FINAL REPORT

CSS325 Database Systems

Database System Project

TrackBuddy: Parcel Delivery Tracking

By

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TrackBuddy: Design and Implementation of a Database System for Parcel Delivery Tracking

Contents

Abstract

This project introduces TrackBuddy, a database system designed to efficiently manage and track parcel deliveries. TrackBuddy enables senders and recipients to monitor the progress of parcels from dispatch to delivery. The system is designed to handle multiple distribution centers, with updates provided at each step of the parcel's journey until the parcel is completely delivered. The core feature allows users to track their parcels using a unique tracking ID, which records status changes, timestamps, and location updates. This report outlines the project's database structure, including the ER Diagram, Context Diagram, Data Flow Diagram, Functional Design, and User Interface tailored for both staff and couriers to ensure effective management and confirmation of parcel movements, highlighting the relationships between key entities. The system is designed to improve the efficiency of parcel tracking by allowing seamless updates at each distribution center.

1. Introduction

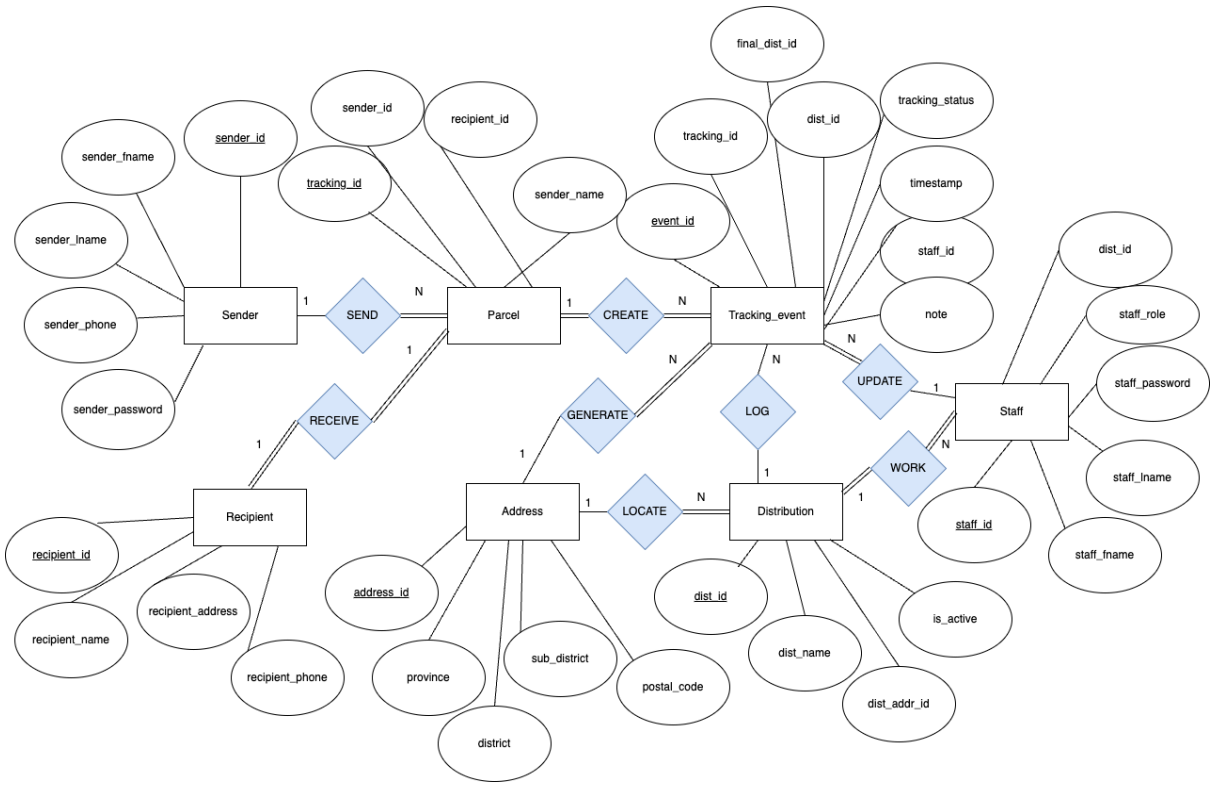
In today’s logistics and delivery industry, having a dependable parcel tracking system is crucial for maintaining customer trust and operational efficiency. The increasing demand for reliable delivery services, especially with the growth of e-commerce, emphasizes the importance of robust parcel tracking systems. For both senders and recipients, being able to track the status of parcels helps manage expectations and improves the shipping experience. This project presents a database-driven parcel tracking system that provides updates as a parcel moves between distribution centers. Updates are made at key points in the delivery process—specifically when the parcel arrives at each distribution center—ensuring that the parcel's status is recorded with accurate timestamps.

The system is designed to track parcels reliably, capturing key events and providing both senders and recipients with timely updates. By focusing on accurate status updates with timestamps, the system ensures that users have access to up-to-date information regarding the progress of their shipments. The relationships between the system's key entities—Sender, Recipient, Parcel, Address, Tracking Event, Distribution, and Staff—are structured to ensure efficient tracking throughout the entire delivery process. This report includes the ER Diagram, Context Diagram, Data Flow Diagram, Functional Design, and User Interface, providing a comprehensive view of the TrackBuddy system architecture.

2. Design and Architecture

2.1 Entity-Relationship (ER) Diagram

The system is composed of seven key entities: Sender, Recipient, Parcel/Order, Address, Tracking Event, Distribution, and Staff. These entities work together to enable accurate and efficient tracking of parcels throughout the delivery process.



Entities and Attributes:

1. Sender
   This entity holds the details of the parcel's sender.
   a. sender_id (Primary Key): A unique identifier for each sender.
   b. sender_fname: The first name of the sender.
   c. sender_lname: The last name of the sender.
   d. sender_phone: The contact number of the sender.
   e. sender_password: Password for sender's account access.
2. Recipient
   This entity holds the details of the parcel's recipient.
   a. recipient_id (Primary Key): A unique identifier for each recipient.
   b. recipient_name: The full name of the recipient.
   c. recipient_address: The recipient's address.
   d. recipient_phone: The contact number of the recipient.

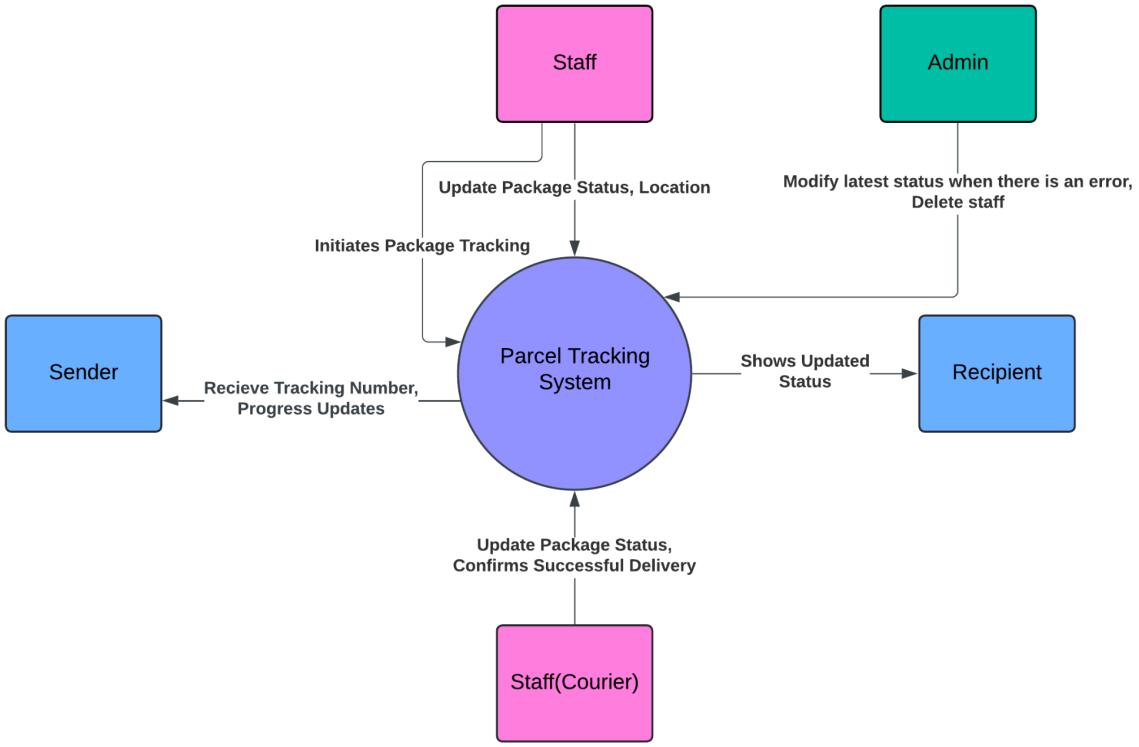
3. Parcel
   This entity tracks each parcel by generating a unique tracking number and associates the sender and recipient with the parcel.
   a. tracking_id (Primary Key): The unique tracking number used to track the parcel.
   b. sender_id (Foreign Key, references Sender(sender_id)): The ID of the sender associated with the parcel.
   c. recipient_id (Foreign Key, references Recipient(recipient_id)): The ID of the recipient associated with the parcel.
   d. sender_name: The name of the sender.
   e. sender_phone: The contact number of the sender.
4. Address
   This entity holds address-related information, capturing the hierarchical relationship between provinces, districts, sub-districts, and postal codes.
   a. address_id (Primary Key): A unique identifier for each address.
   b. province: The province where the address is located.
   c. district: The district of the address.
   d. sub_district: The sub-district of the address.
   e. postal_code: The postal code associated with the address.
5. Tracking Event
   This entity logs updates to the parcel's status as it moves between distribution centers, including timestamps and current status.
   a. event_id (Primary Key): A unique identifier for each tracking event.
   b. tracking_id (Foreign Key, references Parcel(tracking_id)): The ID of the parcel for which the event is recorded.
   c. final_dist_id (Foreign Key, references Address(address_id)): The ID of the final distribution where the parcel will be delivered.
   d. dist_id (Foreign Key, references Distribution(dist_id)): The ID of the current distribution center where the parcel is located.
   e. staff_id (Foreign Key, references Staff(staff_id)): The ID of the staff member who updates the parcel's status.
   f. timestamp: The date and time when the parcel's status was updated.
   g. tracking_status: The current status of the parcel, such as 'pick up,' 'arrived at distribution A/B/C,' 'out for delivery,' or 'delivered.'
   h. note: If the delivery is unsuccessful, there will be a note why it is.
6. Distribution
   This entity stores information about the various distribution centers.
   a. dist_id (Primary Key): A unique identifier for each distribution center.
   b. dist_name: The name of the distribution center.
   c. dist_addr_id (Foreign Key, references Address(address_id)): The address ID of the distribution center.
   d. is_active: Indicate if the distribution is active or not.
7. Staff
   This entity holds details about the staff members working at each distribution center.

a. staff_id (Primary Key): A unique identifier for each staff member.
b. staff_fname: The first name of the staff member.
c. staff_lname: The last name of the staff member.
d. staff_password: Password for staff's account access.
e. dist_id (Foreign Key, references Distribution(dist_id)): The distribution center where the staff member is assigned.
f. staff_role: Role of the staff member (Staff, Courier, Admin)

2.1.2 Relationships Between Entities:

- Sender - Parcel (One-to-Many):
  A sender can send multiple parcels, but each parcel is associated with only one sender.
- Recipient - Parcel (One-to-One):
  A parcel is linked to one recipient, and a recipient receives one parcel in each tracking instance.
- Parcel - Tracking Event (One-to-Many):
  Each parcel can generate multiple tracking events as it progresses through different stages in the delivery process.
- Tracking Event - Address (Many-to-One):
  Multiple tracking events can occur at a single address.
- Distribution - Address (Many-to-One):
  A single address can be associated with multiple distribution centers located in the same district area.
- Distribution - Tracking Event (One-to-Many):
  A distribution center can log many tracking events as parcels arrive and depart.
- Staff - Distribution (Many-to-One):
  Many staff members work at a distribution center, but each staff member is associated with only one center.
- Staff - Tracking Event (One-to-Many):
  A staff member can update multiple tracking events.

2.2 Context Diagram



The context diagram illustrates the high-level interactions between key stakeholders and the TrackBuddy Parcel Tracking System, outlining how different user roles—Sender, Recipient, Staff, and Courier—interface with the system.

2.2.1 Key Entities and Interactions:

1. Sender:
    - Interaction with the Tracking System: The sender initiates parcel tracking by submitting the necessary package details to the system. Upon successful submission, the system generates a unique Tracking Number, which is shared with the sender. The sender also receives Progress Updates as the parcel moves through the delivery process.
2. Recipient:
    - Interaction with the Tracking System: The recipient accesses the system to view Updated Status information, allowing them to monitor the parcel's journey and expected delivery timeline.
3. Staff:
    - Interaction with the Tracking System: Staff members at distribution centers are responsible for Updating Package Location whenever a parcel arrives or departs from their facility, ensuring accurate tracking.
4. Courier (a specific type of staff):

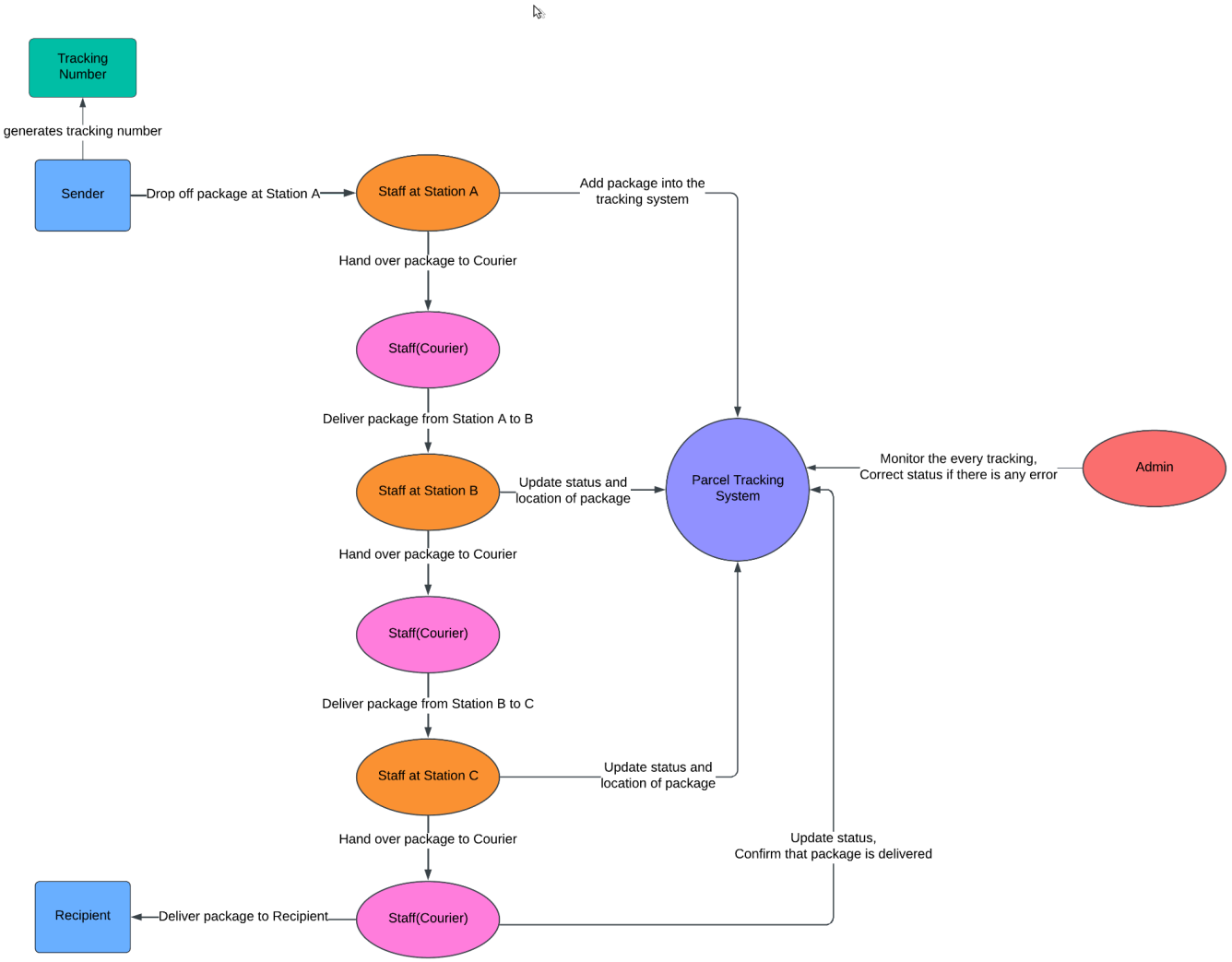
- Interaction with the Tracking System: Couriers confirm the Successful Delivery of parcels to the recipient by updating the system with the delivery status once the parcel has been delivered.

5. Admin:
    - Interaction with the Tracking System: Admins review reports submitted by staff or couriers regarding parcel issues or unsuccessful deliveries. They modify or correct Parcel Status in the system if errors are identified. Admins have the authority to delete inactive staff or courier accounts and ensure the system maintains accurate user data.

2.2.2 Central System:

The Parcel Tracking System functions as the core hub for recording, managing, and disseminating parcel information. It receives input from senders, staff, admin, and couriers, processes the data, and provides tracking updates to the recipient.

2.3 Data Flow Diagram



The provided Data Flow Diagram (DFD) represents the flow of information within the TrackBuddy Parcel Tracking System, illustrating how parcels are tracked as they move through various distribution stations.

2.3.1 Key Components:

1. Sender:
    - The process starts when the sender initiates a shipment. Upon sending the parcel, the system generates a Tracking Number, which is used to monitor the status of the parcel.
2. Staff (at Various Locations):

    - As the parcel moves through various distributions, staff members at each location update the Parcel Tracking System. This ensures that the system accurately reflects the parcel's location and current status at all times.
    - These updates are made at each checkpoint along the parcel's journey.
3. Courier:
    - Once the parcel reaches the final stage before delivery, a courier delivers it to the recipient and confirms the completion of the process in the tracking system.
4. Parcel Tracking System:
    - The central Parcel Tracking System records and updates the status of the parcel at each step, from its origin to its destination.
    - At each distribution, staff provide status updates to the system, which then makes this information available to all involved parties, including the sender and recipient.
5. Recipient:
    - The recipient is able to track the parcel’s progress using the tracking number provided by the sender. They can view status updates until the parcel is delivered to them.
6. Admin:
    - The admin oversees the overall operation of the system.
    - They monitor reported issues, resolve delivery problems, and manage system updates as needed.

2.3.2 Flow Summary:

- This DFD illustrates how the parcel's tracking information flows between various entities: sender, staff, couriers, admin, and the recipient.
- Each staff member at each distribution along the route is responsible for updating the system to ensure that the tracking information remains current and accurate.
- The Parcel Tracking System centralizes all tracking information, providing transparency and updates on the parcel's location and status.

2.4 Functional Design

The functional design of the TrackBuddy parcel tracking system is structured to support efficient parcel management and tracking for different user groups, including senders, recipients, staff, and couriers. The system facilitates the tracking of parcels throughout the delivery process, ensuring timely updates at each key stage. Below is a detailed overview of the core functionalities of the system:

2.4.1 User Registration and Authentication

- Senders and Recipients: Users are required to create an account by providing their first name, last name, phone number, and a password. Once registered, users can log in using their phone number and password to access the system.

- Staff and Couriers: Similarly, staff members and couriers must register by providing their first name, last name, assigned work office branch, and a password. Once registered, they can log in using their staff ID and password.

2.4.2 Parcel Tracking

- Senders and Recipients:
    - Users can track parcels by entering a unique tracking number. The system provides an overview of the parcel's current status, including its location and timestamp of the most recent update.
    - A detailed tracking history is also available, showing all updates from dispatch to delivery, with timestamps corresponding to each event.
- Staff:
    - Staff members are responsible for confirming the arrival of parcels at each distribution center. Upon confirmation, the system updates the parcel's status, capturing the location and timestamp of the event.

2.4.3 Parcel Status Management

- Senders and Recipients:
    - Users can access a summary of all their shipments through the "My Shipment" page, with the ability to filter parcels based on status, such as "In Progress," "Delivered," or "Unsuccessful."
    - A search functionality enables users to find specific parcels by entering a tracking number or recipient name.
- Couriers:
    - Couriers are tasked with managing parcels that are marked "Out for Delivery." They can confirm successful or unsuccessful delivery attempts, updating the parcel’s status in the system accordingly.
    - After delivery confirmation, the system records the timestamp and final status of the parcel.

2.4.4 Branch Locator

- Senders and Recipients:
    - Users can search for distribution centers (branches) by entering the branch name, district, or postal code. The system will display a list of branches that match the entered search criteria, aiding users in locating nearby distribution centers.

2.4.5 Profile Management

- All Users (Senders, Recipients, Staff, and Couriers):
    - Users have the option to modify their profile details, including their name, phone number, and password. For staff and couriers, their assigned work office branch can also be updated.
    - A logout function is available, which redirects users to the login page once their session is terminated.

2.4.6 Key Functionality by User Role

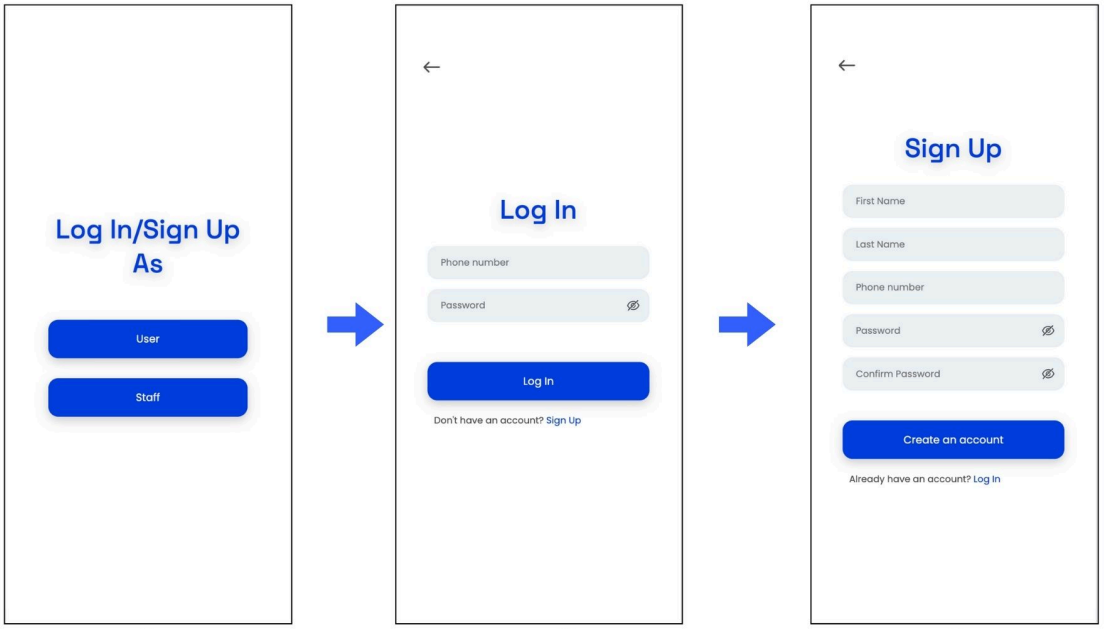
- Senders and Recipients:
    - Track parcels using the unique tracking number.
    - View the detailed history of parcel movements with timestamps.
    - Search for distribution branches based on specific criteria.
    - Access and manage all personal shipments, with filtering capabilities for different statuses.
    - Modify profile information and log out of the system.
- Staff:
    - Confirm the arrival of parcels at distribution centers, updating the parcel status with location and timestamp data.
    - Edit personal profile details and log out of the system.
- Couriers:
    - Confirm when parcels are out for delivery and update the delivery status upon completion, marking parcels as either "Delivered" or "Unsuccessful."
    - Edit personal profile details and log out of the system.

2.5 User Interface

Our parcel tracking system features three distinct user interfaces, tailored for different user roles: senders and recipients, staff, and couriers.

2.5.1 The senders and recipients interface

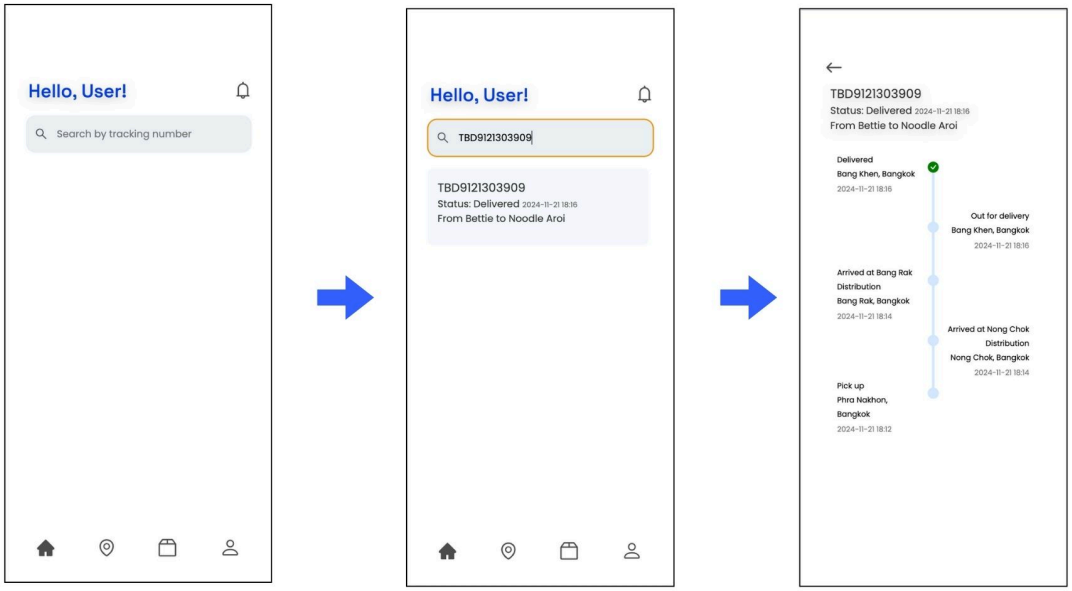
Flow 1: Sign-Up and log-in



(a) (b) (c)

(a) The user must choose their role to log in. If the user is a sender or a recipient, the user must choose ‘User’.
(b) Users can sign in by entering their phone number and password. If the user does not have an account, they can click "Sign Up."
(c) To sign up, the user must enter their first name, last name, phone number, and create a password, then click "Create an Account."

Flow 2: Track a parcel by a tracking number



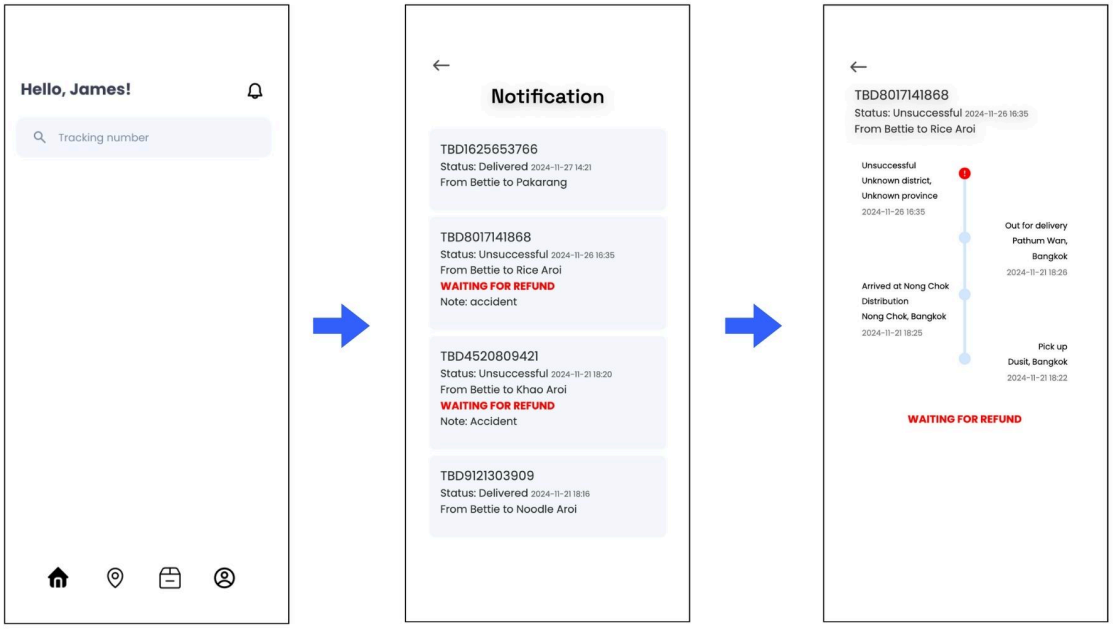
(a) (b) (c)

(a) On the home page, go to the search bar and enter the parcel's tracking number.

(b) The parcel's overview (tracking number, sender and recipient names, current status with timestamp) will be displayed. Users can click to view detailed status.

(c) The detailed status will show the full tracking history, from the initial position to the current location, along with timestamps.

Flow3: Check notification

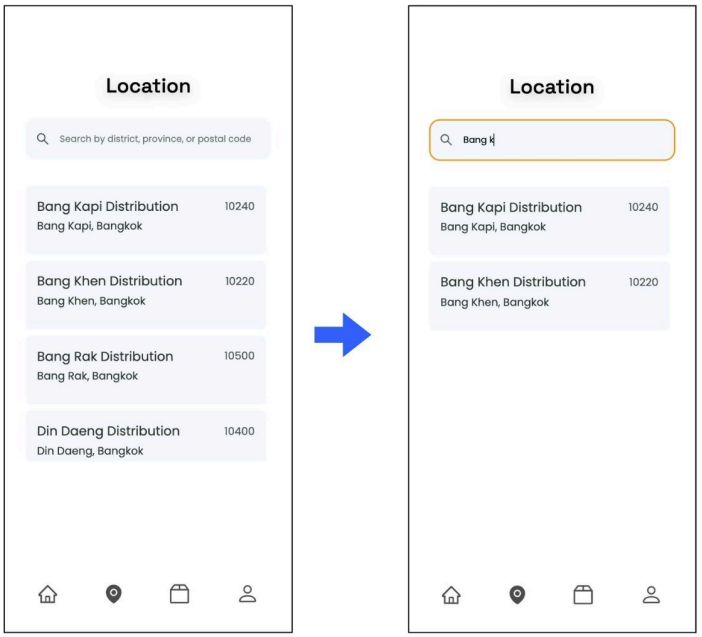


(a) (b) (c)

(a) On the home page, a bell icon is displayed in the top right corner, representing notifications.

(b) Clicking the bell icon opens a list displaying all parcels with a status of either "Delivered" (successful) or "Unsuccessful."
(c) Users can click on each parcel entry to view detailed information about its delivery status.

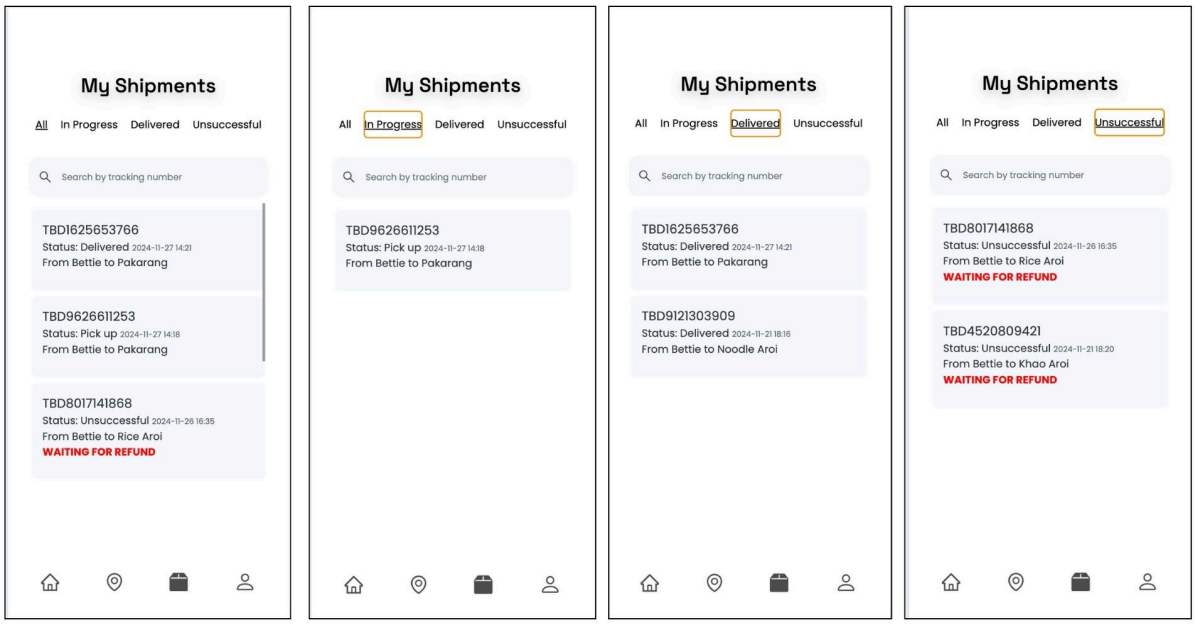
Flow 4: Find Branches



(a) (b)

(a) From the bottom navigation bar, go to the “Location” page. A list of branches will be displayed. Users can search for a branch by entering the distribution name, district, or postal code.
(b) After entering the information, a list of branches matching the search criteria will be shown.

Flow 5: Check the Status of All Your Shipments



(a) (b) (c) (d)

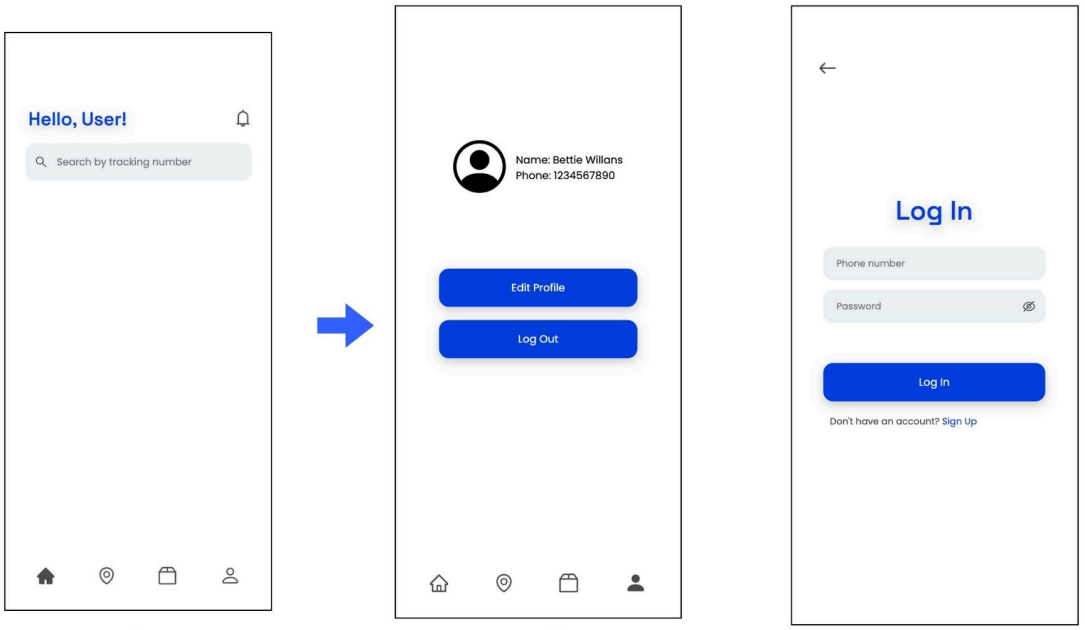
(a) From the navigation bar, go to the "My Shipment" page. A list of parcels sent by the user will be displayed, with filters for parcel status: All Status, In Progress, Delivered, or Unsuccessful. A search bar is available for users to search by tracking number or name. ; All Status: Displays all shipments regardless of status.

(b) In Progress: Shows shipments with statuses like "Picked Up," "Arrived at Distribution," or "Out for Delivery".

(c) Delivered: Displays all shipments that have been successfully delivered.

(d) Unsuccessful: Shows all shipments with failed delivery attempts.

Flow 5: Edit Profile or Log Out



(a) (b) (c)

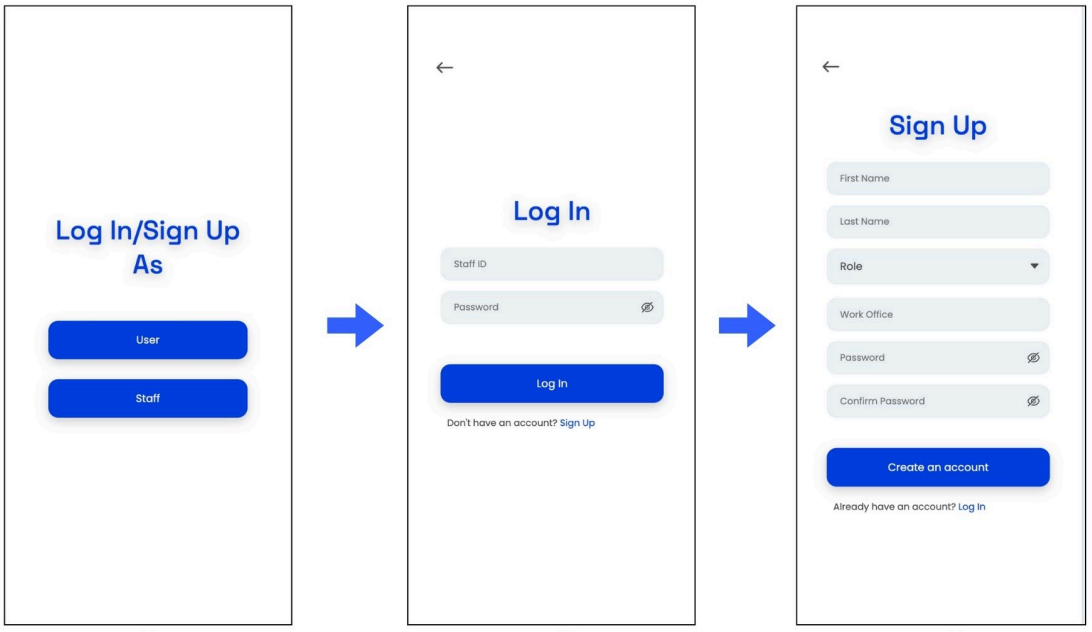
(a) From the navigation bar, navigate to the "Profile" page, where two options are displayed: "Edit Profile" and "Log Out."

(b) Selecting "Edit Profile" allows users to update their name, phone number, and password.

(c) Selecting "Log Out" will securely log the user out and redirect them to the sign-in page.

2.5.2 The staff interface

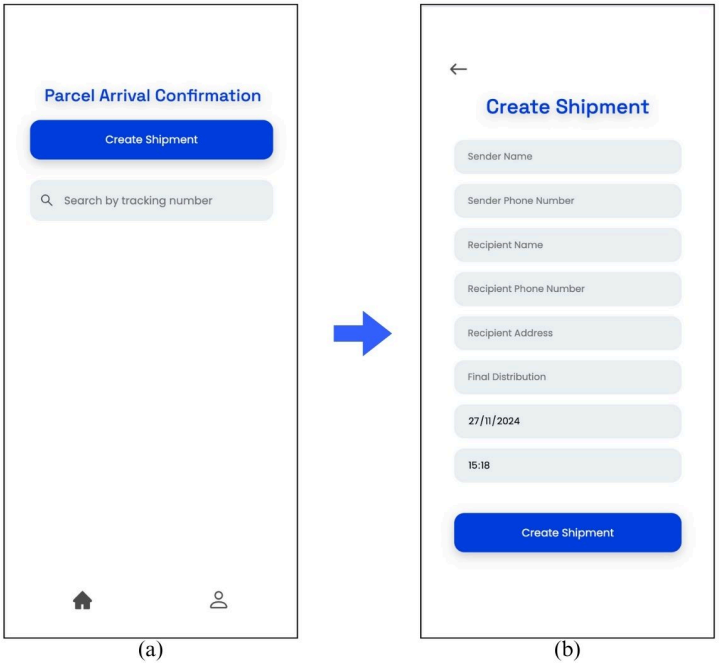
Flow 1: Sign-Up and log-in



(a) (b) (c)

(a) The user must choose their role to log in. If the user is a staff, courier, or admin, the user must choose ‘Staff’.
(b) Users can sign in by entering their staff id and password. If the user does not have an account, they can click "Sign Up."
(c) To sign up, the user must enter their first name, last name, phone number, and create a password, then click "Create an Account."

Flow 2: Create a Shipment



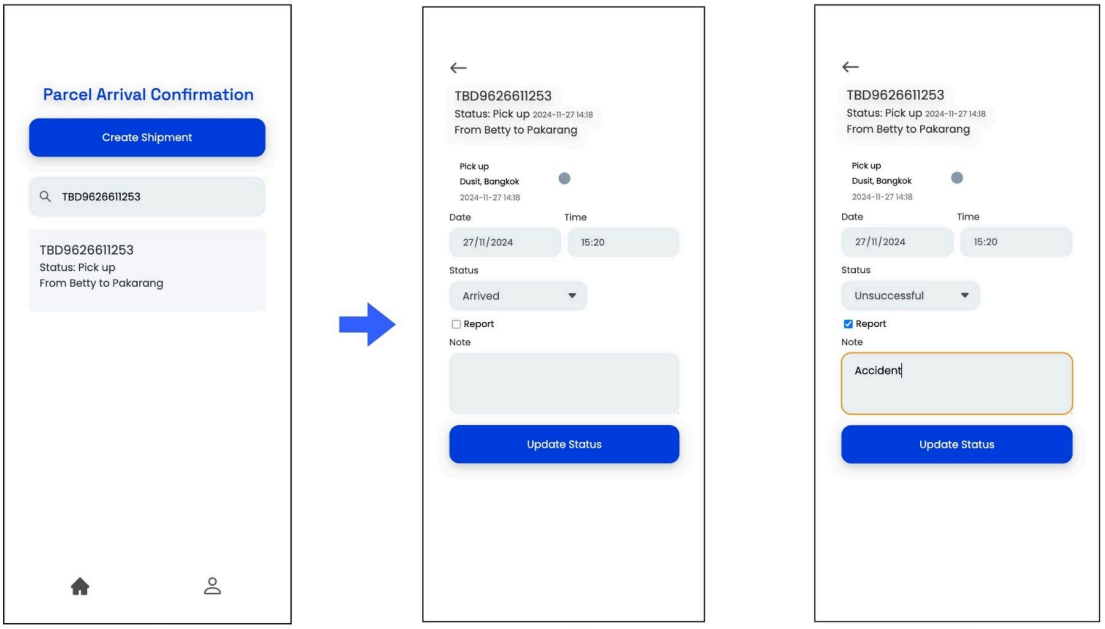
(a) (b)

(a) On the Home Page, click the "Create a Shipment" button.
(b) This opens the "Create a Shipment" page, where the user must fill in:

- Sender info: name and phone number
- Recipient info: name, phone number, and address
- Final distribution name: the branch nearest to the recipient's address

After filling in the details, click "Confirm Pickup." A tracking number will be generated, and the shipment information will be inserted into the database.

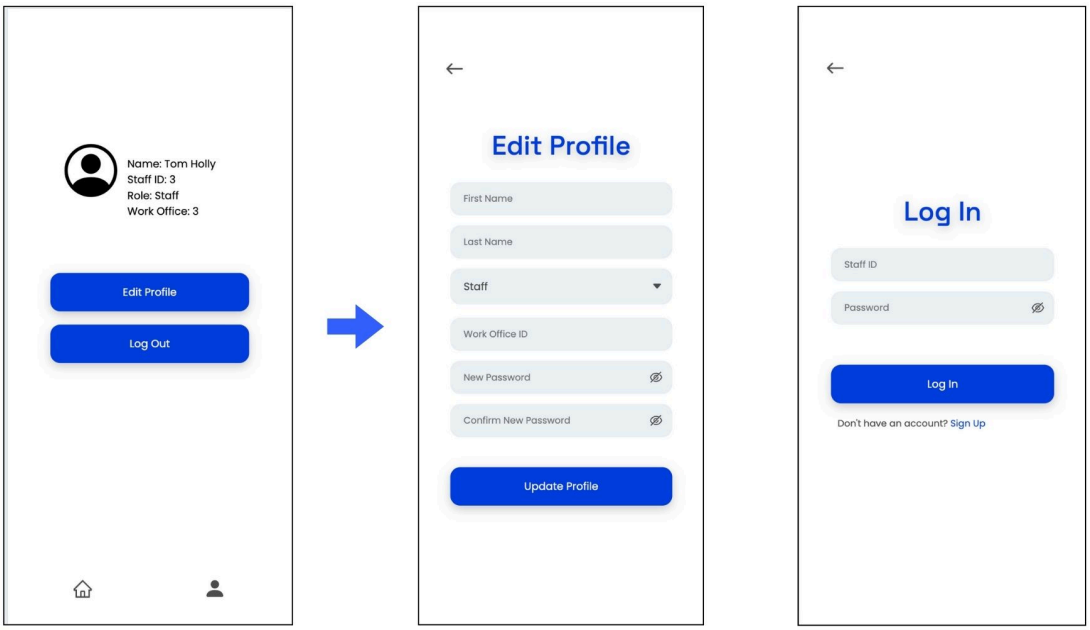
Flow 3: Parcel Arrival Confirmation



(a) (b) (c)

(a) On the home page, There is a search bar to look up a parcel by tracking number. The parcel overview (tracking number, sender and recipient names, current status with timestamp) is shown. Users can click to view detailed status.
(b) The current location and time are displayed. Users click "Update status" to confirm the parcel's arrival.
(c) If any issues arise and the parcel cannot proceed with shipping, they can select a "Report" checkbox and provide details about the issue in a notes text box. Once completed, clicking "Update status" will update the parcel status to be “Unsuccessful” and send the issue report to the admin.

Flow 4: Edit Profile or Log Out

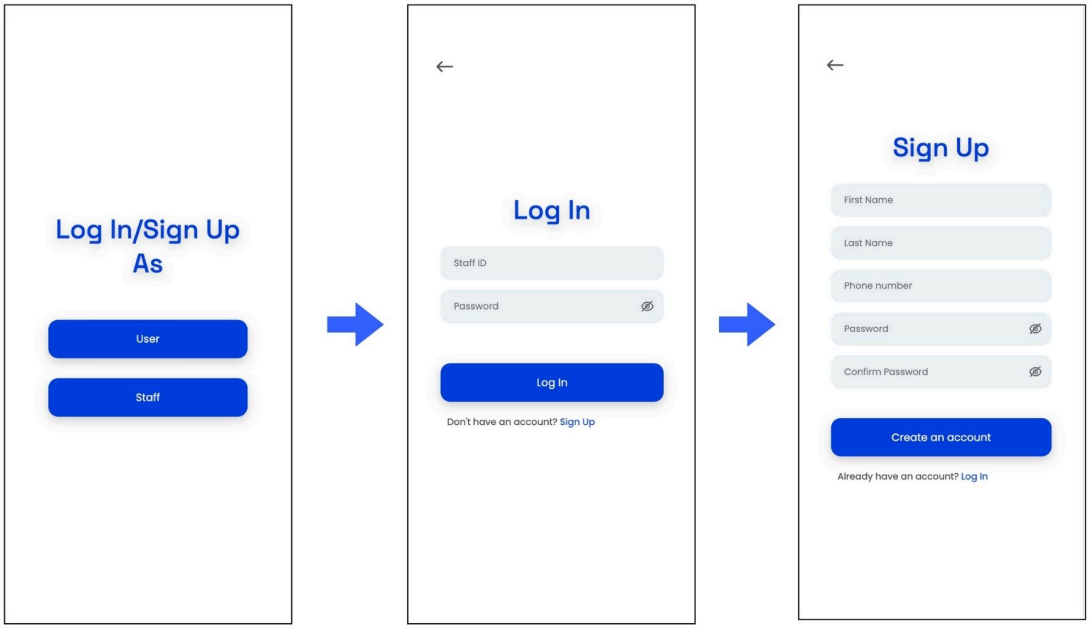


(a) (b) (c)

(a) From the navigation bar, navigate to the "Profile" page, where two options are displayed: "Edit Profile" and "Log Out."
(b) Selecting "Edit Profile" allows users to update their first name, last name, role, work office (distribution branch they are working at), and password.
(c) Selecting "Log Out" will securely log the user out and redirect them to the sign-in page.

2.5.3. The couriers interface

Flow 1: Sign-Up and log-in



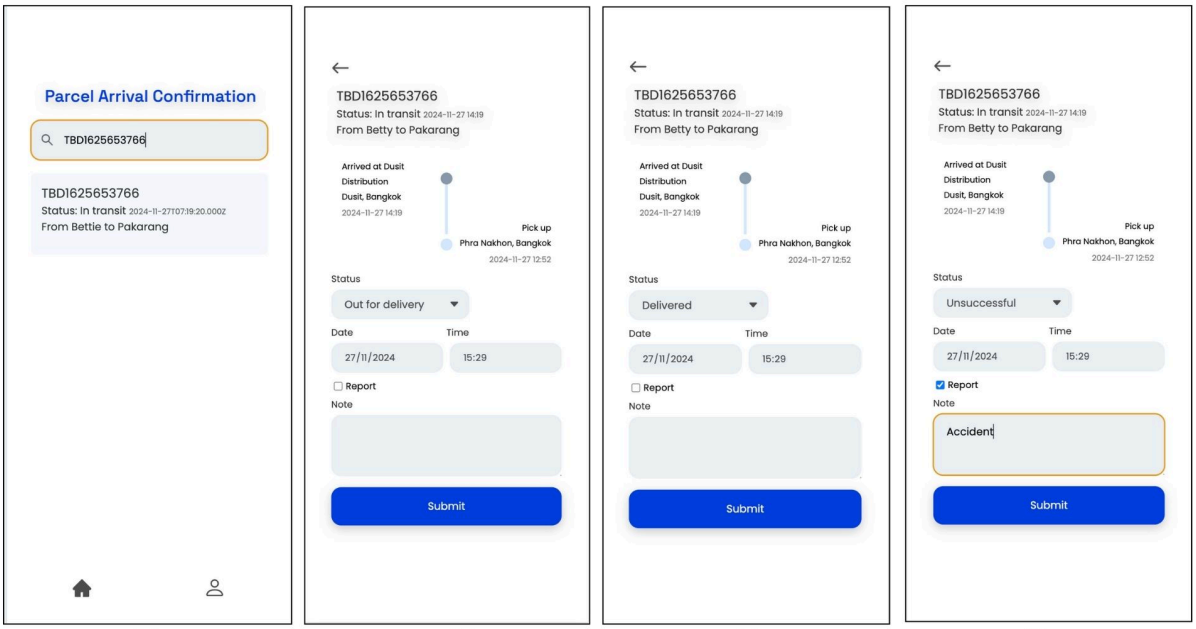
(a) (b) (c)

(a) The user must choose their role to log in. If the user is a staff, courier, or admin, the user must choose ‘Staff”.

(b) Users can sign in by entering their staff id and password. If the user does not have an account, they can click "Sign Up."

(c) To sign up, the user must enter their first name, last name, phone number, and create a password, then click "Create an Account."

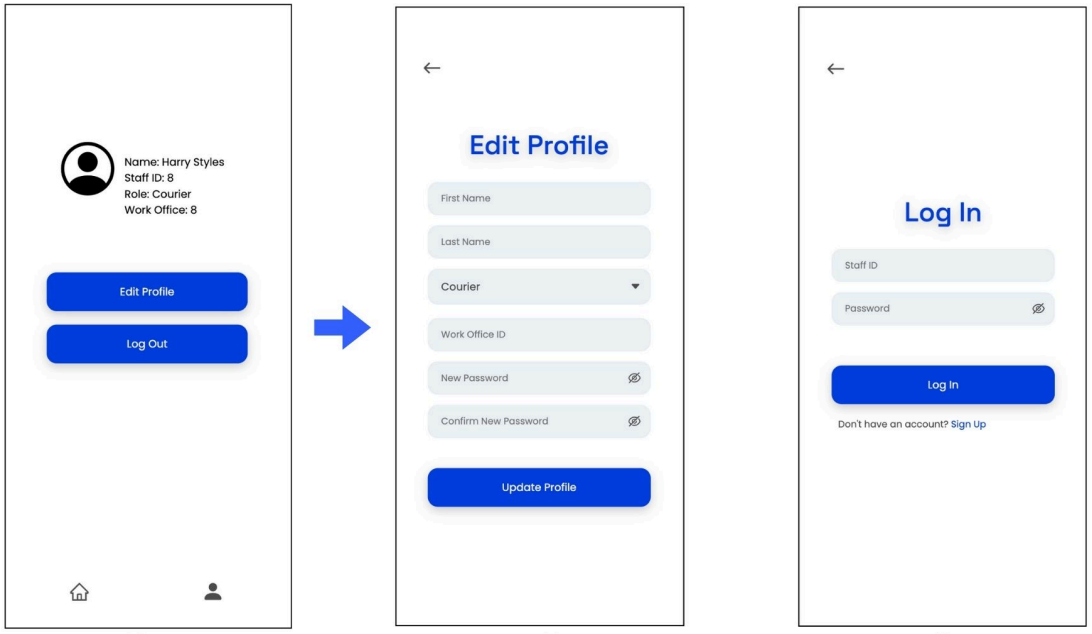
Flow 2: Parcel Out for Delivery, Delivered, Unsuccessful Confirmation



(a) (b) (c) (d)

(a) Users can search by tracking numbers using the search bar and the parcel overview (tracking number, sender and recipient names, current status with timestamp) is shown. Users can click to view detailed status.
(b) The current date and time are displayed. When users click "Status," three options are shown. Select one:
(c) “Out for delivery”: Users click "Submit" to confirm the parcel is ready to deliver. After confirming, the status is updated to "Out for Delivery".
(d) “Delivered”: Users click "Submit" to confirm the parcel is delivered. After confirming, the status is updated to "Delivered".
(e) If any issues arise and the parcel cannot proceed with shipping, they can select a "Report Issue" checkbox and provide details about the issue in a notes text box. Once completed, clicking "Confirm" will update the parcel status to be “Unsuccessful” and send the issue report to the admin.

Flow 3: Edit Profile or Log Out

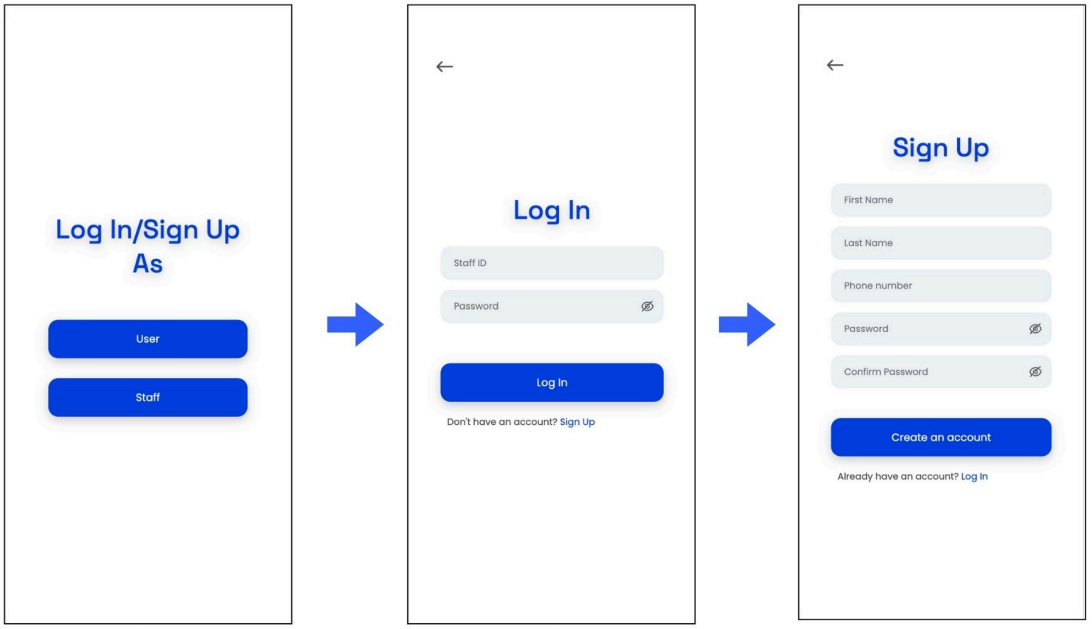


(d) (e) (f)

(a) From the navigation bar, navigate to the "Profile" page, where two options are displayed: "Edit Profile" and "Log Out."
(b) Selecting "Edit Profile" allows users to update their first name, last name, role, work office (distribution branch they are working at), and password.
(c) Selecting "Log Out" will redirect users to the sign-in page.

2.5.4. The admin interface

Flow 1: Sign-Up and log-in



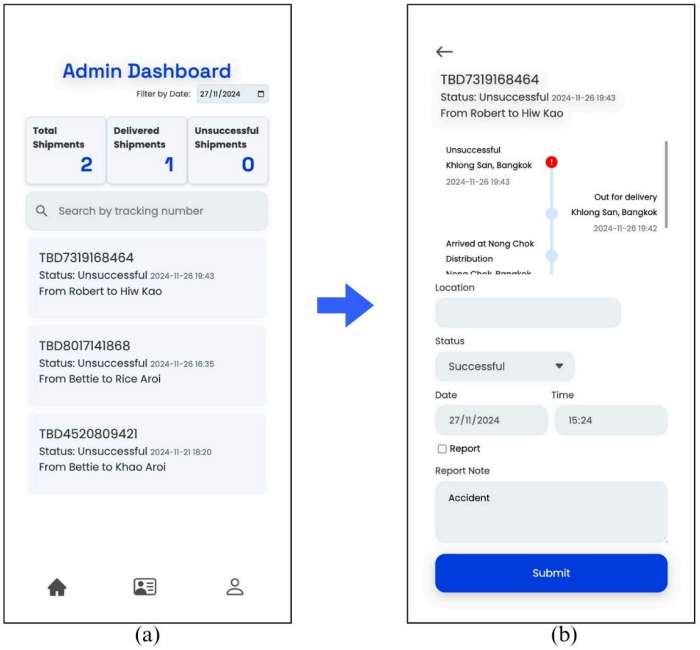
(a) (b) (c)

(a) The user must choose their role to log in. If the user is a staff, courier, or admin, the user must choose ‘Staff”.

(b) Users can sign in by entering their staff id and password. If the user does not have an account, they can click "Sign Up."

(c) To sign up, the user must enter their first name, last name, phone number, and create a password, then click "Create an Account."

Flow 2: Dashboard and Status Update

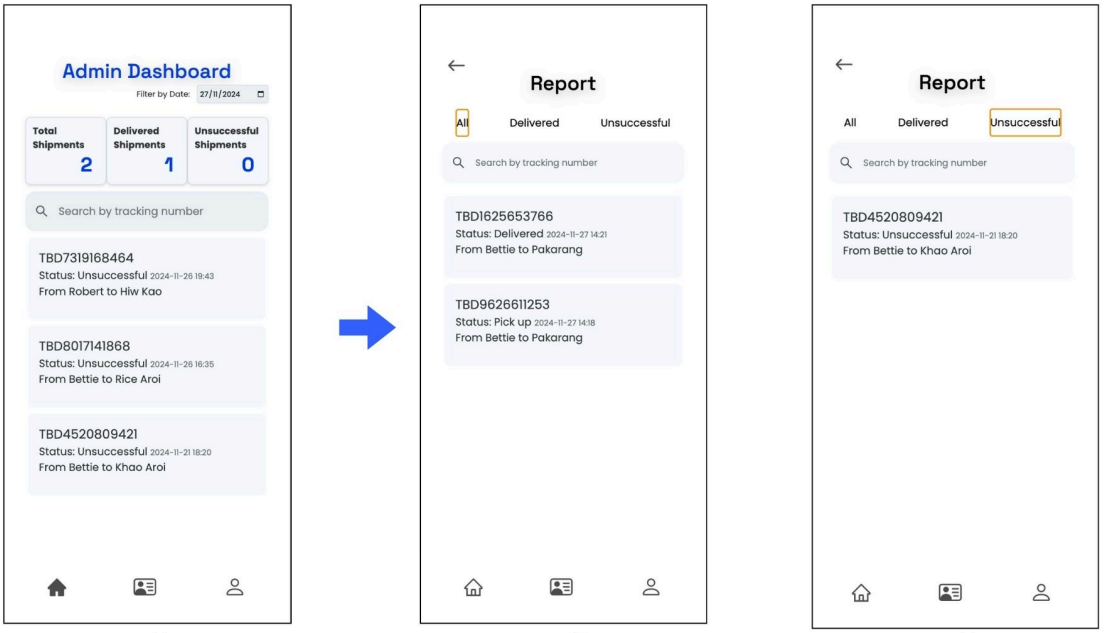


(a) (b)

(a) On the Home page, a dashboard displays the total number of parcels delivered for the selected day (with an option to filter by date) in the top section. The second section lists all parcels reported as unsuccessful, with entries submitted by either staff or couriers.

(b) By clicking on any reported parcel entry, the admin can review its details, verify accuracy, and update the status if corrections are needed.

Flow 3: Dashboard overview

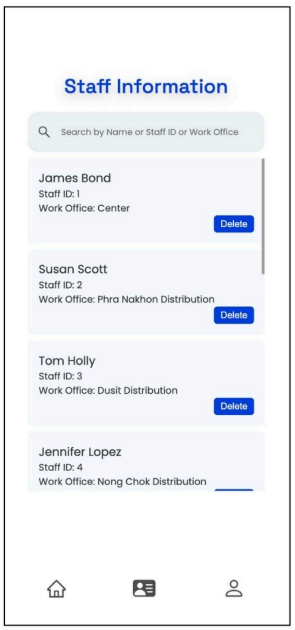


(a) (b) (c)

(a) On the Home Page, a dashboard will display the total number of parcel deliveries for the selected date (with an option to filter by date). This summary includes all parcels, organized by status: All Status, Delivered, and Unsuccessful.

(b) , (c) Users can select any status category, and parcels with the selected status will be displayed in detail.

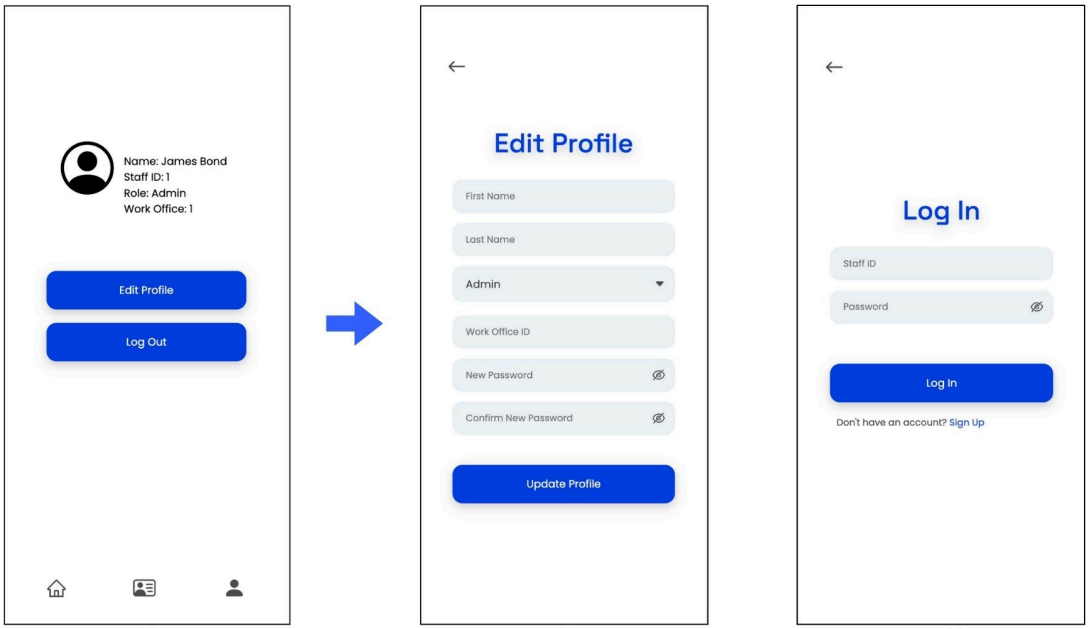
Flow 4: Delete Staff



(a)

(a) A page displays a list of all staff members along with a 'Delete' button. Clicking the 'Delete' button removes the selected staff member's information from the database if they are no longer employed.

Flow 5: Edit Profile or Log Out



(a) (b) (c)

(a) From the navigation bar, navigate to the "Profile" page, where two options are displayed: "Edit Profile" and "Log Out."
(b) Selecting "Edit Profile" allows users to update their first name, last name, role, work office (distribution branch), and password.

(c) Selecting "Log Out" will securely log the user out and redirect them to the sign-in page.

3. Implementation of Database Management Systems

Sign-up:

```
INSERT INTO Sender (sender_fname, sender_lname, sender_phone,
sender_password)
       VALUES (?, ?, ?, ?)
INSERT INTO Staff (staff_fname, staff_lname, staff_password,
dist_id, staff_role)
       VALUES (?, ?, ?, ?, ?)
```

To create a new account, the user must provide the required information. If the user does not already have an account, their details will be added to the database using the following **INSERT** commands.

Log-in:

```
SELECT sender_id, sender_fname, sender_lname, sender_phone,
sender_password
       FROM Sender
       WHERE sender_phone = ?

SELECT * FROM Staff WHERE staff_id = ?
```

To log in, the system retrieves user information from the database. The **SELECT** statements are used to find and verify the information based on sender_phone for senders and recipients or staff_id for staff, couriers, and admins.

Retrieve the journey of the parcel:

```
SELECT
         te.tracking_status,
         te.timestamp,
         a.district AS location_district,
         a.province AS location_province
```

```
        FROM TrackingEvent te
        LEFT JOIN Distribution d ON te.dist_id = d.dist_id
        LEFT JOIN Address a ON d.dist_addr_id = a.address_id
        WHERE te.tracking_id = ?
        ORDER BY te.timestamp DESC;
```

Use the **SELECT** command in this query to retrieve parcel journey details, including status, timestamp, and location (province and district). The results are ordered from newest to oldest for easy tracking(ORDER BY te.timestamp DESC).

Insert a new status:

```
SELECT dist_id, final_dist_id, tracking_status
     FROM TrackingEvent
     WHERE tracking_id = ?
     ORDER BY timestamp DESC
     LIMIT 1
```

First, fetch the most recent tracking status for the given tracking ID by ordering the events by timestamp in descending order and limiting the results to 1.

```
SELECT dist_name FROM Distribution WHERE dist_id = ?
```

Next, fetch the staff's current distribution center name by querying the name of the distribution center using the dist_id.

```
INSERT INTO TrackingEvent (tracking_id, final_dist_id,
dist_id, staff_id, timestamp, tracking_status, note)
      VALUES (?, ?, ?, ?, NOW(), ?, ?)
```

Lastly, insert the updated information into the TrackingEvent table. Use NOW() to capture the current timestamp.

Update the latest tracking status:

```
UPDATE TrackingEvent
       SET
         dist_id = ?,
         staff_id = ?,
         timestamp = ?,
         tracking_status = ?,
         note = ?
       WHERE tracking_id = ?
```

```
        ORDER BY timestamp DESC
        LIMIT 1
```

The **UPDATE** command is used to modify the latest tracking status (determined by ORDER BY timestamp DESC LIMIT 1) with the appropriate information.

Delete staff by ID:

```
DELETE FROM Staff
          WHERE staff_id = ?
```

Using the **DELETE** command to remove the information of a staff member who is no longer working, this will delete the staff record from the database based on the provided staff ID.

Conclusion

The TrackBuddy Parcel Tracking System provides a reliable and efficient solution for managing and monitoring parcel deliveries, offering frequent updates, timestamped status changes, and detailed tracking history to enhance user experience. Its well-structured database design integrates key entities—Sender, Recipient, Parcel, Tracking Event, Distribution, and Staff—ensuring seamless tracking from dispatch to delivery. Role-specific functionalities for senders, recipients, staff, couriers, and admins enable accurate parcel handling and efficient delivery management across multiple distribution centers. The system's clear entity relationships, comprehensive user interfaces, and SQL-based database management ensure data integrity, scalability, and operational efficiency. By addressing critical logistics challenges, TrackBuddy enhances transparency, streamlines workflows, and meets the growing demands of the logistics and delivery industry.