**Truck Assignment and Route Optimization for Istanbul–France Corridor**

**Title:** Truck Assignment & Route Optimization

**Name:** Mehmet Yusuf Demirci, [ID: 31187]

**Company:** Lotus Antrepo / VIP Lojistik (Hadımköy, Istanbul)

**Internship Period:** June – September 2025

**Internship Supervisor:** Akın Mutlu, Manager of Lotus Antrepo

**Academic Supervisor:** Kemal Kılıç

**Submission Date:** August 15, 2025

**Faculty of Engineering and Natural Sciences, Sabancı University**

**Major:** Industrial Engineering

**Abstract**

This internship report presents the development of a decision-support tool to assign trucks and optimize road routes for exports from Istanbul/Hadımköy to multiple destinations in France. The work models VIP Lojistik’s real operating corridor—departing Istanbul, exiting Turkey at Kapıkule (TR–BG), traversing Europe via Bulgaria–Slovenia–Austria–Germany, and entering France typically through Strasbourg. The problem is formulated as a fixed-charge, capacitated multi-vehicle Vehicle Routing Problem (VRP) and solved with Gurobi. Costs combine a fixed round-trip charge per active truck (€2,700) and a distance-based fuel cost (€0.32/km). Distances are sourced from a square Excel distance matrix compiled using Google Maps, and monthly demands (kg) for French destinations were collected with the operations team. The model enforces Istanbul → Kapıkule → Strasbourg outbound, ensures each customer node is served exactly once, and respects a practical truck capacity of 23,000kg. Outputs include the number of trucks used, per-truck routes, corridor vs. delivery kilometers, and a transparent cost breakdown. The report concludes with recommendations to incorporate time windows, driver-hour constraints, heterogeneous fleets, arc-level tolls/emissions, and a weekly data pipeline to keep parameters current.

**Table of Contents**

1. **Introduction**
2. **Company Information**
3. **Project Background**

**3.1 Department Information**

**3.2 Status at the Beginning**

**3.3 Motivation / Problem Definition**

**3.4 Related Literature**

1. **Internship Project**

**4.1 Objective**

**4.2 My Responsibilities**

**4.3 Methodology / Tools**

**4.4 Expected Outcome & Deliverables**

**4.5 Details**

**4.6 Results**

1. **Internship Experience**

**5.1 Learning**

**5.2 Relation to Undergraduate Education**

**5.3 Difficulties**

**5.4 A Typical Day**

1. **Conclusions**
2. **Recommendations**
3. **References**
4. **Appendices**
5. **Introduction**

This report documents an optimization-based planning tool for truck assignment and routing on VIP Lojistik’s Istanbul→France export corridor. The project integrates realistic operating assumptions (origin in Hadımköy, Kapıkule border crossing, Strasbourg entry to France), recent monthly order weights (kg) by destination, a practical truck capacity of 23 tons, and a cost model that combines a fixed per-truck charge with per-kilometer fuel costs. The optimization is cast as a capacitated multi-vehicle VRP with a fixed-charge (truck activation) term and solved by Mixed-Integer Programming (MIP) in Gurobi. Results provide a repeatable, auditable plan that reduces ad-hoc scheduling and enables what-if analysis.

1. **Company Information**

VIP Lojistik is an international road-transportation company. Outbound flows originate at Istanbul/Hadımköy, exit Turkey via Kapıkule, and travel through Bulgaria–Slovenia–Austria–Germany, entering France predominantly via Strasbourg. Customer locations are distributed across France and may require full-truckload (FTL) or consolidated shipments depending on order volumes.

3. **Project Background**

**3.1 Department Information**

The internship was hosted by the Fleet Operations / Planning unit. I collaborated with an operations specialist and a fleet planner to gather monthly order weights (kg) per French city, average truck capacities, and cost inputs.

**3.2 Status at the Beginning**

Before this project, assignment and routing relied heavily on expert knowledge and manual scheduling. Distances were not centralized; demand weights resided in notes and spreadsheets. This fragmented information flow limited reproducibility and hindered rapid sensitivity analysis.

**3.3 Motivation / Problem Definition**

The company needed an evidence-based approach that balances truck count, route length, and capacity while providing transparent cost trade-offs. The aim was to consolidate distances, demands, capacities, and costs in a single optimization tool that yields a minimum-cost, feasible plan.

**3.4 Related Literature**

The model follows standard VRP literature: capacitated, multi-vehicle routing with fixed-charge activation, binary visit/arc variables, and subtour elimination (e.g., Miller–Tucker–Zemlin, MTZ). Solution method: MIP (Gurobi).

**4. Internship Project**

**4.1 Objective**

Build a reproducible, data-driven model to (i) decide how many trucks to activate and (ii) assign French delivery nodes to specific trucks while enforcing the Istanbul→Kapıkule→Strasbourg transit structure and respecting truck capacity. The objective minimizes total logistics cost = fixed truck cost + fuel cost × total kilometers (corridor + inside-France legs).

**4.2 My Responsibilities**

* Collect monthly order weights (kg) with the operations team.
* Compile a square distance matrix with matching row/column labels (Google Maps shortest practical truck routes).
* Encode demands and parameters in Python.
* Formulate and implement the MIP model in Gurobi.
* Run scenarios; generate per-truck routes and cost breakdowns; document methodology and results.

**4.3 Methodology / Tools**

* Model: Capacitated Multi-Vehicle VRP with fixed-charge truck activation.
* Solver: Gurobi (MIP), practical settings for time/gap.
* Data stack: Python + Pandas for I/O; Excel for distance matrix.
* Corridor logic: Each active truck’s kilometers = Istanbul→Kapıkule + Kapıkule→Strasbourg + (Strasbourg→deliveries→Kapıkule) + Kapıkule→Istanbul.

**Decision variables (per truck t, node i/j):**

* zₜ ∈ {0,1}: truck activation.
* xₜⱼ ∈ {0,1}: truck t serves delivery node j.
* yₜ,ᵢⱼ ∈ {0,1}: truck t traverses arc (i→j) within the France VRP leg.
* uₜⱼ ≥ 0: MTZ order variable (subtour elimination).

**Parameters:**

* Capacity Q = 23,000 kg per truck (operational average).
* Fleet size T = 110 trucks (active planning size).
* Fixed cost F = €2,700 per active truck (round-trip; includes driver wage ≈ €920, driver expenses ≈ €630, and averaged one-way tolls: BG €55, SI €20, AT €220, DE €220).
* Fuel cost α = €0.32/km (≈ 1,000 L per 3,200 km × €1/L after refunds/discounts).
* Distance cᵢⱼ: from the square Excel matrix (Google Maps).
* Base-legs distance per active truck B = dist(Istanbul, Kapıkule) + dist(Kapıkule, Strasbourg) + dist(Kapıkule, Istanbul).

**Objective (minimize):**

TotalCost = Σₜ F·zₜ + α·[ Σₜ Σ₍ᵢ,ⱼ₎ cᵢⱼ·yₜ,ᵢⱼ + B·Σₜ zₜ ].

**Core constraints:**

1. Cover: each delivery node visited exactly once (Σₜ xₜⱼ = 1 for all customer j).
2. Start/End: one outgoing arc from Strasbourg and one incoming arc to Kapıkule per used truck.
3. Flow conservation at deliveries (in-degree = out-degree = xₜⱼ).
4. Linking: x and y only allowed if zₜ = 1.
5. Capacity: Σⱼ demandⱼ · xₜⱼ ≤ Q for each truck t.
6. Subtour elimination: MTZ inequalities on uₜⱼ.

**4.4 Expected Outcome & Deliverables**

* Outputs: total cost (split fixed vs. distance), number of trucks used, per-truck corridor route string, inside-France km vs. base-legs km, per-truck cost.
* Artifacts: Python/Gurobi scripts, Excel distance matrix template, parameter/demand definitions, and this report.

**4.5 Details**

**Nodes:**

* Origin: Istanbul (Hadımköy)
* Transit: Kapıkule (TR–BG), Strasbourg (FR entry)
* Deliveries (France): Lille, Macon, Colmar, Beauvais, Nantes, Rouen, Versailles, Goussainville, Saint-Michel-sur-Orge, Orléans, Melun

(Transit nodes have zero demand.)

**Demands (kg) — snapshot (monthly totals gathered with operations team):**

* Lille 6,351; Macon 11,580; Colmar 8,767; Beauvais 14,781; Nantes 1,900;
* Rouen 22,483; Versailles 2,139; Goussainville 8,095; Saint-Michel-sur-Orge 13,218;
* Orléans 10,885; Melun 3,933.

**Feasibility safeguards:**

* Square, symmetric distance matrix with identical row/column labels enforced at load time.
* No self-loops; transit nodes carry no demand.
* Capacity and flow constraints ensure feasible routing.

**4.6 Results**

The solver returns a feasible, minimum-cost assignment plan under practical time/gap settings. Outputs report:

* total cost (split into fixed charge and fuel),
* number of trucks used,
* a per-truck route representation along the corridor (Istanbul → Kapıkule → Strasbourg → **deliveries** → Kapıkule → Istanbul), and
* kilometer and cost breakdowns (inside-France vs. base legs).

These results provide an auditable baseline for weekly operational planning and sensitivity studies (e.g., changes in fuel price, capacity, or demand mix).

**5. Internship Experience**

**5.1 Learning**

I strengthened skills in data modeling, Python (Pandas), and MIP modeling with Gurobi. I observed how operational assumptions—average loading, treatment of tolls, and fixed/variable cost split—affect feasibility and cost calibration.

**5.2 Relation to Undergraduate Education**

The project integrated Operations Research (VRP/MIP), Data Analysis (data cleaning, structuring), and Engineering Economics (cost modeling). Course concepts directly informed the model design and validation.

**5.3 Difficulties**

1. Data consistency (naming, units, missing items) across spreadsheets.
2. Balancing realism vs. tractability in the model scope.
3. Cost calibration without overfitting to a single month.

Mitigations included a strict naming convention, staged model building (baseline first, then features), and sensitivity checks.

**5.4 A Typical Day**

I validated inputs with operations staff, updated the distance matrix, ran the solver with current parameters, reviewed route/cost outputs, and documented findings and next-step adjustments.

**6. Conclusions**

The VRP-based planning tool consolidates distances, demands, capacity, and costs into a single optimization that delivers repeatable, transparent routing decisions for the Istanbul→France corridor. It reduces reliance on manual planning, quantifies cost trade-offs, and enables data-driven scenario analysis.

**7. Recommendations**

**Short term:**

* Establish a weekly data pipeline (demands, updated fuel index, consistent naming).
* Track actual kilometer and fuel (L) per route to recalibrate the €0.32/km parameter.
* Maintain a small scenario library (fuel ±, capacity ±, demand re-mix)

**Medium term:**

* Incorporate time windows and driver-hour constraints (EU regulations).
* Add heterogeneous fleet options and arc-level tolls/emissions for more accurate cost-to-serve.
* Consider backhauls and multi-depot variants to lift asset utilization.
* Build a simple dashboard for reporting and plan/actual comparisons.

**8. References**

* Dantzig, G. B., & Ramser, J. H. (1959). The Truck Dispatching Problem. Management Science, 6(1), 80–91.
* Toth, P., & Vigo, D. (2014). Vehicle Routing Problems, Methods, and Applications (2nd ed.). SIAM.
* Gurobi Optimization, LLC. (2024). Gurobi Optimizer Reference Manual.

**9. Appendices**

**Appendix A – Demand Snapshot (kg)**

Lille 6,351; Macon 11,580; Colmar 8,767; Beauvais 14,781; Nantes 1,900;

Rouen 22,483; Versailles 2,139; Goussainville 8,095; Saint-Michel-sur-Orge 13,218;

Orléans 10,885; Melun 3,933.

(Transit nodes Istanbul, Kapıkule, Strasbourg: 0)

**Appendix B – Mathematical Model (compact form)**

* Variables: zₜ ∈ {0,1}; xₜⱼ ∈ {0,1}; yₜ,ᵢⱼ ∈ {0,1}; uₜⱼ ≥ 0.
* Objective: minimize Σₜ F·zₜ + α·[ Σₜ Σ₍ᵢ,ⱼ₎ cᵢⱼ·yₜ,ᵢⱼ + B·Σₜ zₜ ].
* Constraints:

(i) Coverage: Σₜ xₜⱼ = 1 ∀ customer j.

(ii) Start/End: exactly one outgoing from Strasbourg and one incoming to Kapıkule per used truck.

(iii) Flow: in-degree = out-degree = xₜⱼ at deliveries.

(iv) Linking: xₜⱼ ≤ zₜ, yₜ,ᵢⱼ ≤ zₜ.

(v) Capacity: Σⱼ demandⱼ·xₜⱼ ≤ Q.

(vi) MTZ subtour elimination on uₜⱼ.