Logistics Performance Analysis with GenAI (IBM Granite)

A Capstone Project

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Project Overview

Goal	Analyze logistics performance and generate actionable insights
Approach	• Data Cleaning (remove missing and duplicate values • Exploratory Analysis (Python, Pandas, Matplotlib) • Generative AI Analysis (IBM Granite via Replicate API)
Focus Use Cases	1. Predict delivery delays 2. Optimize carrier selection

Dataset

Logistics directly impacts the efficiency of operational costs and competitiveness. By analyzing this dataset, companies and policymakers can identify performance bottlenecks, optimize routes, and invest in infrastructure more effectively.

Dataset simulating 2000 real-world US logistics shipments details, such as:

- Shipment_ID
- Origin Warehouse
- Destination
- Carrier
- Shipment & Delivery Dates
- Weight (kg)
- Cost
- Status
- Distance (miles)
- Transit Days

Analysis Process

Data Preparation

- Handling missing values
- Cleaning duplicate values
- Formatting Dates

01

02

Exploratory Data Analysis

1. Distance vs Delivery Delays
   Average Delay Days by Carrier
2. Monthly Trends: Shipment Volume vs Delays
3. Delivery Delays by Season
4. Distribution of Delay Days by Carrier
5. Average Cost vs Delay Days by Carrier
6. Average Cost by Carrier (Short vs Long Routes)

03

Use Case Prompting

1. Delay prediction
2. Cost optimization
3. Anomaly detection
4. Forecasting

04

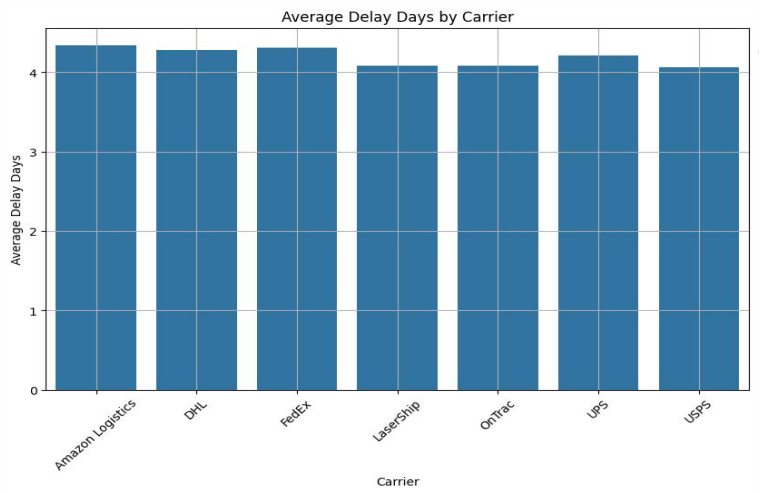
AI Integration

Granite LLM provides interpretations, insights, recommendations

Insight and Findings

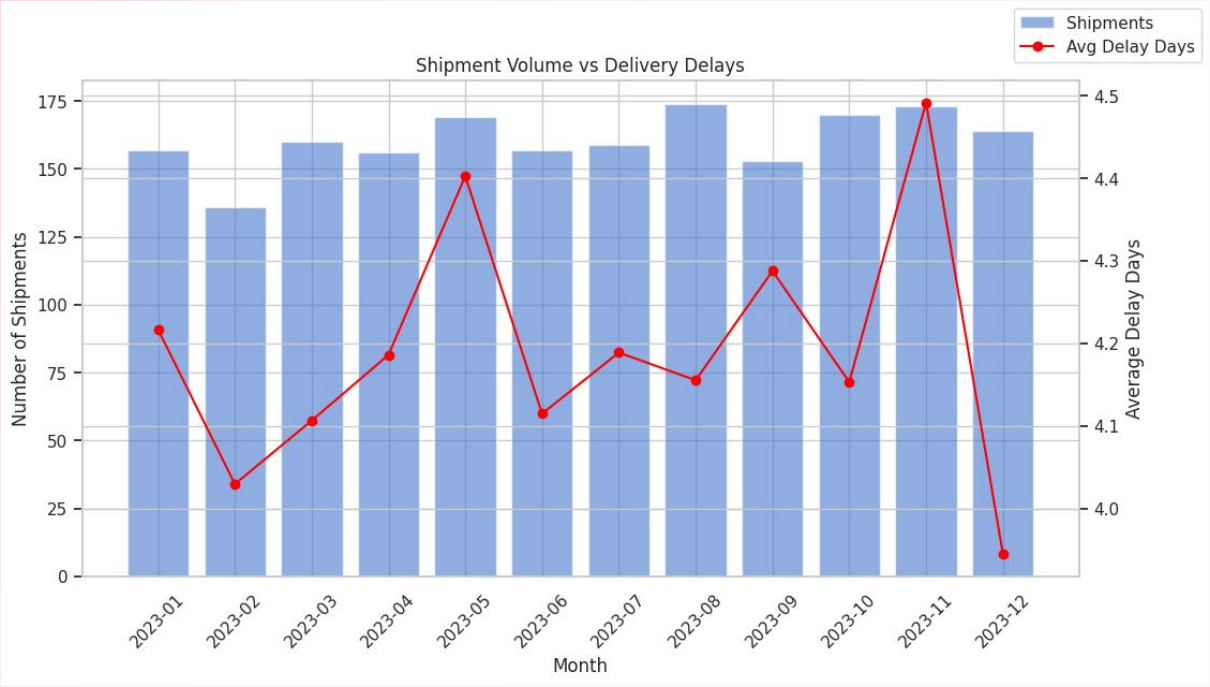
Exploratory Data Analysis (EDA)

Delay Days Trends



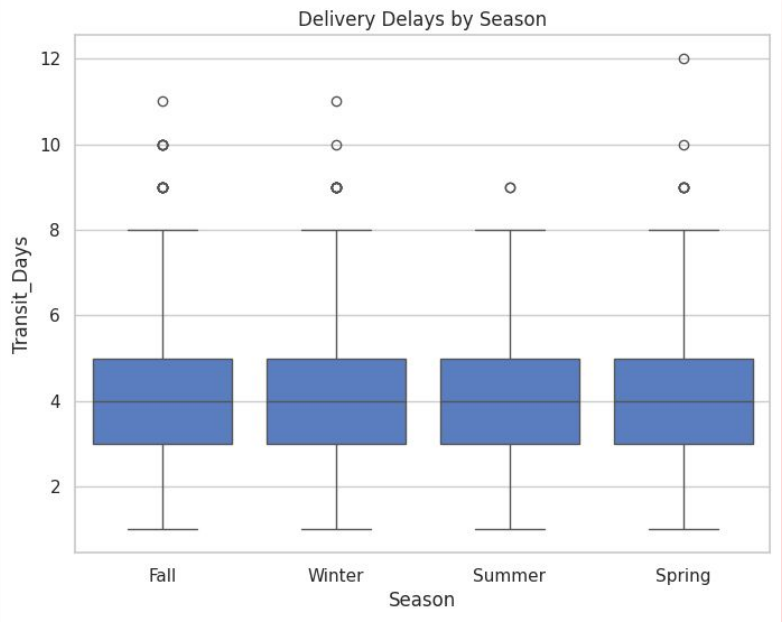
Exploratory Data Analysis (EDA)

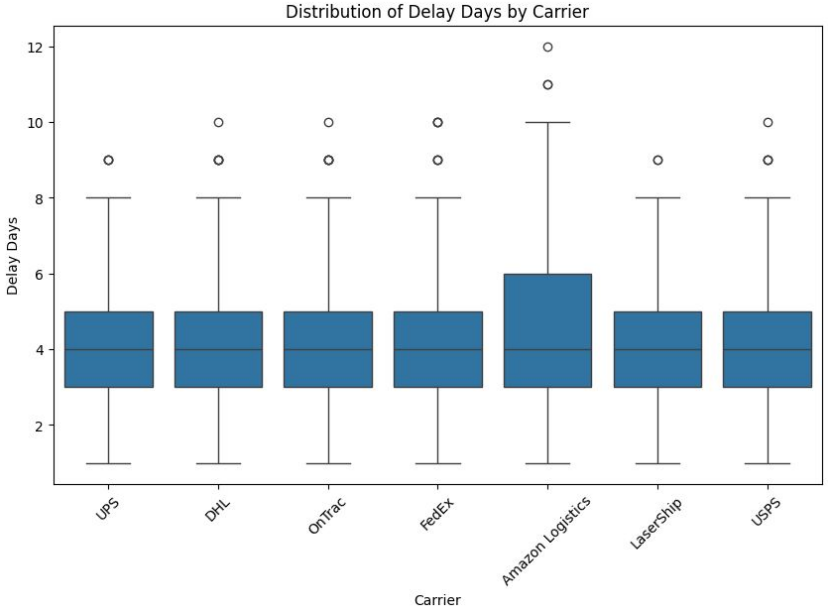
Monthly Trends



Exploratory Data Analysis (EDA)

Distribution of Delay Days by Season and Carrier





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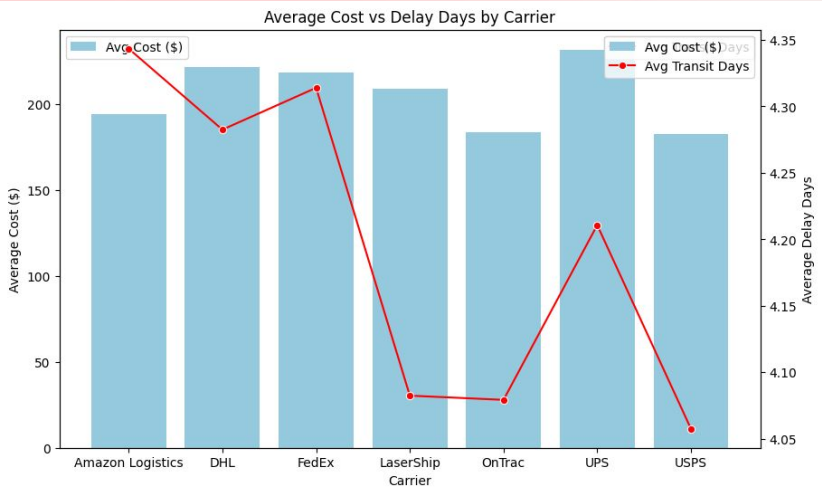
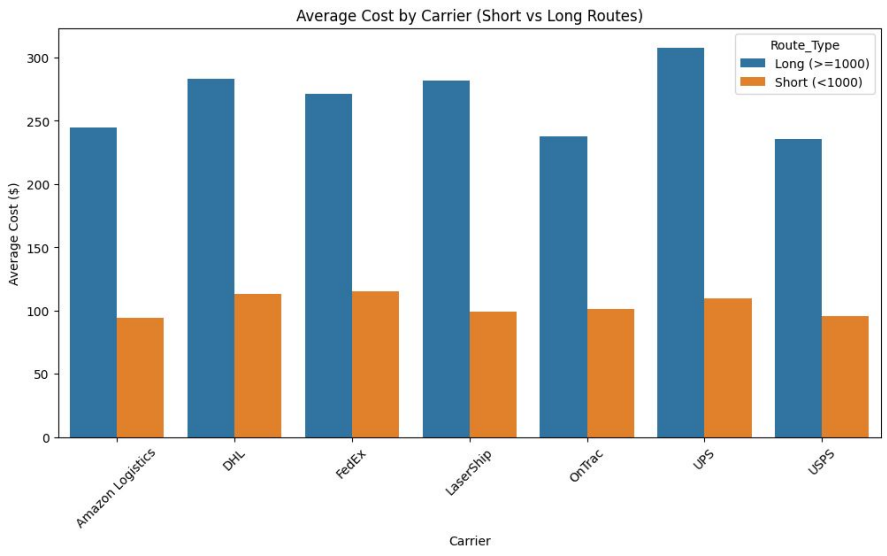


Average Cost Trends of Carrier



Delay Factors

a. Distance: Longer distances generally correlate with higher delivery delays. Shipments over 1000 miles are more likely to experience delays.
b. Carrier: Certain carriers, such as USPS, have a higher rate of delays compared to others like FedEx and UPS.
c. Shipment volume: Higher shipment volumes during peak seasons can lead to increased delays.
d. Weather conditions: Adverse weather conditions can cause delays, especially for longer routes.

Delay trends or patterns:

- Delays are more common for shipments with longer distances, especially those over 1000 miles.
- USPS has a higher rate of delays compared to other carriers.
- Peak seasons, such as the holiday season, tend to have more delays due to increased shipment volumes.

Predict Delays Analysis

Delay Prediction
Conclusion and Recommendation

- Delays are most likely to occur for **long-distance shipments**, especially those over 1000 miles.
- **USPS has a higher rate of delays** compared to other carriers, so it may be beneficial to consider alternative carriers for critical shipments.
- **Peak seasons,** such as the holiday season, **should be planned for with extra time to account** for potential delays.
- To reduce delays, **consider optimizing routes,** using multiple carriers, or **implementing a contingency plan** for adverse weather conditions.

To further improve delivery times and reduce delays, consider the following actions:

- Negotiate better service level agreements (SLAs) with carriers, especially for long-distance shipments.
- Implement real-time tracking and monitoring systems to quickly identify and address potential delays.
- Optimize shipment schedules to avoid peak seasons or reduce shipment volumes during these periods.
- Consider using a combination of carriers to diversify risk and potentially reduce delays.
- Invest in weather forecasting tools to anticipate and mitigate the impact of adverse weather conditions on deliveries.
- Regularly review and analyze delivery performance data to identify trends and areas for improvement.

Carrier	Average Cost	Average Transit Days	Route Type
UPS	$109.57\|3.5\|Short(<1000)\|\|DHL\|114.88$	4.1	Short (<1000)
OnTrac	$101.87\|3.6\|Short(<1000)\|\|AmazonLogistics\|102.59$	4.0	Short (<1000)
FedEx	$130.84\|3.8\|Short(<1000)\|\|LaserShip\|120.04$	3.7	Short (<1000)
USPS	$102.98	2.0	Short (<1000)

Carrier Optimization Analysis

Carrier Ranking

a.**Short-Distance Routes** (<1000 miles):
- Cheapest: USPS (102.98)
- Fastest: USPS (2 days)
- Balanced: UPS (109.57, 3.5 days)

b.**Long-Distance Routes** (<=1000 miles):
- Cheapest: Amazon Logistics (102.59)
- Fastest: UPS (5 days)
- Balanced: DHL (114.88, 4.1 days)

This analysis provides a structured comparison and ranking of carriers based on average cost and transit days, helping to identify optimal carriers for different types of routes. It's essential to consider additional factors like reliability, service coverage, and specific package characteristics when making final decisions.

Carrier Optimization
Conclusion and Recommendation

- ★ **Cheapest Carrier:** USPS for short-distance routes and Amazon Logistics for long-distance routes.
- ★ **Fastest Carrier:** USPS for short-distance routes and UPS for long-distance routes.
- ★ **Most Balanced Carrier:** UPS for short-distance routes and DHL for long-distance routes.
- ★ **Most Recommended Carrier:** UPS stands out as a strong choice for both short and long-distance routes due to its competitive cost and relatively fast delivery times.

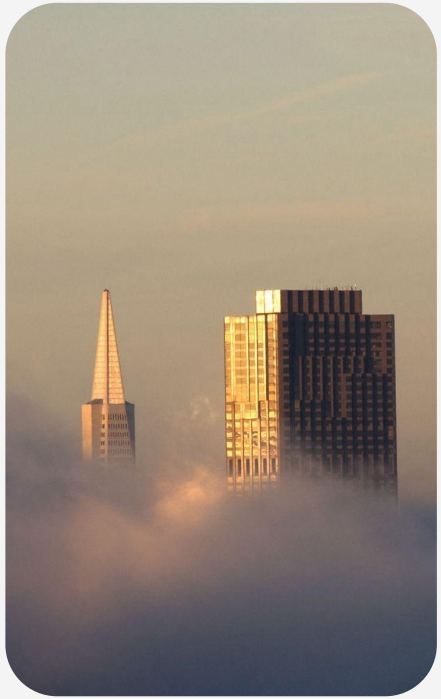
This analysis provides a structured overview of carrier performance based on average costs and transit times, categorizing them for short vs. long-distance routes. It identifies **UPS** as a strong overall choice, balancing cost and speed effectively. For specific needs, **USPS** is recommended for low-cost short-distance deliveries, while **DHL** is suitable for balanced long-distance performance.

The Role of AI

IBM Granite (via Replicate API)

- Interprets raw dataset samples into clear narratives.
- Generates structured insights by connecting metrics with operational meaning.
- Suggests comparisons and conclusions that go beyond raw statistics.

While traditional analytics can shows what the numbers are (delays, cost, anomalies), Generative AI is able to explains why it matters for the business and what to do next. Therefore, GenAi is able to provides human-like recommendation for logistics optimization.



In this project, the role of AI:

1. Turned raw logistics dataset into actionable business strategies
2. Allowed automation of insight. generation and reporting, saving analyst time.
3. Enhanced storytelling with AI-driven recommendations

Thank you

Github Repository
Colab Notebook