PROCESS MINING AND DATA ANALYTICS FOR IMPROVED AIRPORT OPERATIONS

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SKY AI

Problem Statement

Airports struggle with delays and inefficiencies due to unpredictable conditions and limited real-time decision support. Existing systems lack predictive capabilities and integrated simulations. This project solves that by developing a data-driven digital twin model that predicts delays, simulates airport operations, and helps optimize resources in real-time.

Objective

The objective of this project is to design and implement an interactive, data-driven airport optimization platform that combines machine learning and digital twin simulation to achieve the following:

1-Predict Flight Delays

Using ensemble machine learning models—Random Forest, XGBoost, and Linear Regression (models.py)—the system forecasts total expected delays based on environmental and operational factors like wind speed, precipitation, maintenance status, crew availability, and passenger load.

2-Simulate Real-Time Airport Operations

The simulation engine (simulation.py) serves as a digital twin of airport ground processes, tracking aircraft across stages (Gate, Taxiing, Runway, etc.), modeling process delays (fueling, cleaning, baggage, security), and computing KPIs like emissions, costs, and on-time departures.

3-Enable Intelligent Decision Support

Through a Dash-based UI (app.py), airport staff can access real-time visualizations, model predictions, and resource statuses. The system highlights conflicts, suggests corrective actions, and supports interactive "what-if" scenario testing.

4-Optimize Resource Utilization and Performance

The platform continuously monitors and updates key KPIs, including:
- Average delay (minutes)
- Operational cost (simulation_state)
- Emissions (kg CO_2)
- Staff utilization

These insights drive better scheduling, staffing, and infrastructure planning.

5-Support Strategic Planning with Scenario Analysis

Downloadable CSV tools (download_ input_ data, download_prediction_data callbacks) enable airport authorities to export and compare operational scenarios offline, aiding long-term improvements.
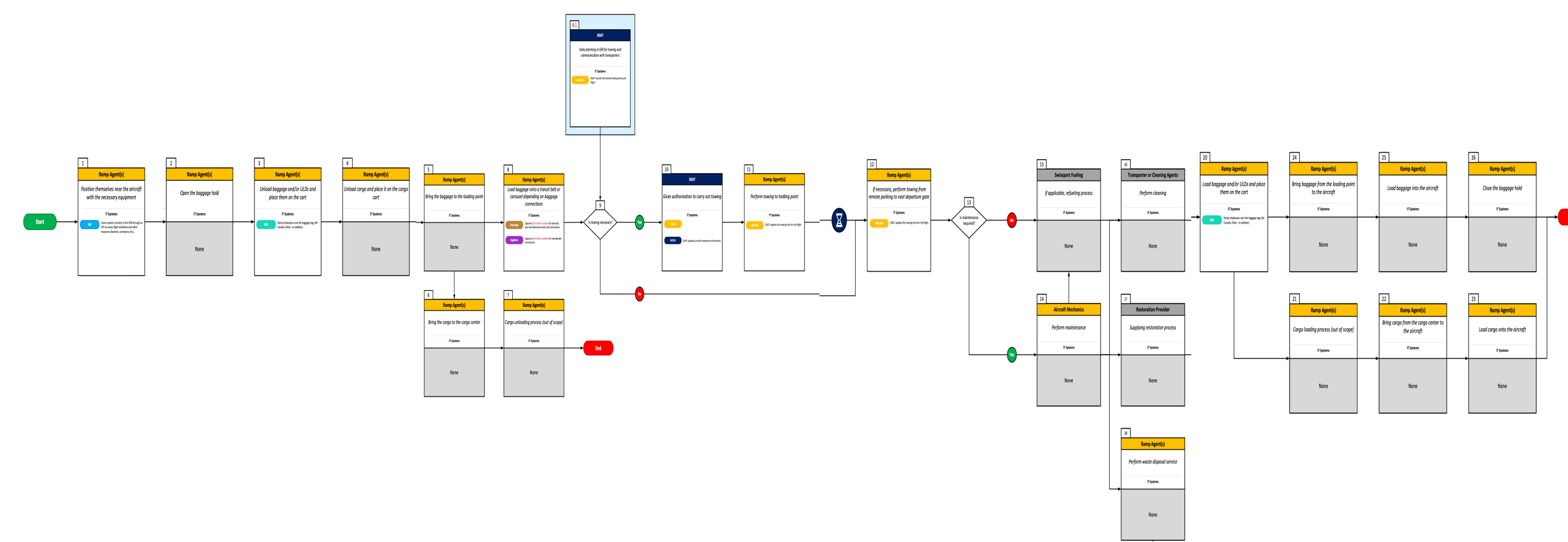
Users

Airport Authorities and Control Center , Airline Operations Teams, Ground Operations and Maintenance Crews, IT and Analytics Departments.
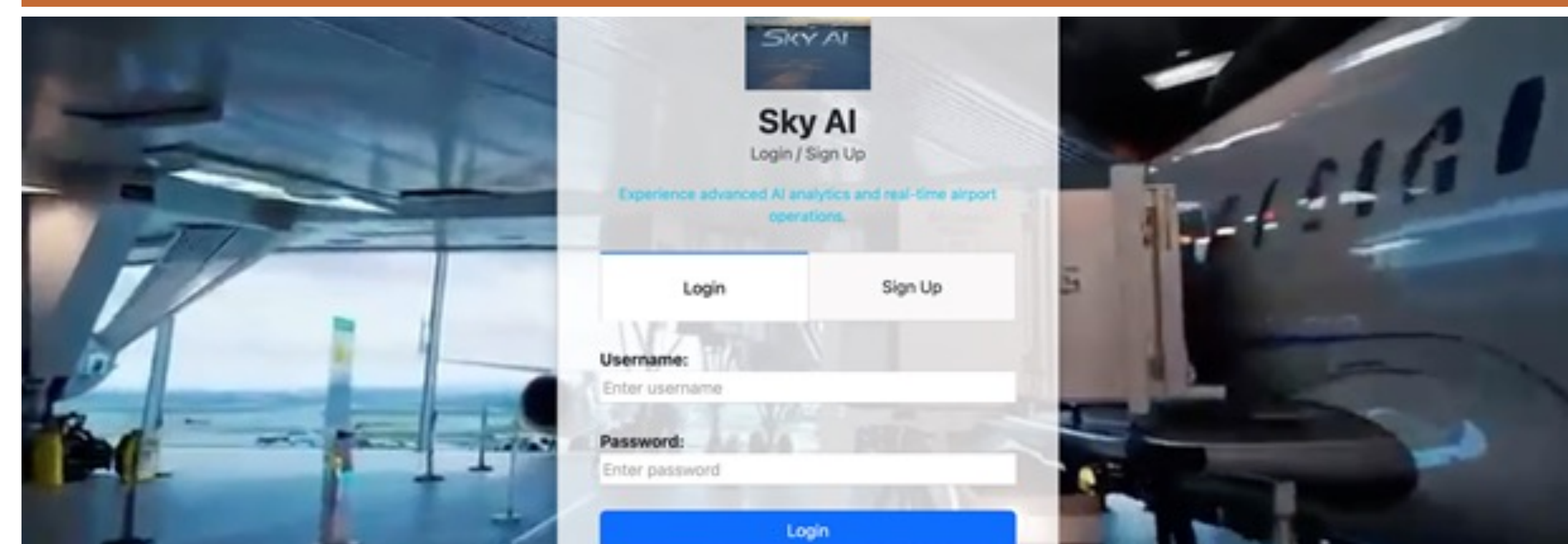
System Architecture Diagram
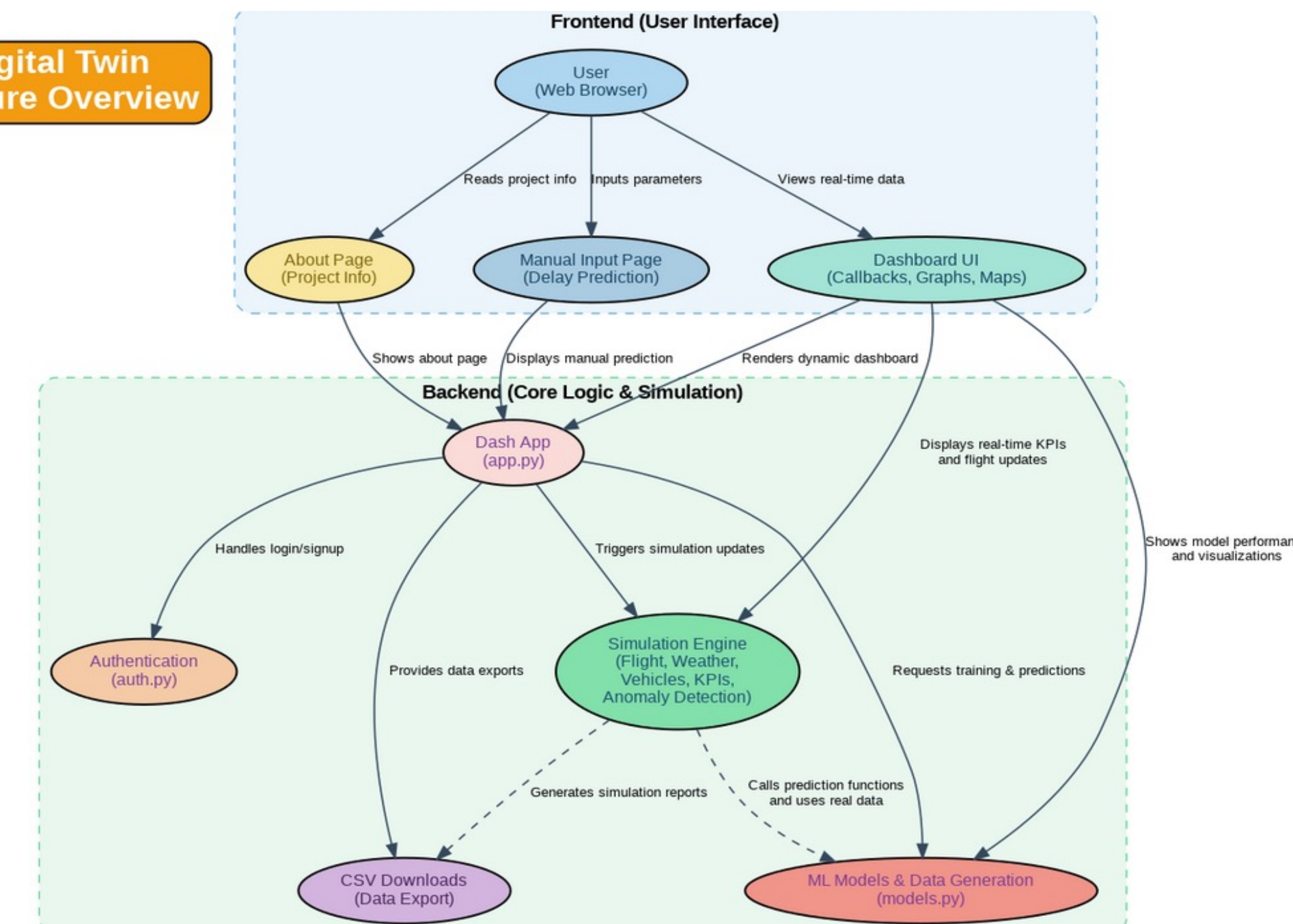
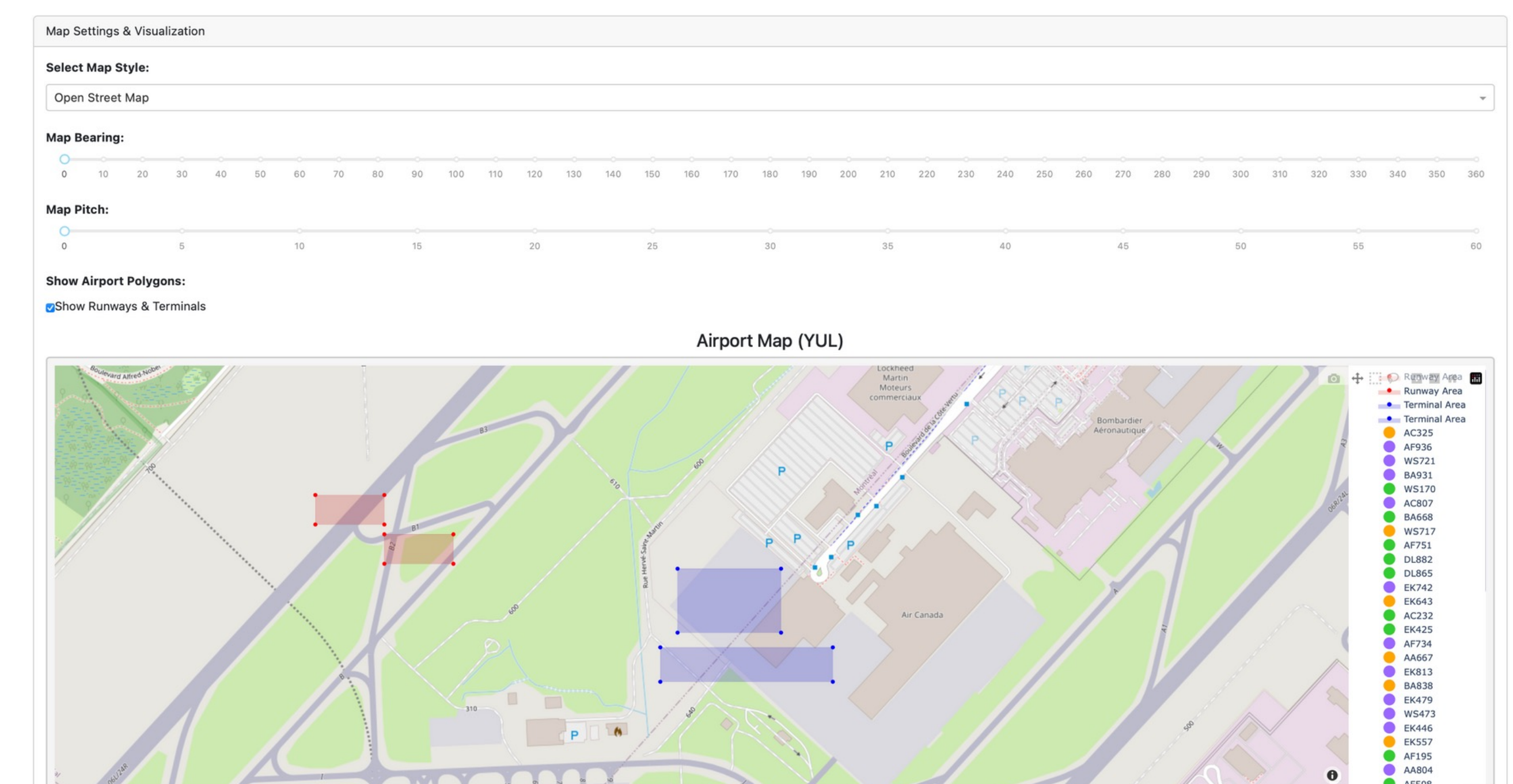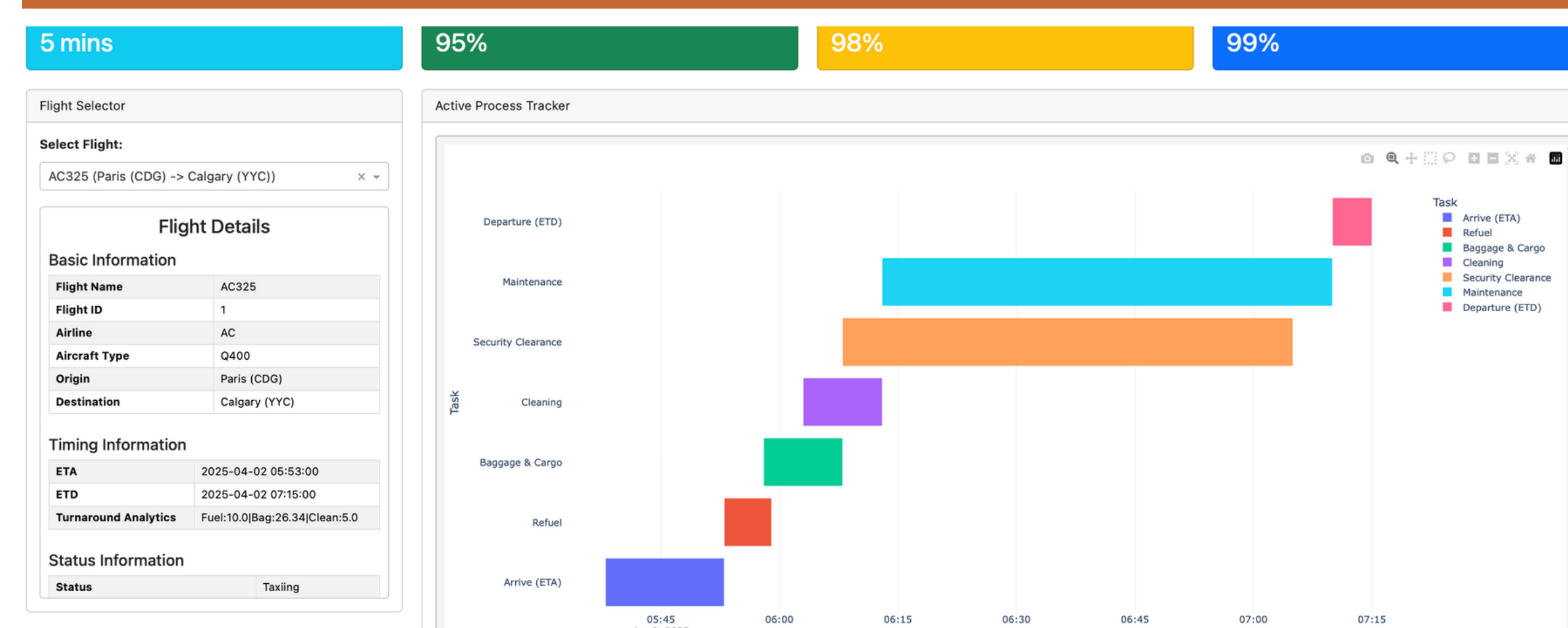## Actual Flow Chart for Turnaround Activities
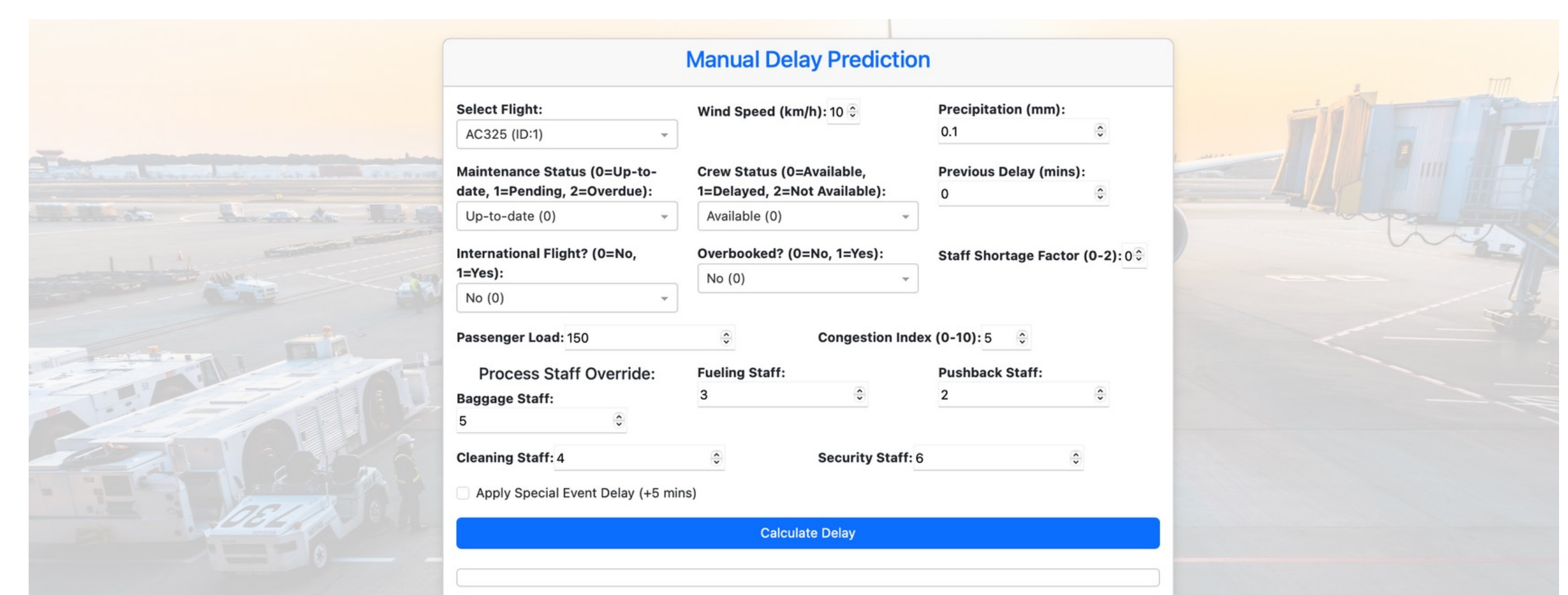

User Interface

Login Page

Dashboard – Predictive Analytics (ML)

What if Scenario – Digital Twin

Technology Used

Industry Collaboration