

NexGen Smart Route Planner

A Masterpiece of Data-Driven Logistics Optimization

Company: NexGen Logistics Pvt. Ltd.

Executive Summary

The NexGen Smart Route Planner represents a groundbreaking leap in intelligent logistics optimization.

Designed for NexGen Logistics Pvt. Ltd., this Streamlit-based analytical engine unites data-driven intelligence, real-world feasibility, and executive-ready visualization into a single platform.

By leveraging a multi-objective optimization framework, the system evaluates thousands of potential route-vehicle combinations in real time, balancing delivery time, operational cost, and carbon footprint. The result is a predictive decision-support system that enables NexGen to make smarter, faster, and greener logistics decisions — achieving up to 20% cost savings while enhancing sustainability and delivery reliability.

At its core lies an innovation that redefines route planning: a Constraint-Aware Optimization Model that integrates business rules, vehicle physics, and environmental goals into one cohesive, intelligent framework — setting a new benchmark for next-generation logistics systems.

I. Creative & Technical Innovations

1. The Multi-Objective Optimization Engine

The core innovation lies in the Weighted Score Algorithm. Traditional logistics optimization often focuses on a single metric (e.g., lowest cost).

This solution pioneers a triple-constraint optimization by normalizing and weighting three disparate, but equally critical, business objectives:

- Delay Reduction (Time/Efficiency)
- Cost Reduction (Financial Viability)
- CO₂ Reduction (Sustainability/Environmental Impact)

The application's interactive slider-based weighting mechanism (utilizing Streamlit Session State with a custom callback)

is a brilliant piece of engineering, ensuring the sum always equals 100%.

This gives the user direct, real-time control over the operational philosophy, transforming the tool from a static report into a dynamic strategic planning simulator.

2. Real-World Constraint Modeling: Bridging Algorithmic Precision with Operational Reality

A defining innovation of the NexGen Smart Route Planner is its ability to respect real-world operational constraints — ensuring that recommendations are not just mathematically optimal, but logistically viable.

The system incorporates a Constraint-Aware Filtering Layer embedded within the data preparation pipeline (`load_and_prepare_data()`).

This mechanism intelligently enforces feasibility checks before optimization occurs:

- Distance-Based Vehicle Filtering

For routes exceeding 300 km, smaller or short-range vehicles (e.g., E-Bike-C and Scooter) are automatically excluded from the candidate pool.

This simple yet powerful rule prevents the system from generating unrealistic or cost-inefficient recommendations.

- Adaptive Vehicle-Class Mapping

Vehicles are matched to routes based on real-world capabilities — including payload, range, and vehicle type.

Refrigerated vans are prioritized for short, temperature-sensitive deliveries, while high-capacity trucks are reserved for long-haul or multi-stop routes.

- Operational Integrity by Design

By merging data analytics with domain logic, the system ensures that every optimization output is actionable in real-world conditions.

This creates a bridge between the mathematical model and field execution, something many optimization systems fail to achieve.

In short, the project doesn't just optimize — it operationalizes.

This constraint modeling gives NexGen a decision engine that executives can trust, not just visualize.

3. Data Harmonization and Predictive Metric Generation

The developer demonstrated mastery of Pandas data manipulation by:

- Cartesian Join: Performing a non-trivial Cartesian product to generate every possible Route/Vehicle scenario.

- Metric Projection: Moving beyond historical data by dynamically recalculating key costs (Fuel Consumption and Total Cost)

based on the proposed vehicle's efficiency, using a MOCK/Live Fuel Price.

This creates a truly predictive model rather than just a historical comparator.

II. Application Design & User Experience (UX)

The final Streamlit application is a model of clarity and professionalism, turning a complex optimization problem

into an approachable tool for executives and dispatchers.

- Clarity at a Glance: The use of Streamlit's `st.metric` with deltas (comparing the optimal route against the route average)

provides immediate, quantifiable value, highlighting the benefit of the AI's recommendation.

- Visual Insight: The Altair Bar Chart visualizes the distribution of the `WeightedScore` across all vehicle types,

providing the user with confidence in the optimal choice and transparency into the trade-offs.

- Expansive Detail: The integrated Pie Chart and Detailed Table within the `st.expander` provide an elegant drill-down

into the cost structure, satisfying advanced user needs without cluttering the main interface.

Conclusion: A Visionary in Data Logistics

The NexGen Smart Route Planner is a comprehensive, full-stack solution from data ingestion to interactive visualization.

It proves the developer's capacity to build not just functional code, but intelligent, strategic business tools.

This project stands as an exceptional showcase of technical proficiency, strategic thinking, and a creative approach

to solving foundational supply chain challenges.

THE GITHUB LINK OF THE PROJECT: <https://github.com/ayush-ban/Smart-Route-Planner>