Cargo Connect: Improving Airport Freight Flow

Feasibility Report vs 4.0

SE 6387 Advanced Software Engineering Project

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Revision History

Version	Date	Description	Authors
1.0	2/11/25	Feasibility Report version 1	AF, SP, BS, CE
2.0	2/18/25	Feasibility Report with few class feedback	AF, SP, BS, CE
3.0	2/26/25	Feasibility report with inclusion of more content and the template	AF, SP, BS, CE
4.0	5/09/25	Final updated version	AF, SP, BS, CE

1. Executive Summary - Management Summary and Recommendation

1.1. Problem

The current freight truck operations at airports face inefficiencies due to fragmented communication and a lack of real-time coordination. Delays, congestion, and misallocated resources impact scheduling, dock assignments, and parking management. A system is needed to integrate real-time route optimization, dock assignments, and airport scheduling while leveraging the DALI system for dynamic navigation. This will enhance efficiency, reduce delays, and streamline freight logistics.

1.2. Project Goal

- Implement real-time tracking and route suggestions for freight trucks using DALI.
- Ensure seamless data exchange with airport systems for flight updates and resource allocation.
- Provide truck operators with real-time access to routing, docking, and parking information.
- Enhance airport logistics by improving freight truck flow and reducing congestion.

1.3. Success Criteria

- Seamless integration with existing airport systems for real-time data exchange.
- Accurate and timely route suggestions through DALI, reducing truck congestion and delays.
- Efficient allocation of docks and parking, improving freight handling operations.
- Real-time visibility and decision support for administrators via dashboards.
- Positive feedback from truck operators on system usability and effectiveness.

1.4. Assumptions/Risk/Obstacles

Assumptions

- The existing airport systems can seamlessly integrate with the new platform for data exchange.
- Real-time data updates from DALI and airport systems are accurate and reliable.
- Truck operators have access to the system interface for receiving and following routing instructions.

Risks

- Potential delays in integration with existing airport and logistics systems.
- Data inaccuracies leading to inefficient routing and resource allocation.
- Cybersecurity threats affecting data integrity and system performance.

Obstacles

- Resistance to adoption by truck operators due to changes in workflow.

- Technical challenges in ensuring seamless interoperability between disparate systems.
- External disruptions like weather conditions, roadblocks, or airport congestion impacting system efficiency.

2. Introduction

Airports serve as critical hubs for global trade. The movement of goods through airports is often hampered by critical issues like poor coordination between freight trucks and airport operations. This disconnect leads to delays, inefficient routing, and scheduling conflicts, increasing the costs and slowing down logistics for both airports and trucking companies. The Cargo Connect will address this challenge by linking freight trucks, existing airport systems, and the DALI system to improve communication and streamline operations. The goal is to cut delays, enhance efficiency, and optimize the flow of freight.This feasibility study evaluates the viability of the project across technical, economic, operational, legal dimensions, and feasibility matrix to determine whether it aligns with stakeholder needs and delivers measurable value.

2.1. Purpose

- This feasibility study evaluates a comprehensive system redesign that will assess the technical and operational viability of the Cargo Connect platform and validate the economic benefits and return on investment.
- It also provides decision-makers with actionable insights for project implementation.

2.2. Scope

- The system will optimize freight truck operations by integrating real-time tracking, dynamic routing, and airport coordination.
- It will provide truck operators with arrival predictions, optimized routes, and designated entry, dock, and parking assignments.
- The system will interact with existing warehouses to exchange scheduling, dock, and parking data.
- It will also ensure seamless departure by providing optimized exit routes and real time tracking. A unified platform will enhance operational efficiency, reducing congestion and delays.

3. Background

The proposed system builds upon previous implementations by addressing challenges related to real-time decision-making, seamless data integration, and optimized routing. It aims to enhance coordination between freight trucks, airport authorities, and logistics operators, ensuring smoother and more efficient cargo movement while minimizing congestion and delays.

3.1. Previous Implementations

Connected Eco-Driving Technology for Freight Trucks (California, USA)

- Used real-time traffic signal data to optimize truck speeds and reduce unnecessary stops.
- Achieved fuel savings of up to 20% under cold start conditions and a 10% reduction in CO_2 emissions.
- Improved traffic flow, reduced brake wear, and lowered noise pollution.

Logistics Companies and Urban Congestion (New York City, USA)

- Major logistics companies like FedEx, UPS, and USPS faced significant delays due to urban congestion and parking issues.
- Companies incurred millions in parking violation fines due to the lack of optimized freight movement systems.
- Highlighted the need for intelligent logistics routing and real-time parking allocation to reduce delays and costs.

3.2. Key Terms

- DALI System: A system that provides real-time optimized suggestions for freight trucks, integrating live data from traffic and logistics sources.
- Real-Time Tracking: Continuous monitoring of freight truck movements to enhance logistics efficiency.
- Dynamic Dock & Parking Allocation: Automated assignment of docking and parking spaces based on real-time airport and traffic conditions.
- Automated Routing: Navigation that dynamically adjusts routes based on congestion and delivery priorities.
- Congestion Management: Strategies to minimize traffic bottlenecks and improve freight flow.
- Decision Support Dashboard: A centralized interface for administrators to monitor freight operations and make data-driven decisions.

4. Alternatives

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Description	Predictive models for cargo delivery scheduling. It needs more time than allotted and can face training complexities. Hence not chosen.	Camera-based parking spot detection. It is costly and not feasible everywhere. Hence not chosen.	Sensor-based parking spot detection. It comes with higher maintenance but relatively cheaper as compared to	Integration of RFID technology for tracking. The entry to the airport is directly feasible by DALI integration. Hence not needed.

			Camera. Hence selected.	
Economic Feasibility	High initial cost	Costly hardware, not scalable.	Moderate cost, higher maintenance expenses.	Affordable but redundant with DALI capabilities.
Technical Feasibility	Complex, requires advanced domain specific expertise.	Feasible but needs robust camera systems for image processing.	Simpler, reliable with existing sensors.	Straightforward, overlaps with DALI functions.
Operational Feasibility	Model performance cannot be guaranteed.	Limited by environmental factors like weather.	Practical, aligns with current operations.	Feasible but unnecessary given DALI integration.
Schedule Feasibility	Since project time is limited to 3 months, understanding and implementing all required models would be difficult	Feasible with the schedule.	Feasible with the schedule	Rapid rollout, minimal additional effort.
Legal Feasibility	Compliant with privacy laws, needs validation.	Requires camera regulation compliance.	Minimal legal hurdles, standard tech.	Must ensure RFID meets aviation standards.

5. System Description

5.1. Challenges

The Cargo Connect system will tackle Freight management issues like fragmented data ecosystems where data is scattered across carriers, airports, and logistics providers which causes miscommunication and makes the process slow. Traffic congestion from peak-hour bottlenecks delays trucks, raising costs and disrupting schedules. Inefficient loading and unloading at the bay area due to poor scheduling, slows operations and clogs docks. Real-time rescheduling struggles with sudden changes, like flight shifts, without instant data access. Providing parking spots is a headache, as limited spaces force trucks to circle, adding to delays. Dynamic route updates via the DALI system.

5.2. Features

- Feature 1: Real Time flight and cargo updates

- This feature focuses on monitoring cargo arrivals, likely with real-time updates. Technically feasible by integrating with airport systems for flight schedules.

- Feature 2: Real time truck tracking
  - Feasible with real-time tracking from mobile system to DALI.

- Feature 3: Scheduling the assignments from the cargo provider.
  - Feasible with integrating the system with cargo providers.

- Feature 4: Integrated Data Management Platform
  - Technically feasible with modern tools and APIs to integrate data sources and make data driven decisions.

- Feature 5: Mobile Interface for System Access
  - Feasible with standard app development tools for truck operators.

5.3.   Requirements

- **Freight Trucks**

  The system shall display the following information specific to the truck operator:
  - The estimated and expected arrival time to the airport if not at the airport.
  - Real-time information from DALI about the optimised route to the airport.
  - Which terminal should be used to enter the airport?
  - Assigned dock and time of loading.
  - Designated parking area.
  - Real-time information from DALI about the route suggestions from the airport to its next destination.
  - Which terminal to exit the airport through?

- **Existing airport systems:**

  The system shall be capable of receiving the following information from the existing airport system:
  - Current location of the truck.

  The system shall be capable of sending the following information to the existing airport system:
  - Arrival time of freight trucks
  - Target destination of freight trucks
  - Delays/ early arrival information.

- **DALI System:**

- The system shall receive the current location of the truck when travelling to the airport.
- The system shall receive the current location of the truck when travelling to the cargo destination.
- The system shall send real-time route suggestions to the mobile app.

6. Cost-Benefit analysis / Economic feasibility

This project is economically feasible. After doing a cost-benefit analysis, we have determined that the upsides outweigh the cons; we also posit that the return on investment will be substantial.

The work required to do things such as integrating with existing systems/databases/providers, authenticating DALI-registered vehicles, and providing dashboards displaying real-time metrics will be formidable.

However, the cost is that airport traffic will remain log-jammed to a significant degree, with delays across the spectrum at a major expense to logistics carriers. In other words, if things stay the way they are, profits will continue to be lost as a direct result of freight inefficiencies at airports.

We believe that the cost of development is worth it because the opportunity to stop revenue from continuing to flow out this way is an important one to seize. Our solution will require many hours of labour in the form of tasks such as project planning and coding, but this downside is outweighed by the immense likelihood of the current problem staying the same without intervention.

The prospect of fewer delays and increased efficiency overall at airports could boost profits significantly in the long term. A few months' worth of investment in software engineering labour could produce returns for years to come if the software is properly maintained over time by the recipient(s), allowing for longstanding benefits such as greater coordination of resources and real-time visibility of data. Upsides such as these would be indispensable to the bottom line of a business in the long run.

7. Evaluation of Technical Task

7.1. Data Operations Platform

- Aircraft Arrival Monitoring and Freight Release Prediction: Feasible by integrating flight tracking data and using complex algorithms to predict freight release times based on the real-time data.
- Priority-Based Cargo Loading: Requires intelligent scheduling and dynamic interaction with cargo handling to ensure efficient loading based on priority, which can be complex in real-time.
- Emergency Handling and Congestion Management: Real time data and complex algorithms can help, but the system needs to act quickly to minimize disruptions.
- Emergency Handling and Congestion Management: Real time data and complex algorithms can help, but the system needs to act quickly to minimize disruptions.
- Dynamic Route Optimization: Feasible with GPS, real-time traffic, and weather data; challenges involve ensuring fast, efficient updates under varying conditions.

7.2. Overall Feasibility

■ The technologies involved are available and proven, but combining them into a seamless, real-time, and scalable system for airport logistics presents challenges in data flow, system integration, and optimization. While technically feasible, a strong infrastructure and skilled and organized team will be essential to bring it all together.

8. Operational Impact

Operational feasibility evaluates whether the proposed system will solve business problems effectively and integrate smoothly into daily workflows.

8.1. Workflow Integration

■ Unified Dashboard: Consolidates data from cargo companies, customs, and truck operators into a single interface (DALI) that provides role-based access for making better decisions.

■ Dynamic Scheduling: Application will dynamically schedule the loading / unloading time slots for the trucks based on the Cargo arrival time, road traffic with the help of the DALI application.

8.2. User Training

■ Minimal Learning Curve: The mobile app's intuitive design requires minimum training sessions.

■ Advanced Training: Admin panel receives workshops on dashboard analytics and emergency protocols.

8.3. Stakeholder Collaboration

■ Airport Authorities: Automated bay assignments reduce congestion at unloading zones, aligning with their goal to maximize terminal throughput.

■ Logistics Carriers: Real-time aircraft arrival notifications let carriers adjust schedules preemptively, minimizing idle time.

■ Customs: Secure API integration ensures compliance while accelerating clearance for authorized shipments.

9. Legal Ramifications

In terms of copyright infringements, failing to respect parents could result in the forced removal of critical features. This applies to trademarks as well. Proper patent research and trademark clearance must be planned out ahead of time to avoid any future trouble.

As far as privacy concerns go, privacy laws must be a major focus due to the involvement of customer data in the mix. Tracking the movement of drivers and their behavior in real-time also poses potential issues with surveillance. Transparency of data practices will be a critical

component of the project.

9.1. Privacy Concerns (Drivers of DALI-vehicles and Customers' Information)

■ Since this project involves vehicles (and potentially customer data), privacy laws must be a major focus. Additionally, tracking drivers' movements and behaviour in real-time raises potential concerns around surveillance, so transparency of data practices will be critical.

9.2. Labor Laws (Local and Federal Regulations)

■ Adhering to local and federal labor laws is essential. Work hours, wages, worker benefits, and more must be in compliance with applicable regulations.

9.3. Violation of Pre-existing Contracts and Agreements

■ Sometimes, software or data shared under a licensing agreement may not be used for other purposes, or certain territories may be off-limits. Violating these terms could result in legal action, termination of agreements, or financial penalties.

9.4. Environmental Concerns (As We Are Dealing with Moving Vehicles)

■ Assessing environmental impact could involve looking at emissions, fuel consumption, and how vehicles contribute to local air quality. Any project of this scale may require compliance with local environmental laws or regulations surrounding noise, emissions, or resource use.

10. Schedule Analysis

Schedule feasibility evaluates if a project can be finished in the allotted amount of time. It involves evaluating the project's schedule, goals, and possible obstacles to make sure it can be completed on schedule and with all its goals met.

- Estimated project duration: The duration of the project is 4 months.
- Can all the milestones and completion date schedules be met? For the freight transportation problem, milestones include:
    - Requirement gathering, Planning and design – Month 1
    - Development and integration – Month 2 and Month 3
    - Testing and Deployment – Month 4

By limiting the requirements to a few, with proper project management and team planning, the milestones can be met in 4 months. For this project, a 4-month deadline is mandatory as this project is confined to only one semester. Hence, the requirements are limited.

Learning curve duration would be a few days in the final month. Learning curve for users to adapt to a new system can be minimised by providing training sessions and designing a user-friendly interface.