

EcoRoute Optimizer — Project Report

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Executive Summary

EcoRoute Optimizer is an end-to-end pipeline for analyzing taxi trip datasets (NYC & Chicago), estimating per-shipment CO₂ using tonne-km and fuel-consumption methods, and optimizing multi-stop

routes using heuristics (nearest-neighbor + 2-opt, K-Means clustering) and optional OR-Tools CVRP.

The goal is to reduce total travel distance and associated emissions.

Data Sources

- NYC Yellow Taxi (Parquet, Jan 2024 sample)

- Chicago taxi CSV (public city portal)

Processed into standardized 'shipments' with origin/destination coords, distance_km, and weight_kg.

Processing & Methods

- Data cleaning: filter invalid coordinates, unrealistic distances; sample large files.

- Distance calc: Haversine formula (km).

- Weight estimate: passenger-based or fixed defaults -> converted to tonnes.

- Emissions: (1) tonne-km method using g CO₂ per tonne-km, (2) fuel-based method using L/100km and g CO₂ per L.

- Final emission chosen per shipment (prefer tonne-km; fallback to fuel-based).

Optimization Models

- Heuristics: nearest-neighbor route construction + 2-opt local improvement.

- Clustering: K-Means to partition shipments and route each cluster.

- Exact-ish: Google OR-Tools CVRP for small instances (benchmarking).

- Current objective: minimize total distance. Proposed enhancement: minimize tonne-km (distance x carried mass).

Key Results (sample / illustrative)

- Processed sample: ~10k trips (example run).

- Total CO₂ (tonne-km method): ~0.96 tonnes (example; depends on sample).

- Routing optimization reduced total distance and estimated emissions (percentages depend on dataset/sample).

Resume-ready bullets

- Cleaned NYC & Chicago taxi trips into standardized Parquet shipments for emissions analysis.

- Implemented tonne-km and fuel-based CO₂ estimators to compute per-shipment emissions.

- Optimized capacitated VRP using NN+2-opt, K-Means, and OR-Tools for distance/emissions reduction.

Recommendations & Future Work

- Make routing explicitly emissions-aware by using tonne-km as the objective (heuristic or MILP).

- Add time windows, heterogeneous vehicle types, and fuel/engine-specific emission factors.

- Incorporate demand forecasting (LSTM/XGBoost) to predict future shipment volumes and pre-position vehicles.

Appendix: Contact / Notes

Project name suggestion: EcoRoute Optimizer

This report summarizes pipeline design, core methods, and optimization approach implemented in the notebook.