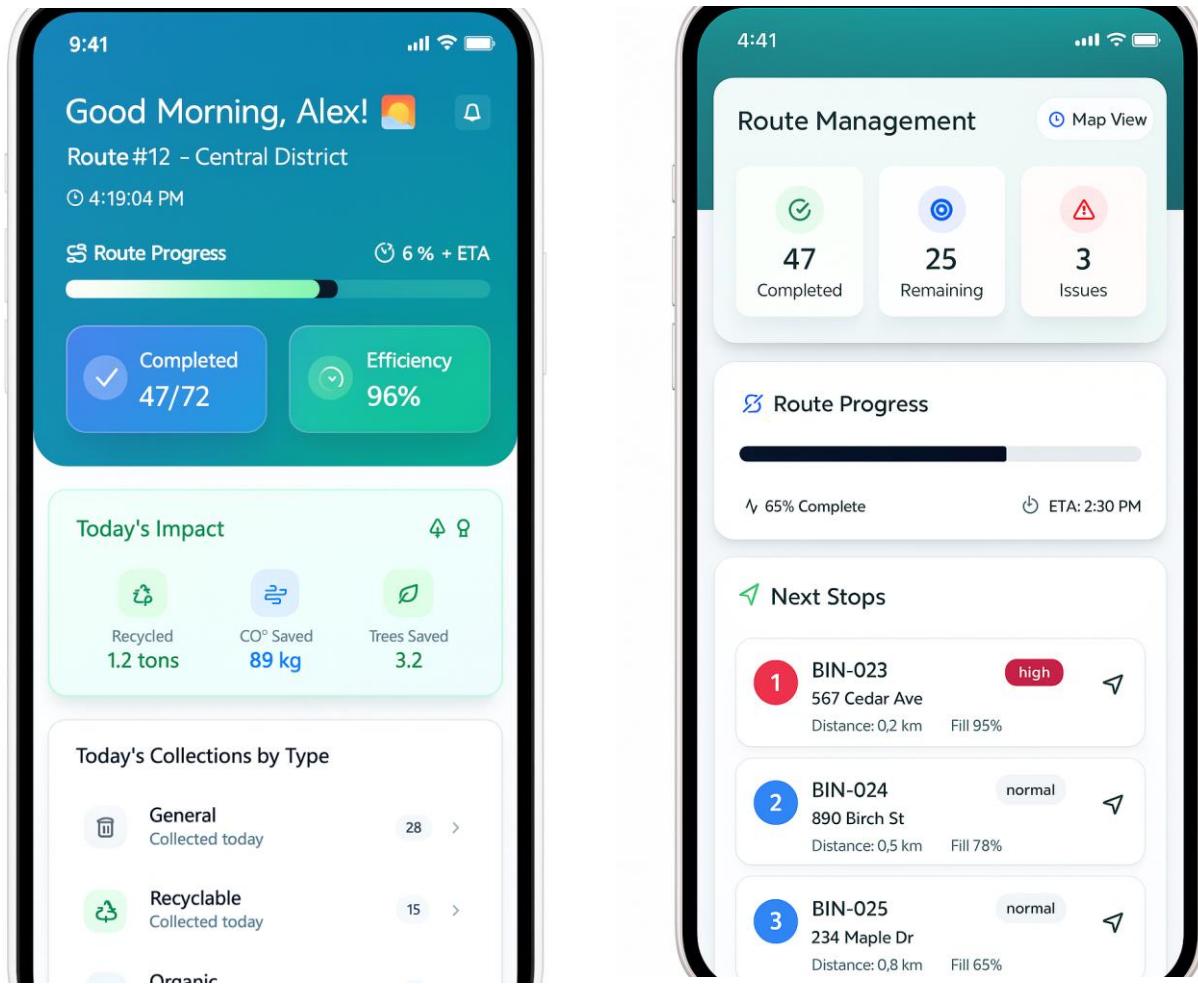
Storyboard

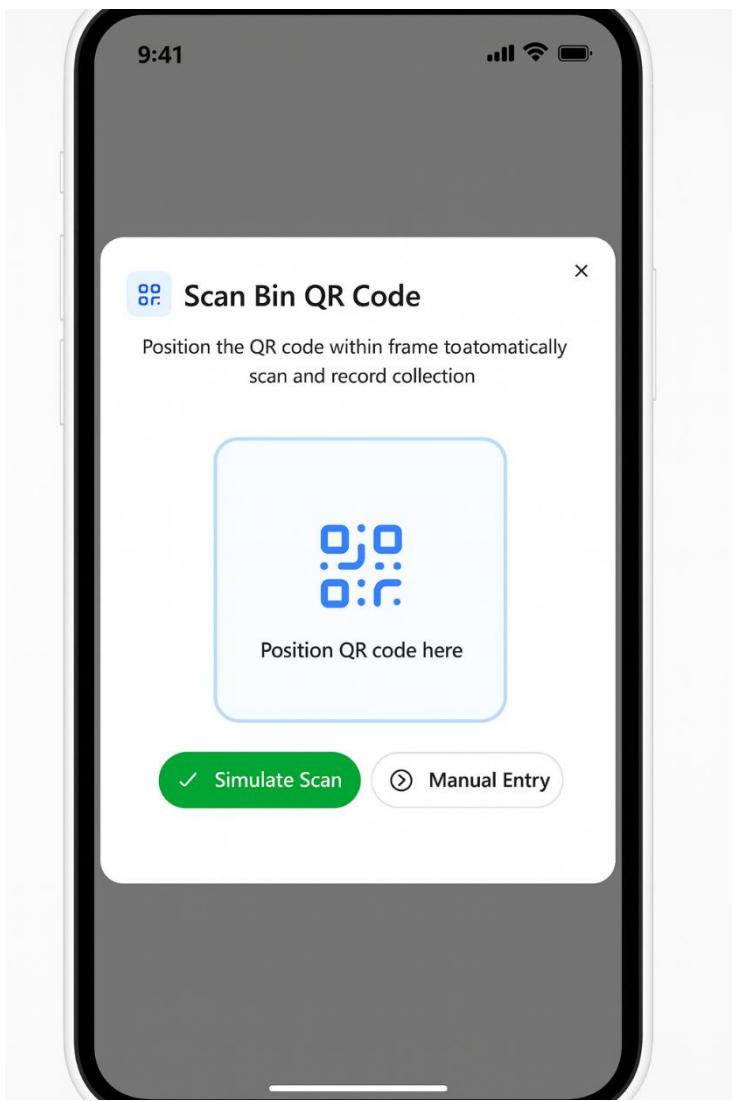
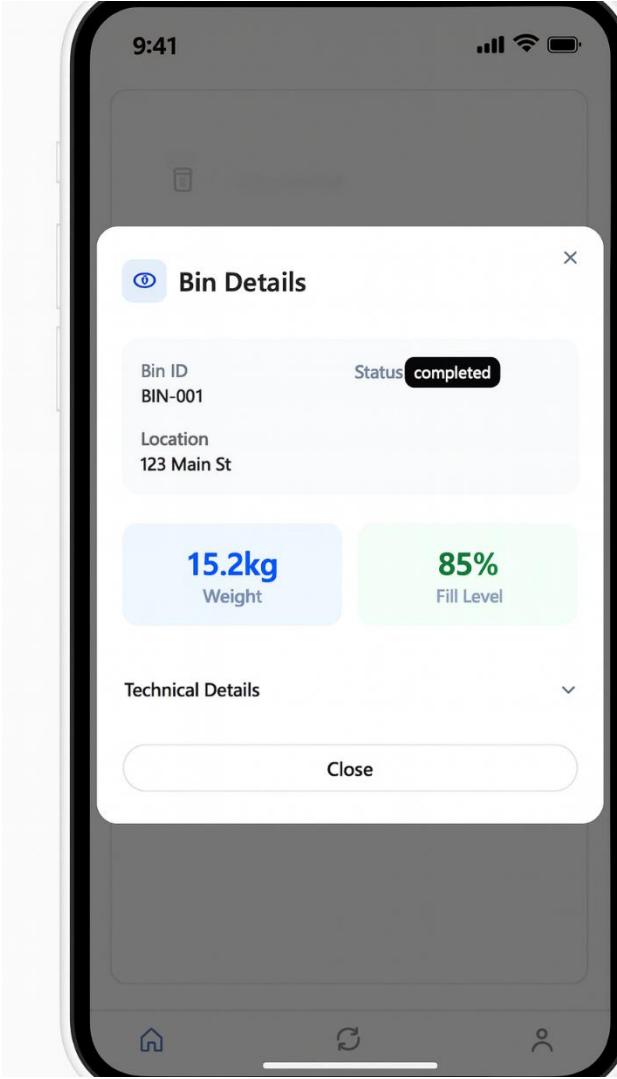


Low fidelity wireframes



High fidelity wireframes





9:41

Good morning
John Smith

+ Register New Bin

Add a new waste bin to collection system

Bin ID *

Location *

Waste Type * Capacity *

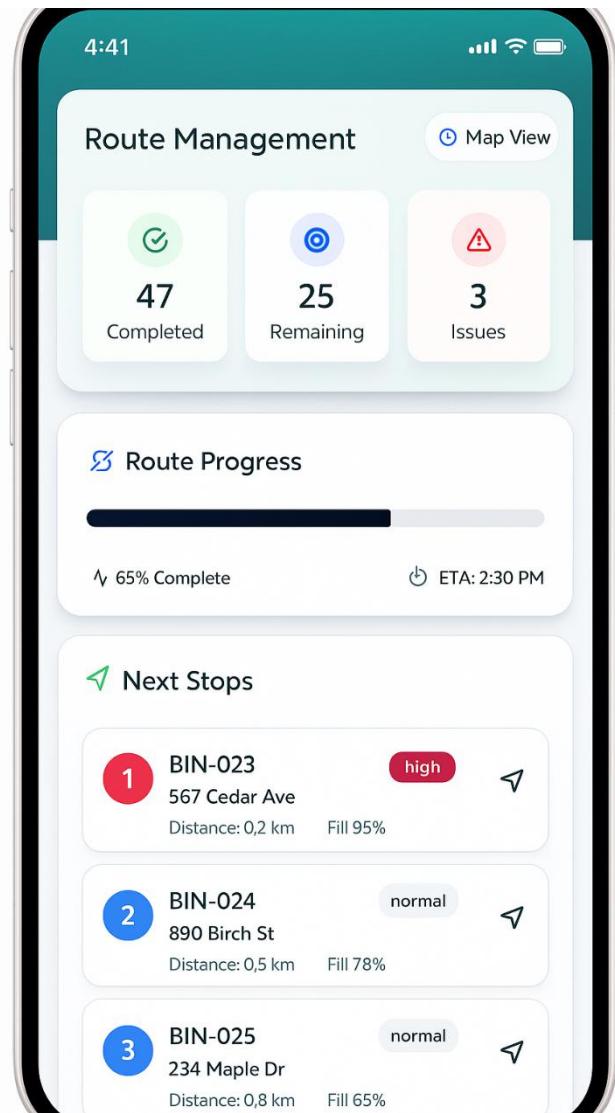
Select type Liters

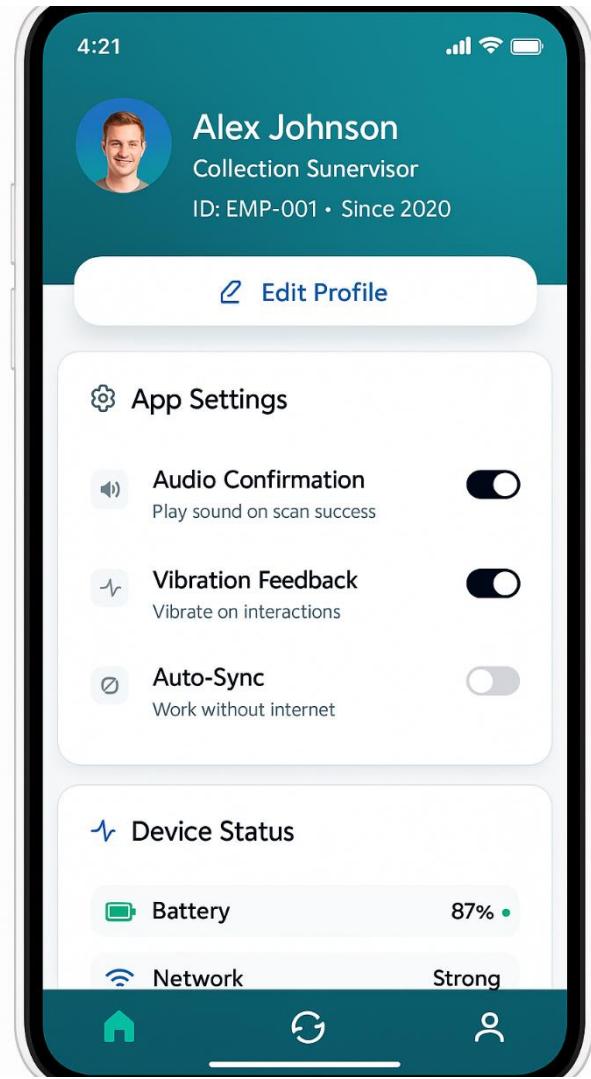
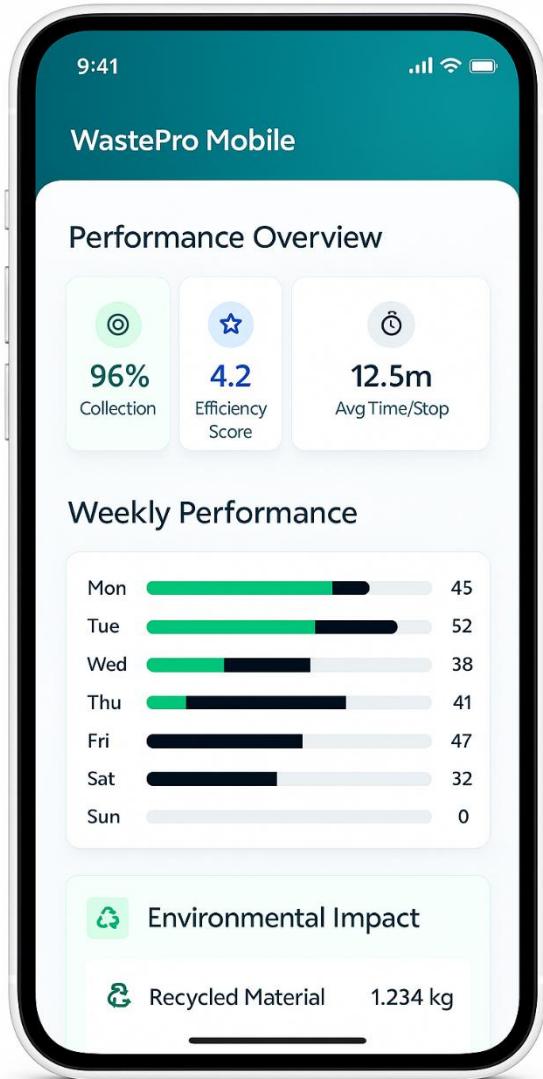
Notes (Opt)

+ Register Bin

Cancel

Home **Reports** **Profile**





2. Data Analytics & Reporting (IT22194862-Senarath S A S M)

Use case scenario

Use case: Data Analytics & Reporting of Waste Data

Description: This function completes data collection, processing and analysis for reporting and decision making

Preconditions:

- Each bin and trucks are registered with the waste management authority.
- The digital waste tracking device should monitor waste levels and send data to the central system.
- The country/region should have a specific waste management model(weight-based, flat-fee, etc.)

Main Flow:

1. The system collects data from bin scans and trucks from sensor readings in the digital waste management system.
2. Cleans data by removing duplicate data, standardizing the measuring units of waste weights and volumes
3. Organize data by location, household/business account, truck route etc.
4. Apply the city or zone's waste collection model (weight-based, flat-fee, etc.)
5. Check whether the waste has been properly categorized into the correct bin types.
6. Count the total number of bins collected, truck route coverage, the missed pickups, recyclables and the time taken in the route.
7. Measure the total weight and volume of data collected and calculate the recyclable percentage of waste.
8. Detect patterns and alerts of waste by identifying unusual waste patterns by detecting areas where bins overflow, areas with less service than promised, sudden waste spikes and lows etc.
9. Suggest improvement/optimization recommendations such as route changes, changing bin sizes according to the amount of waste etc.
10. Show data in a dashboard in diagrammatic formats
11. Generate reports:
 - a. operational reports including key performance indicators, missed pickups, improvement lists etc.
 - b. billing reports including detailed charges for finance team
12. Deliver the reports and save the reports in the system for record keeping

13. Record feedback from the managers and customers regarding the waste data analytics and reports.
14. Record the feedback and suggestions for future improvements to the system

Alternate flows:

Missing/incomplete data:

- Some bin sensors or truck devices fail to send data.
- The system estimates values using historical averages or nearby bins.
- Marks the record as “Estimated” for manager review.

Duplicate or Conflicting Data:

- A bin scan is uploaded multiple times or sensor data conflicts with truck data.
- The system keeps the most recent/correct entry and flags the duplicate.
- If conflict is too large, send for manual review.

Wrong Waste Categorization:

- Waste recorded in the wrong bin type (e.g., recyclables in general waste).
- The system detects and sends alerts.

Abnormal Patterns Detected:

- System notices sudden spikes (festival waste, strikes, weather).
- The system generates a special alert for managers.

Feedback is not clear:

- A resident/manager submits vague feedback (e.g., “service is bad”).
- The system records it but flags it as low priority until more detail is given.

Postconditions:

- The reports are properly generated for different categories
- Reports are sent to the management for decision making
- Optimization recommendations are available for managers
- Feedbacks are included into the system

Exception flows:

Report Generation Delay/Failure:

- If the dashboard or reports cannot be generated on time due to a system issue,
- The system retries automatically, and if it still fails, generates a minimal backup report.

Resident Disagreements:

- A resident checks their history and disagrees on a bill or collection record.
- Trigger the Complaint Handling process

Network failure/System failure:

- The system store data locally or the trucks can manually record until the system is restored
- When restored, the data can be entered into the system

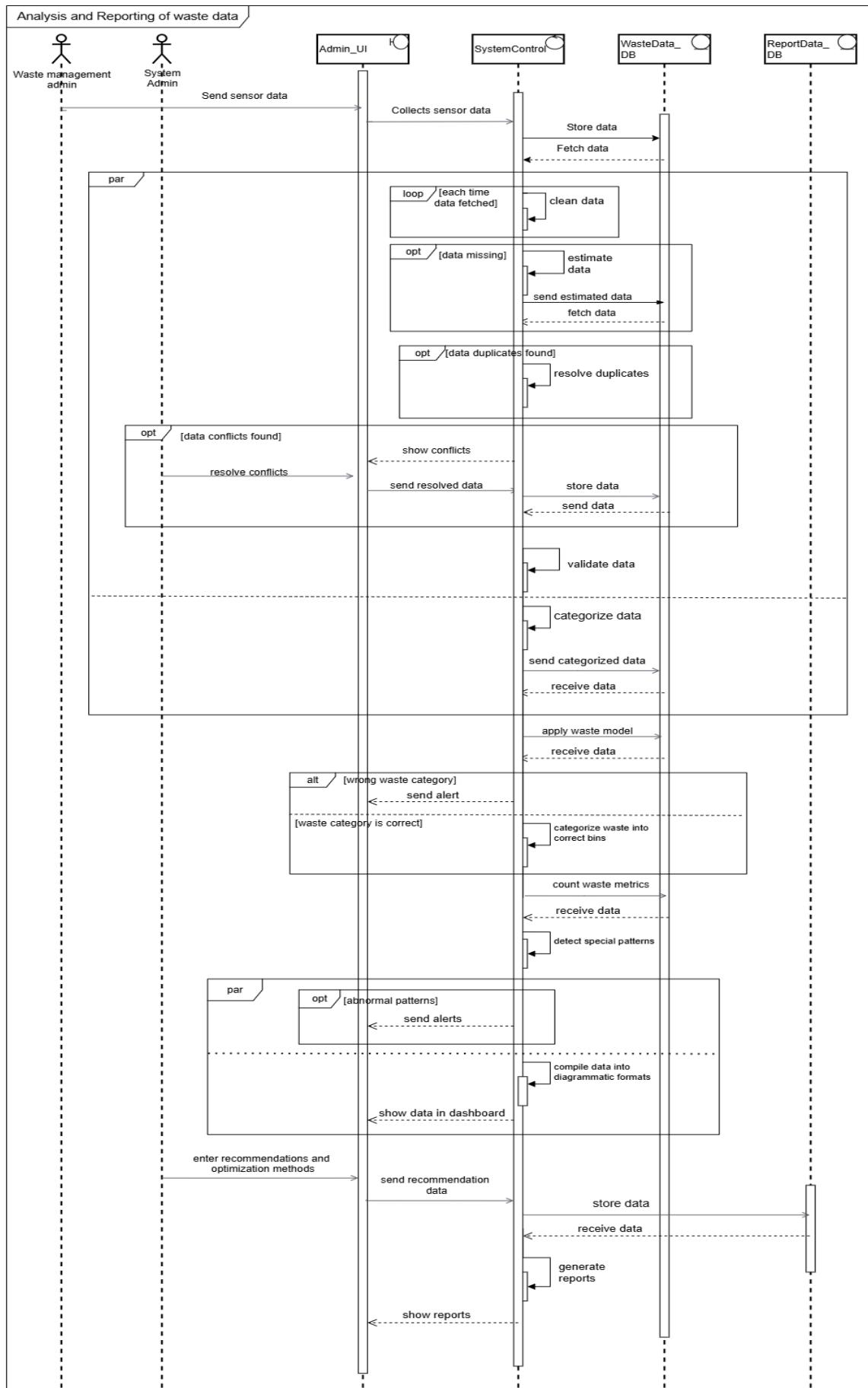
Wrong billing models applied:

- Billing process is paused until corrected

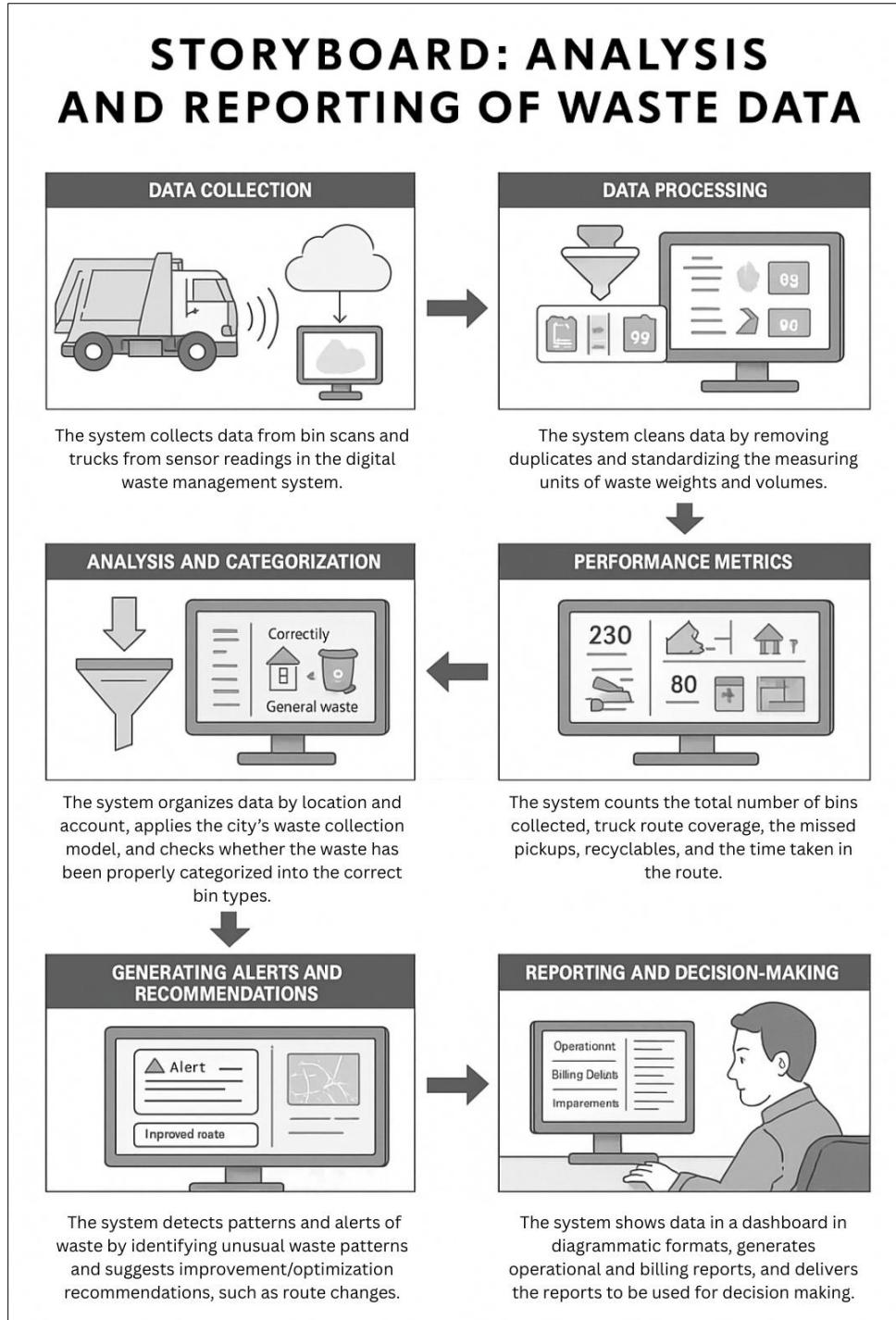
Unauthorized access:

- The system should block the access and send alerts to the central system

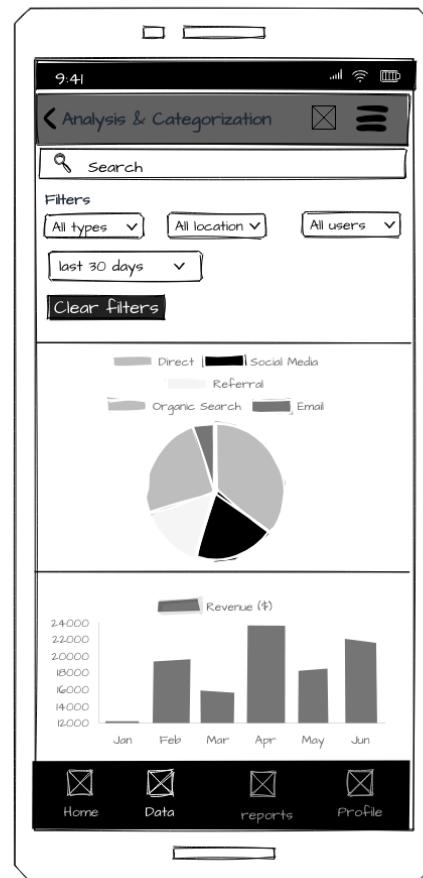
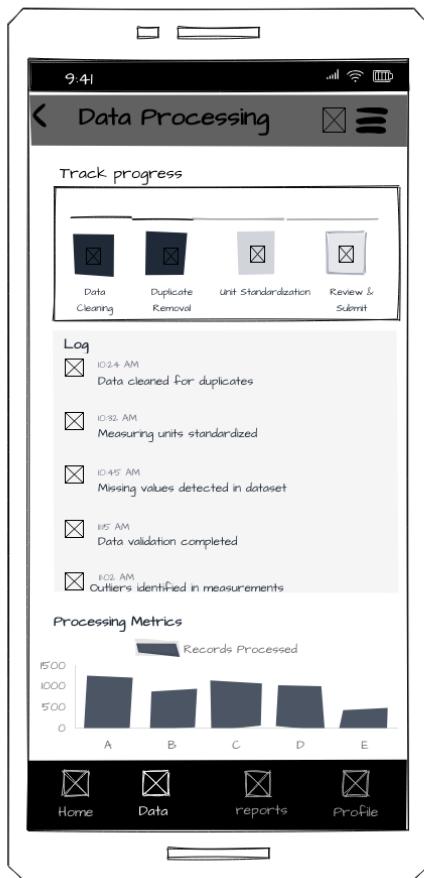
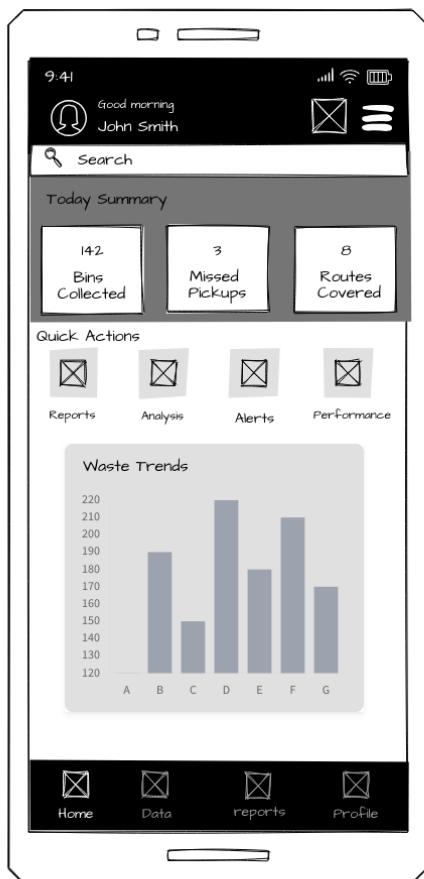
Sequence Diagram : [link](#)

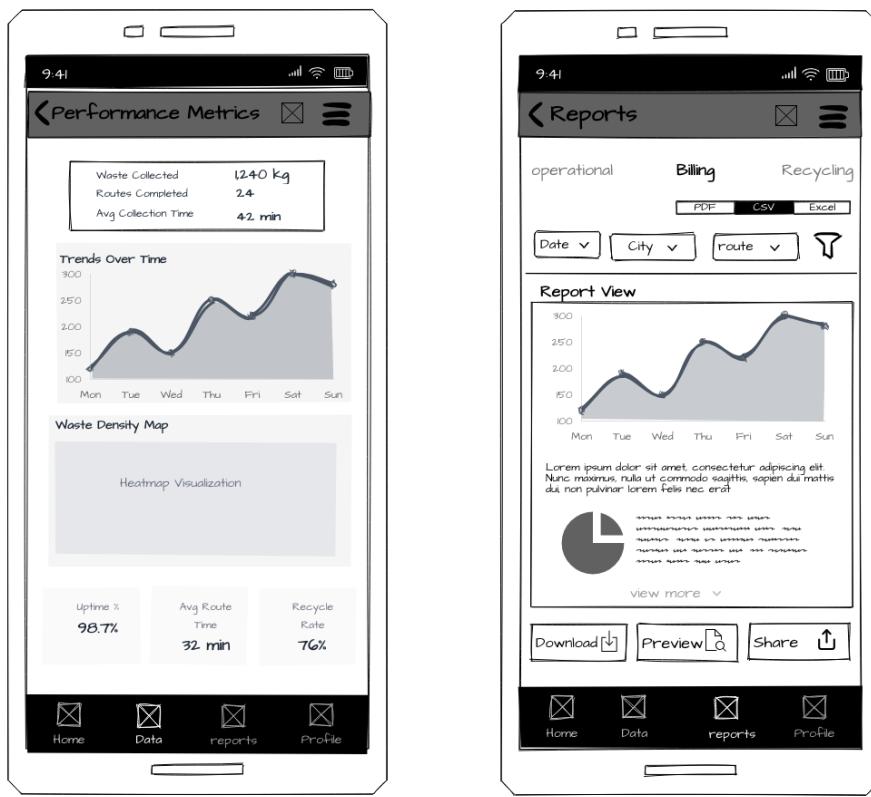


Storyboard



Low-fidelity Wireframes:





High fidelity wireframes:

Home Screen (Left):

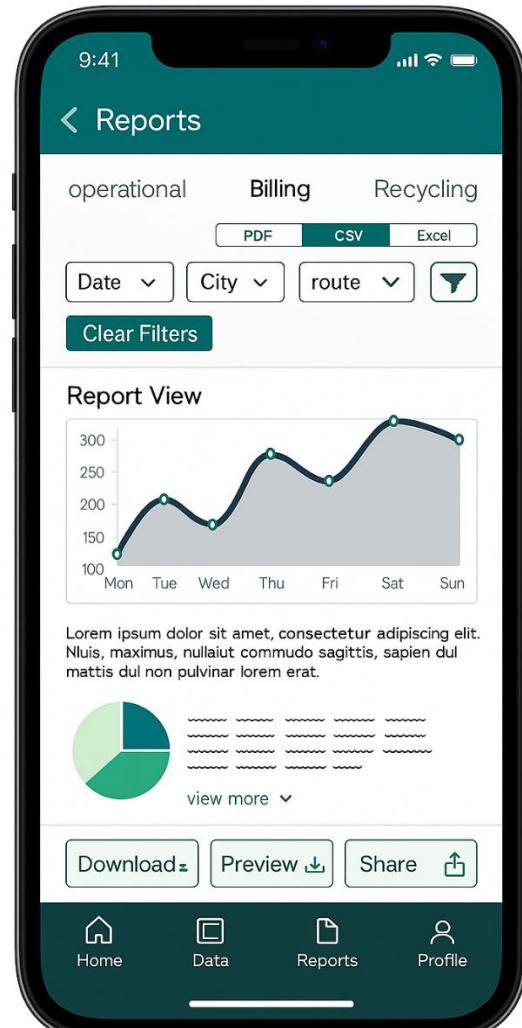
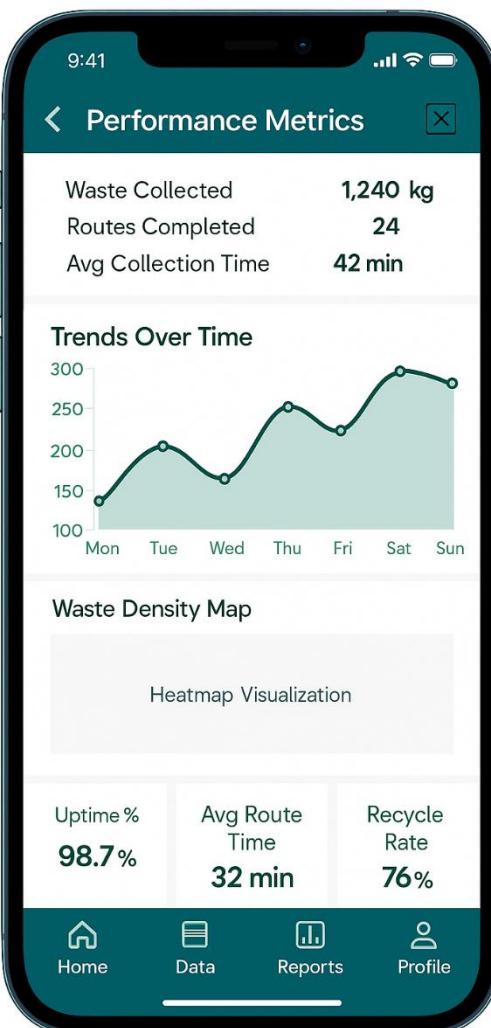
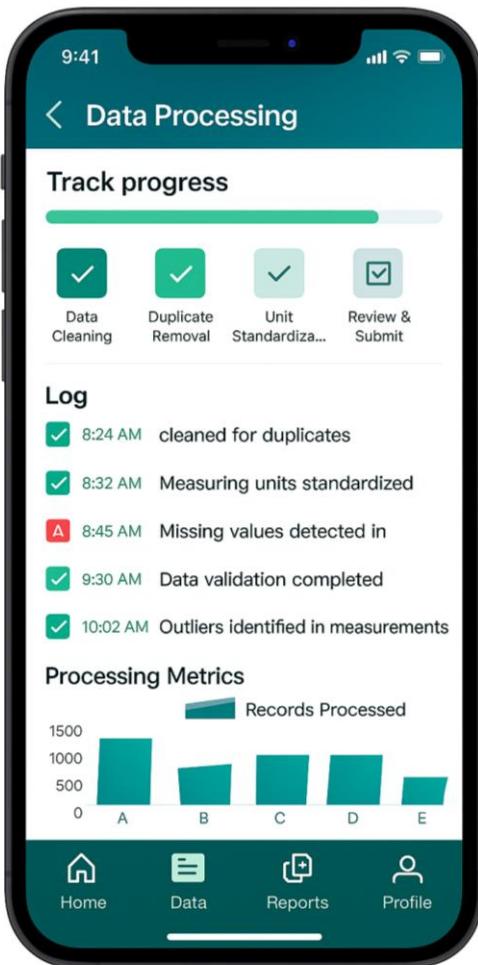
- Good morning John Smith
- Search bar
- Today Summary:
 - Bins Collected: 9
 - Missed Pickups: 9
 - Routes Covered: 8
- Quick Actions: Reports, Analysis, Alerts, Performance
- Waste Trends: Bar chart showing waste trends across zones A-G.
- Bottom Navigation: Home, Data, Reports, Profile

Data Collection Screen (Right):

- Search by bin/route
- Map showing collection points (green, red, orange markers).
- Bin Status Table:

| Bin ID | Location | Status | Time |
|--------|----------|-----------|-------|
| BIN001 | Zone A | Collected | 03:30 |
| BIN002 | Zone B | Missed | 09:45 |
| BIN003 | Zone C | Pending | 10:00 |
| BIN004 | Zone D | Collected | 11:10 |

- Bottom Navigation: Home, Data, Reports, Profile



3. User & Account Management (IT22295842 - Rashad M P M)

Use case scenario

Use case: User and Account Management

Primary Actor: Resident

Secondary Actors: Admin, Logistics Manager

Preconditions:

- Resident/business has an active account in the system.
- Waste bin(s) are linked to the account.
- Resident is logged into the portal/app.

Post-conditions:

- Waste pickup is scheduled and recorded in the system.
- Collection team receives the schedule.
- Resident receives confirmation and fee details.
- Billing is updated if fees are applicable.
- Resident is prompted to provide feedback after collection.

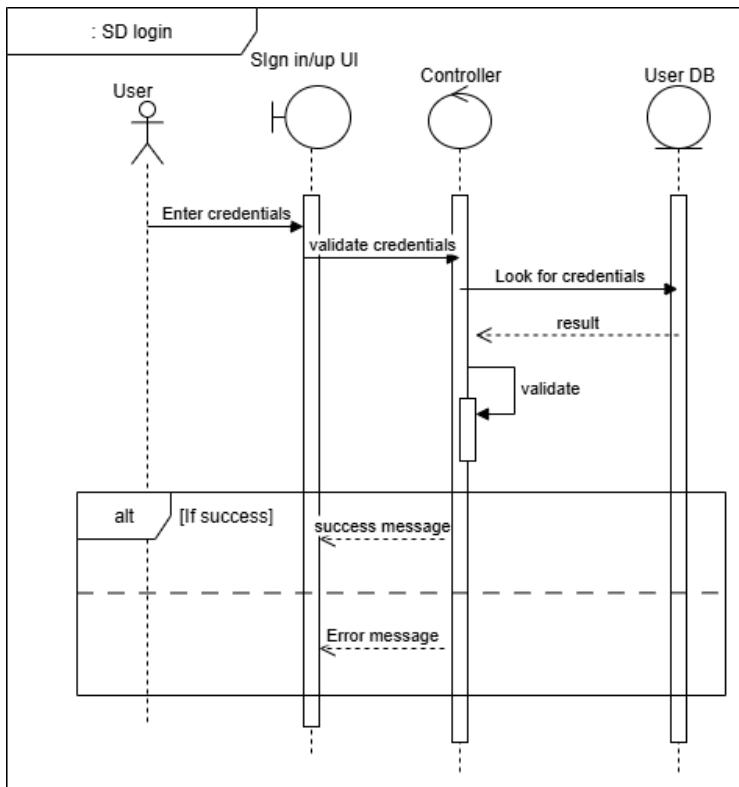
Main Flow:

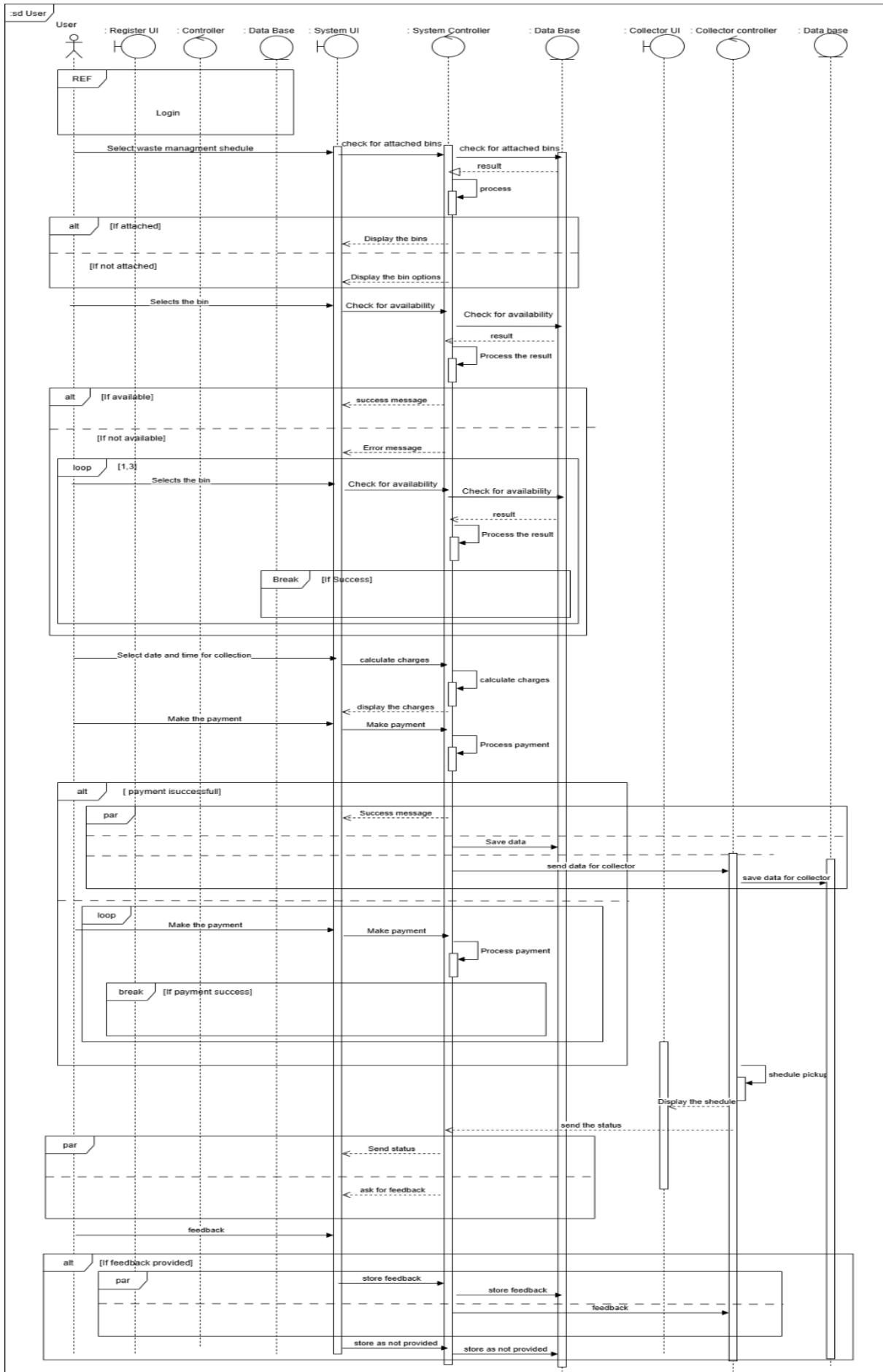
1. Resident logs into the portal/app.
2. Resident selects “Schedule Waste Collection.”
3. System displays the list of bins linked to the account.
4. Resident selects the bin(s) and specifies the type of waste (regular, bulky, recyclable).
5. System offers an **“Automatic Pickup” option for smart bins.**
6. Resident selects a preferred date and time window for collection.
7. System calculates any applicable fees based on the city collection model (flat, weight-based, or hybrid).
8. Resident confirms the request.
9. System records the pickup in the account and collection schedule.
10. Notification system sends confirmation to the resident (SMS/email/app).
11. Collection personnel view the scheduled pickup in their route management system.
12. After collection, the system triggers a feedback request.
13. Resident receives a notification to rate the service and provide feedback.
14. Feedback is stored in the system for quality monitoring and service improvement.

Extensions / Branching Actions:

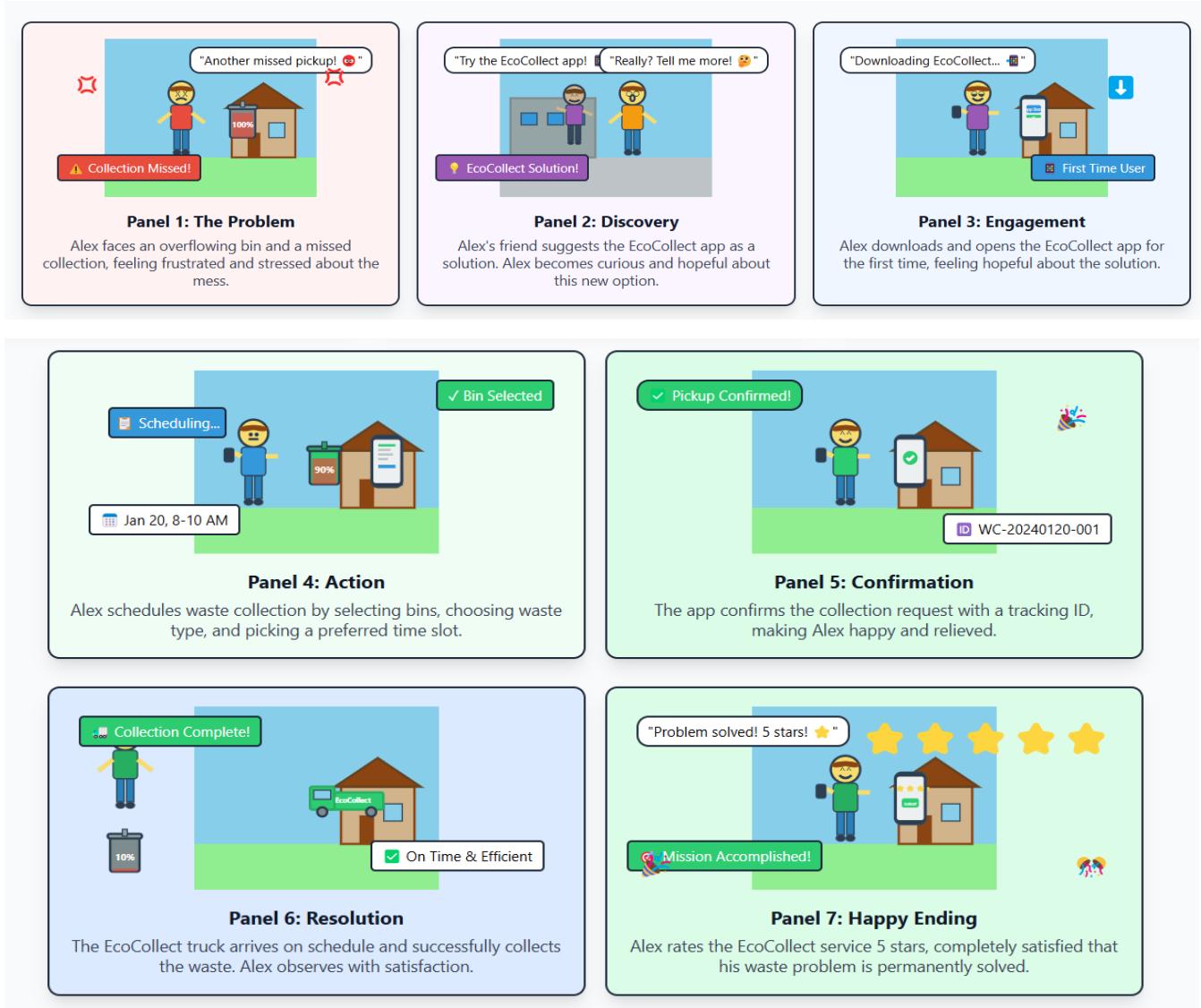
- 1.a If the account is inactive or bins are unlinked system prompts resident to update account or link bins.
- 4.a If the selected time window is unavailable system suggests the next available slot or display a error message
- 5.a If enabled, the sensor monitors waste levels and may trigger a pickup automatically before the selected time if the bin gets full.
- 7.a If payment is required but fails the system will prompts for payment and confirms only after a successful transaction.
- 8.a If the resident cancels before collection feedback prompt is skipped.
- 13.a If the resident does not provide feedback within a given timeframe → System marks it as “No Feedback.”

Sequence diagram



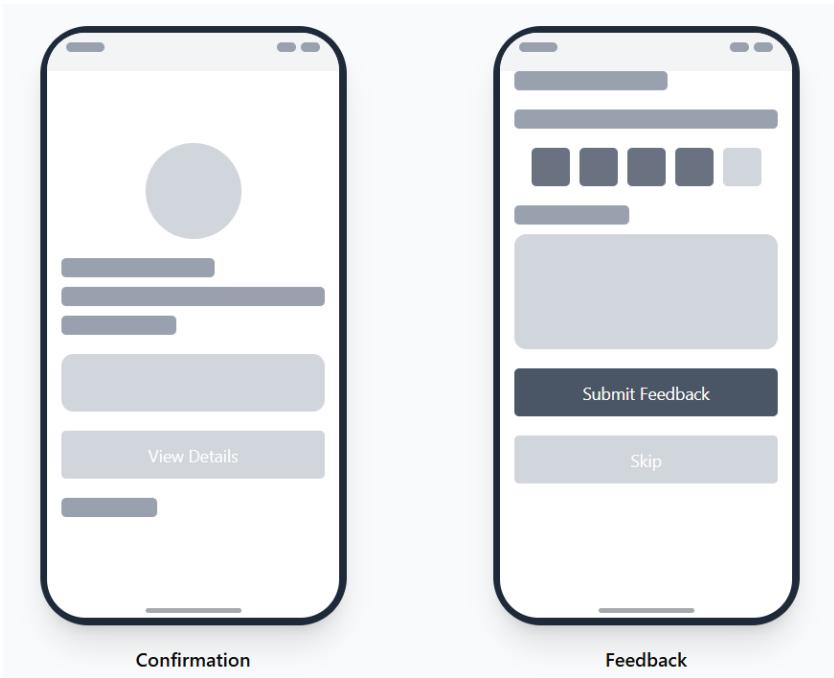


Storyboard

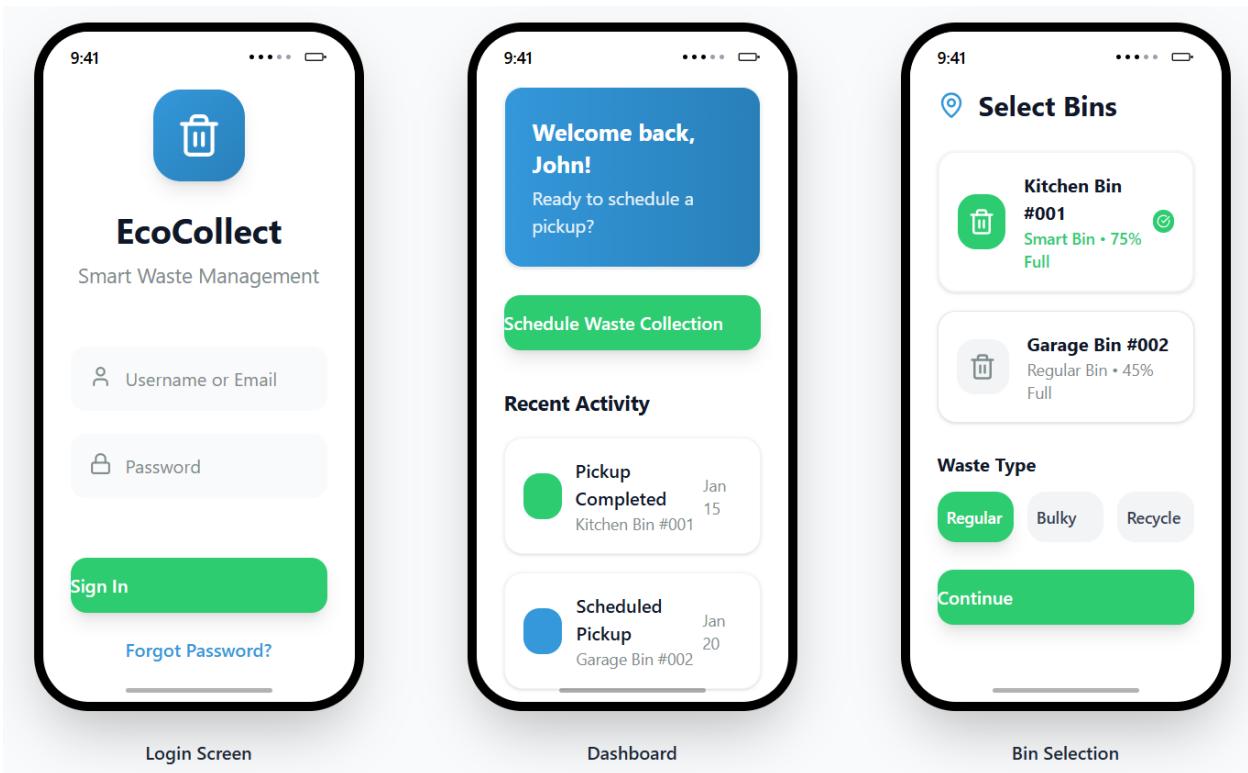


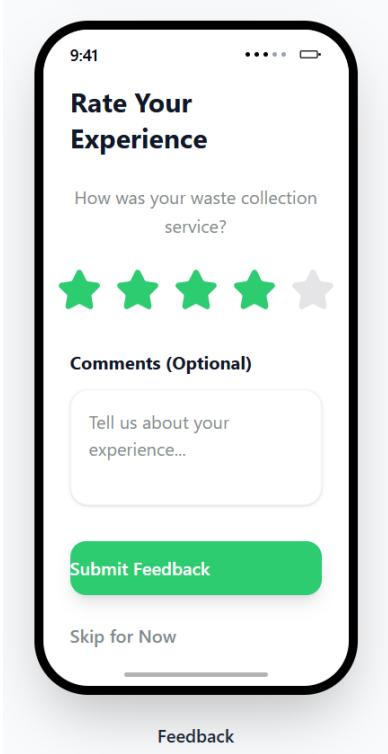
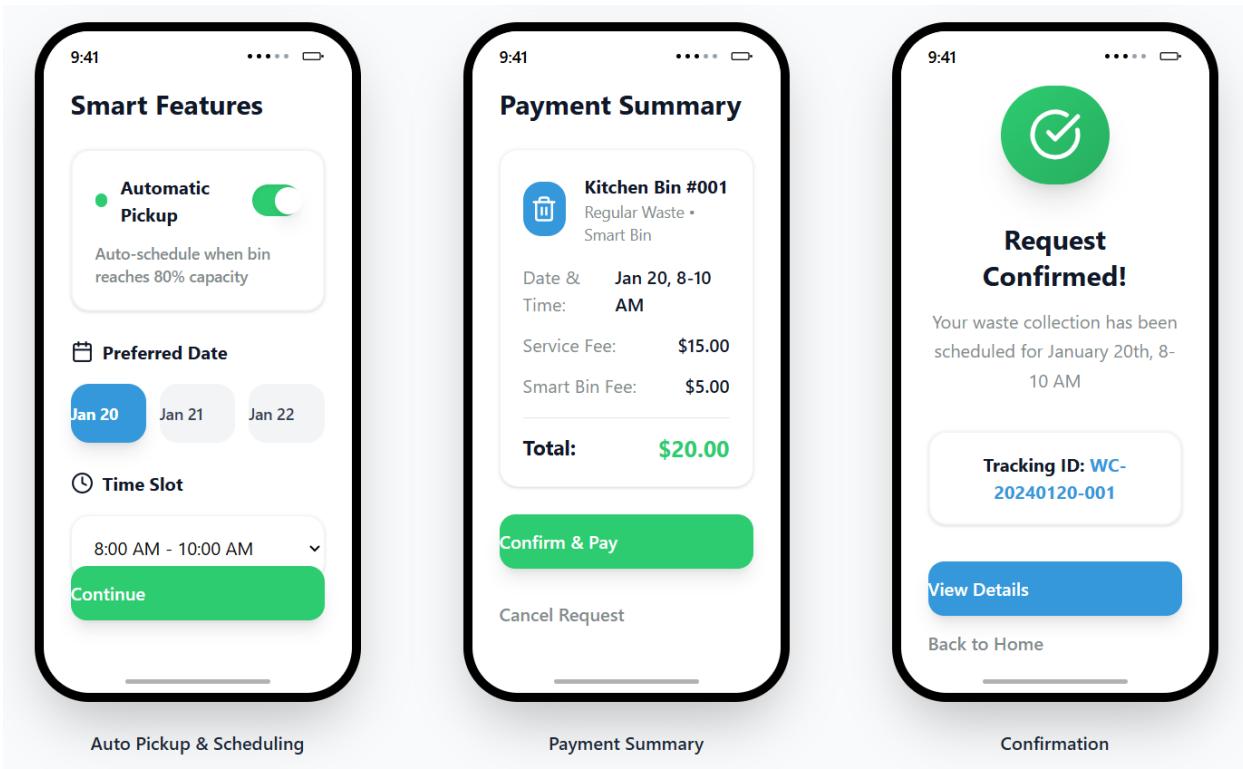
Low fidelity wireframes





High fidelity wireframes





4. Payments & Rewards Management (IT22060426 - Gabilan S)

Use case scenario

Use Case: Resident Pays Bill and Rewards

Description:

This use case describes how a resident or business account holder views their waste management bill, applies available recycling credits or rewards, and makes the payment through the online portal/app.

Preconditions

- The resident has an active account linked to registered bins.
- Waste collection events (weight, volume, or lifts) have been recorded by the system.
- The city has configured a billing model (Flat Fee, PAYT, or Hybrid).
- The resident has available credits/rewards (if earned from recycling).

Main Flow (Happy Path)

1. Resident opens portal/app
 - Resident logs into the waste management app or web portal.
 - System displays billing section.
2. System generates invoice
 - Billing Engine calculates charges based on the configured model.
 - An itemized bill is prepared (base fee, variable charges, taxes).
3. Resident views invoice
 - Resident receives a notification (SMS/email/app).
 - They log in and check the detailed bill.
4. System checks credits/rewards
 - Available credits/reward points are displayed (e.g., “You have Rs. 100 credit available”).
5. Resident applies credits
 - Resident chooses to apply rewards to reduce total charges.
 - System recalculates invoice (e.g., Rs. 600 → Rs. 500).
6. Resident makes payment
 - Resident selects “Pay Now.”
 - Payment Gateway processes the payment via card, bank transfer, or auto-pay.
7. System confirms payment

- If successful, the account balance updates to “Paid.”
 - A digital receipt is generated showing payment details and applied credits.
 - Resident receives confirmation via app/email.
8. Admin dashboard updates
- Finance/Admin dashboard records the transaction.
 - Audit trail logs are updated.

Alternate Flows:

- Auto-Pay Enabled: System auto-deducts bill on due date, applying credits first, then charging balance.
- Partial Payment: Resident pays part of the bill; system records arrears.
- Withdraw Credits: If city policy allows, resident requests withdrawal instead of applying credits to bill.

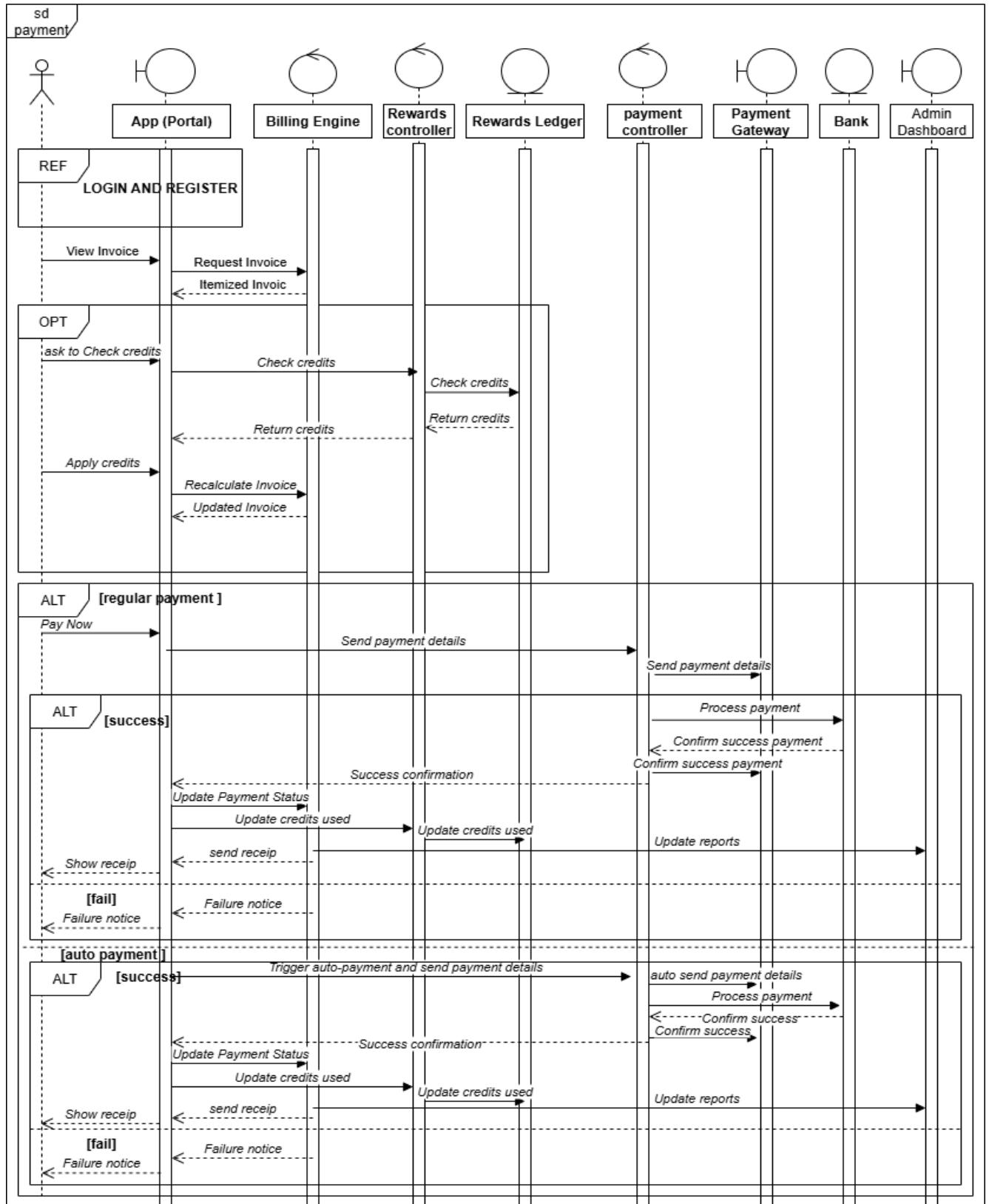
Exception Flows:

- Payment Failure: Payment gateway declines transaction; system notifies resident and retries.
- Invalid/Expired Credits: Credits are expired or exceed city policy limit, so they are not applied.
- Refund Needed: If double-charged or overcharged, admin processes refund and updates ledger.

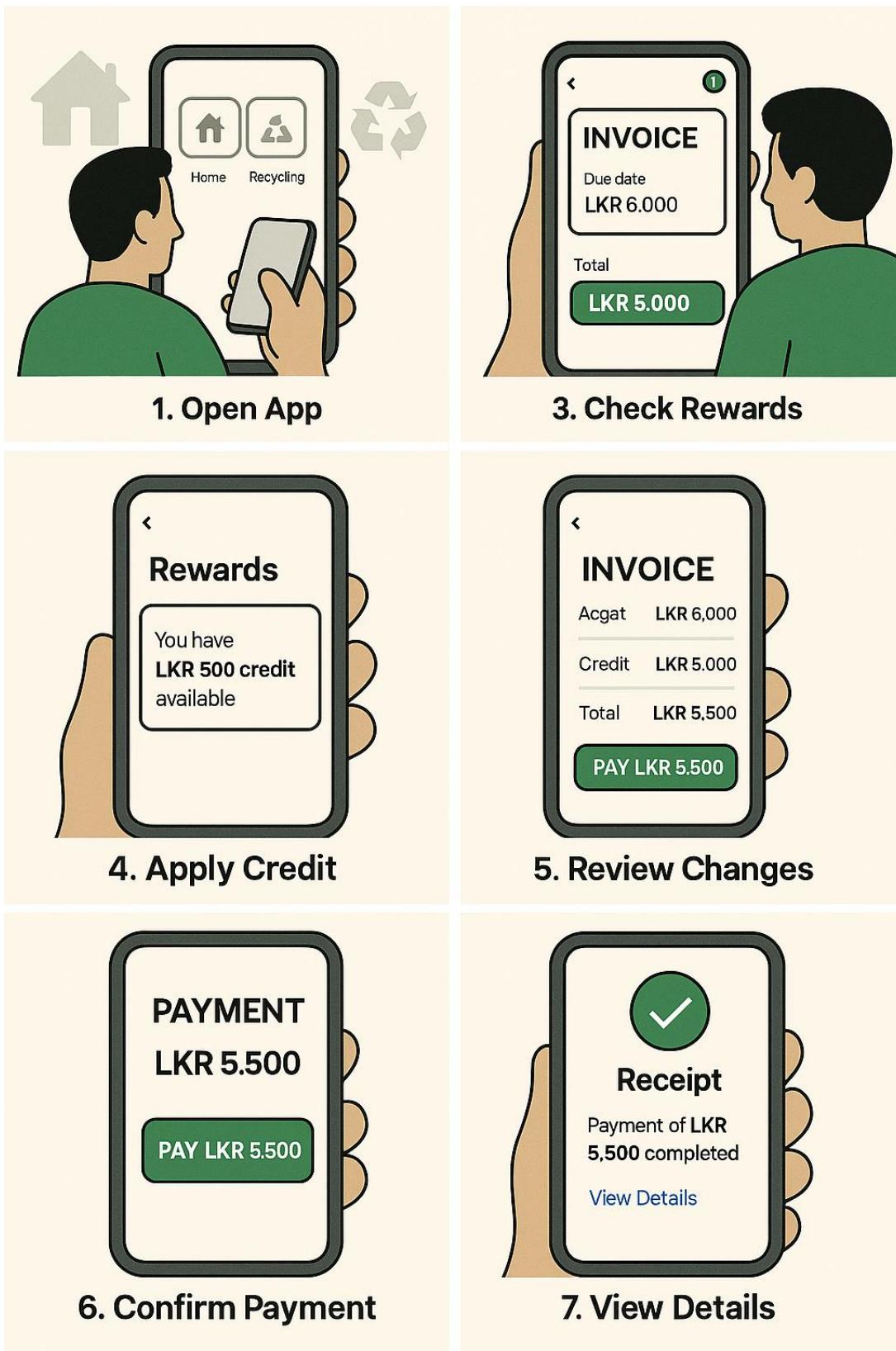
Postconditions:

- Invoice is updated as Paid (or Partially Paid).
- Credits are deducted/updated accordingly.
- Resident has a digital receipt for payment and rewards.
- Admin dashboard reflects updated revenue and credit usage.

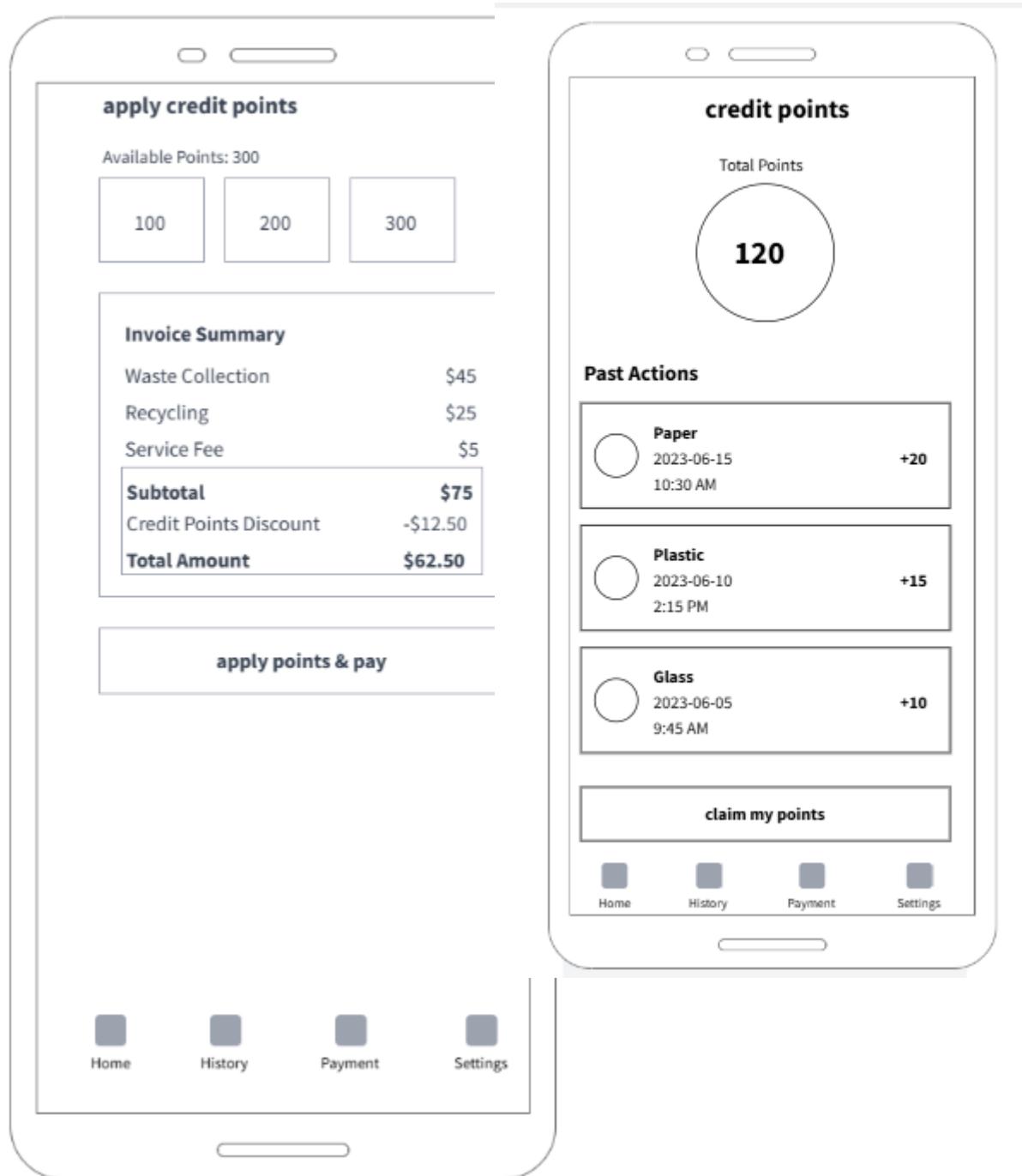
Sequence diagram

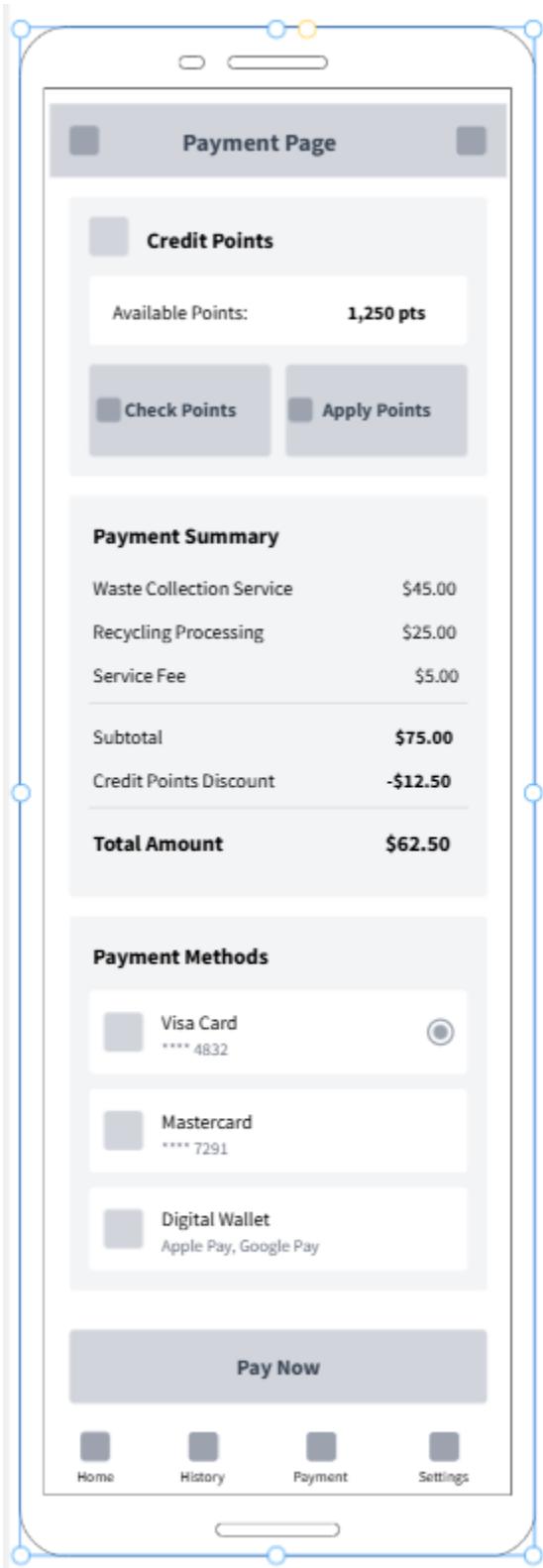


Storyboard

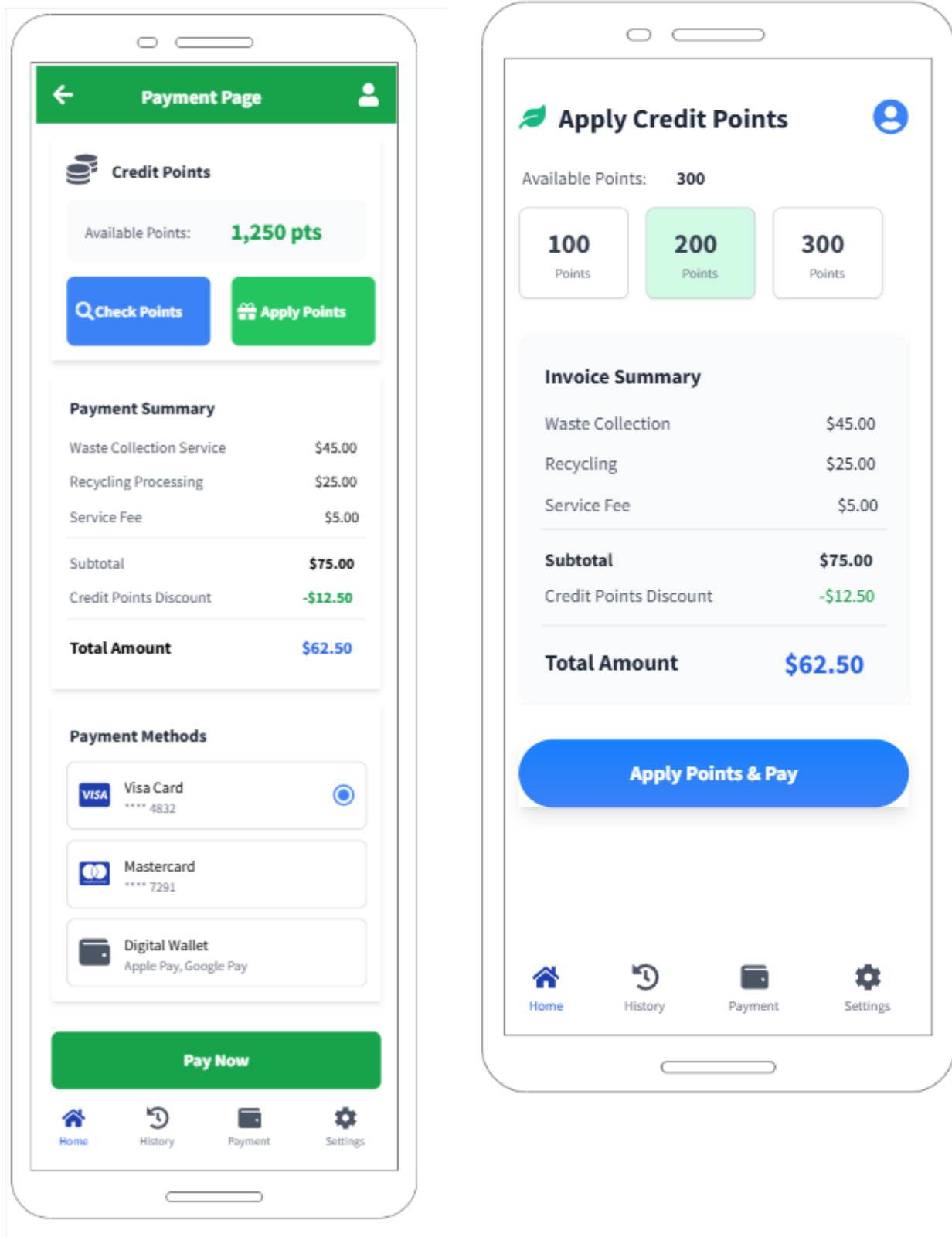


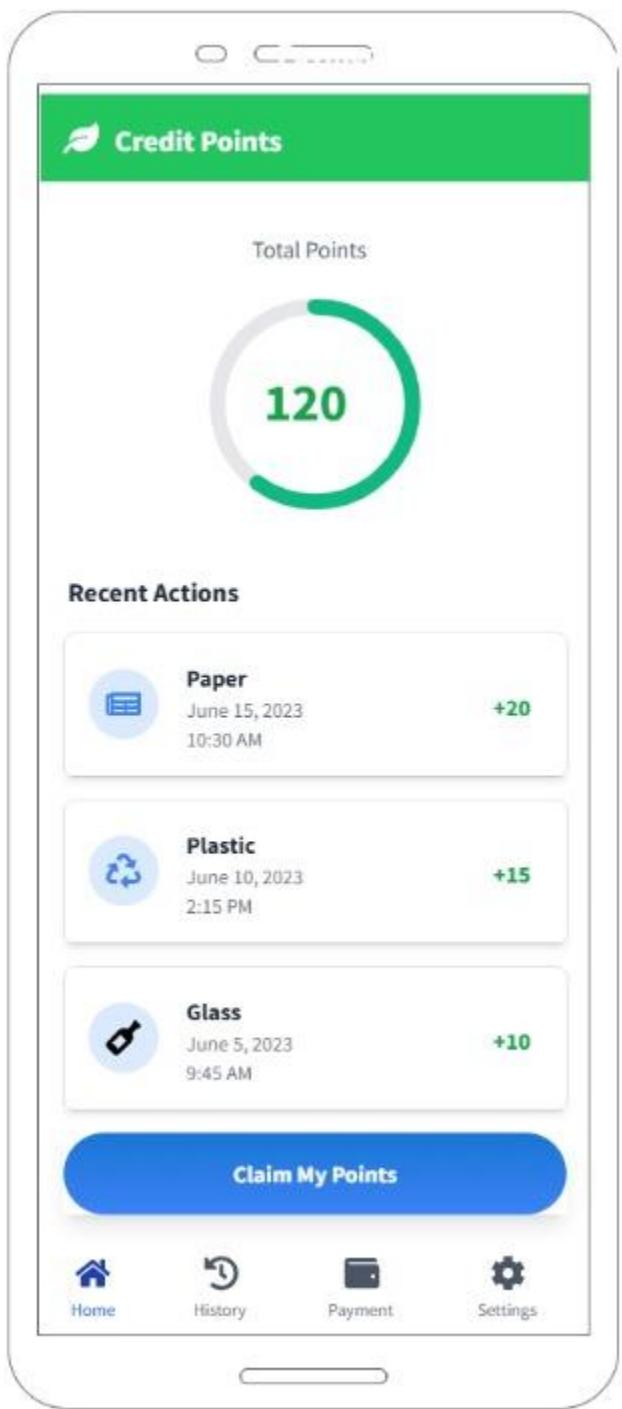
Low fidelity wireframes





High fidelity wireframes





Appendix

UN Environment Programme – Waste Management Overview

👉 <https://www.unep.org/explore-topics/resource-efficiency/what-we-do/cities/waste-management>

EU Smart Cities Marketplace – Smart Waste Collection Solutions

👉 <https://smart-cities-marketplace.ec.europa.eu/solutions/smart-waste-collection>

Bigbelly Smart Bins (real-world product inspiration)

👉 <https://bigbelly.com/>

AI prompts-

Bin & Collection Management

Create a 7-frame storyboard in a flat illustration style showing a field crew scanning a smart bin and recording the collection.

Each frame should show: (1) Crew check-in, (2) Route start, (3) Bin scanning, (4) Successful confirmation, (5) Exception handling (blocked access), (6) Audio/visual feedback, (7) End of route. Use muted background colors, arrows for navigation, and consistent spelling in captions.

Payments & Rewards Management

Create a 7-frame storyboard in a flat illustration style, showing a resident using a mobile app to pay a waste management bill with rewards credits.

Steps: (1) Open App, (2) View Invoice, (3) Check Rewards, (4) Apply Credit, (5) Review Changes, (6) Confirm Payment, (7) View Receipt.

Use infographic storyboard style, muted backgrounds, and consistent text.

User & Account Management

Generate a low-fidelity wireframe for the “Schedule Bulky Waste Collection” page.

Include placeholders for: Calendar date/time picker, Bin selection dropdown, Notes field, and Confirm button.

Use grayscale boxes, labels, and arrows to show navigation.

Data Analytics & Reporting

Create a low-fidelity wireframe of an admin dashboard showing waste collection KPIs.

Sections: route completion %, exceptions heatmap, waste stream breakdown chart, and recent reports list.

Use simple grayscale layout with boxes and text placeholders.

User & Account Management

Create a high-fidelity colored wireframe for the “Schedule Bulky Waste Collection” screen.

Use a clean modern style with blues, greens, whites, and grays.

Include: calendar widget, bin selection dropdown, notes text box, confirm button with hover effect, and notification banner.

Data Analytics & Reporting

Generate a high-fidelity colored wireframe for the Admin Waste Dashboard.

Include: navigation sidebar, KPI cards (completed pickups, missed pickups, exceptions), heatmap visualization, pie chart of waste streams, and recent report downloads section.

Use a professional palette (greens, blues, whites, grays) with icons and subtle shadows.