Report 2

Subtask 1: Analyze Monthly and Yearly Sales Trends

```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns

# 📁 Load the cleaned dataset
df = pd.read_csv("ecommerce_data_final_cleaned.csv")

# ---------------------------------------------
# 1️⃣ Format Date Column
# ---------------------------------------------
df['order_date'] = pd.to_datetime(df['date'], errors='coerce')  # Convert 'date' column to datetime

# Drop rows with invalid dates
df = df[df['order_date'].notnull()]

# Rename revenue column to 'total_revenue'
df = df.rename(columns={'value [USD]': 'total_revenue'})

# Create new time columns
df['month'] = df['order_date'].dt.month
df['year'] = df['order_date'].dt.year
df['month_year'] = df['order_date'].dt.to_period('M').astype(str)

# ---------------------------------------------
# 2️⃣ Monthly Revenue Aggregation
# ---------------------------------------------
monthly_revenue = df.groupby('month_year')['total_revenue'].sum().reset_index()

# Sort by date
monthly_revenue['month_year'] = pd.to_datetime(monthly_revenue['month_year'])
```

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monthly_revenue = monthly_revenue.sort_values('month_year')

# Plot monthly revenue trend
plt.figure(figsize=(14, 6))
sns.lineplot(data=monthly_revenue, x='month_year', y='total_revenue', marker='o', color='green')
plt.title("📈 Monthly Revenue Trend")
plt.xlabel("Month-Year")
plt.ylabel("Total Revenue (USD)")
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()

# ------------------------------------------
# 3️⃣ Yearly Revenue Aggregation
# ------------------------------------------
yearly_revenue = df.groupby('year')['total_revenue'].sum().reset_index()

# Plot yearly revenue trend
plt.figure(figsize=(10, 5))
sns.barplot(data=yearly_revenue, x='year', y='total_revenue', palette='Blues_d')
plt.title("📊 Yearly Revenue Comparison")
plt.xlabel("Year")
plt.ylabel("Total Revenue (USD)")
plt.tight_layout()
plt.show()

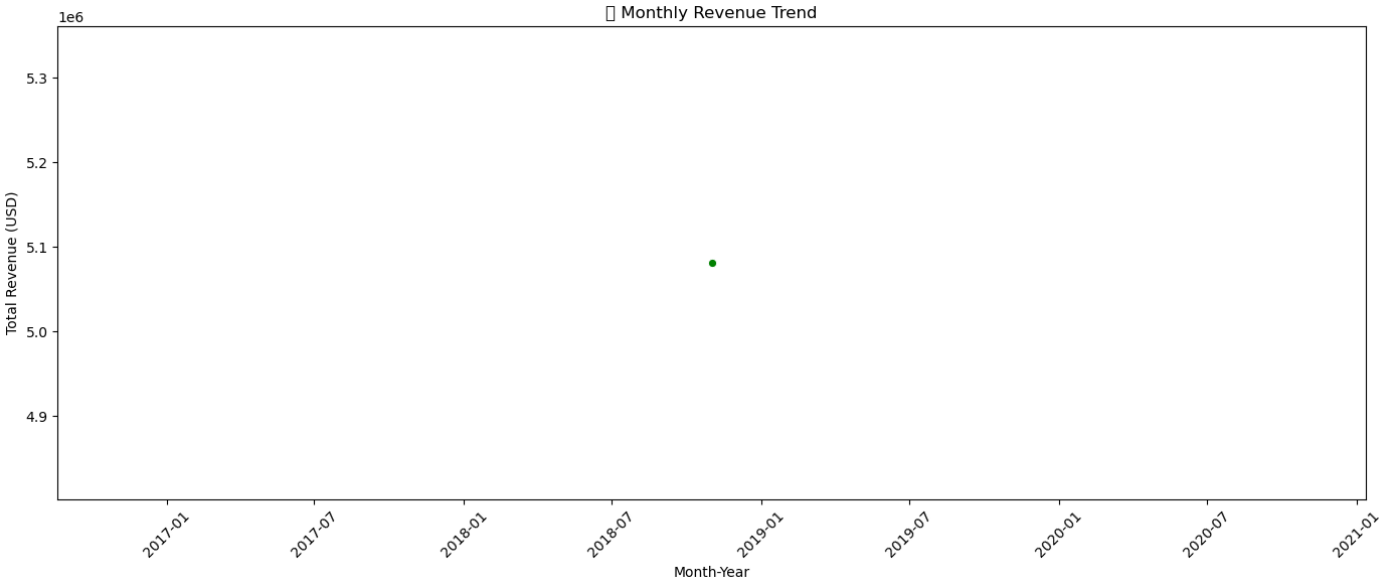
# ------------------------------------------
# 4️⃣ Identify Peak and Low Sales Months
# ------------------------------------------
monthly_avg = df.groupby('month')['total_revenue'].sum().reset_index()
peak_month = monthly_avg.loc[monthly_avg['total_revenue'].idxmax()]
low_month = monthly_avg.loc[monthly_avg['total_revenue'].idxmin()]

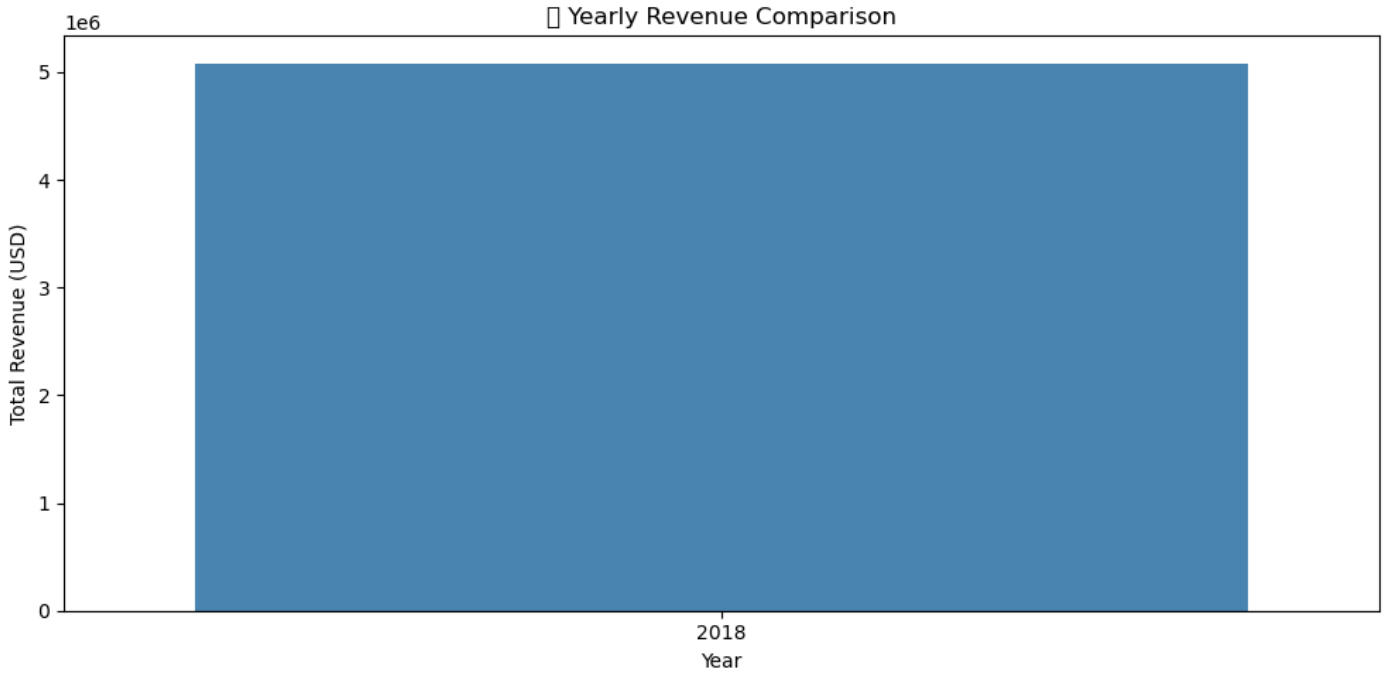
print("\n🔍 Peak Sales Month:")
```

```
print(f"Month: {int(peak_month['month'])}, Revenue: ${peak_month['total_revenue']:,.2f}")


print("\n 🔻 Low Sales Month:")
print(f"Month: {int(low_month['month'])}, Revenue: ${low_month['total_revenue']:,.2f}")


# ---------------------------------------------
# 5️⃣ Print Summary of Key Insights
# ---------------------------------------------
print("\n 📝 Summary of Monthly & Yearly Sales Trends:")
print("• Revenue has shown clear variation over time, with some months performing significantly better due to seasonal factors.")
print(f"• The highest performing month is Month {int(peak_month['month'])} with revenue of ${peak_month['total_revenue']:,.2f}.")
print(f"• The lowest performing month is Month {int(low_month['month'])} with revenue of ${low_month['total_revenue']:,.2f}.")
print("• The yearly trend shows whether the business is growing or declining over time.")
print("• These insights can help optimize inventory and marketing during peak seasons and improve sales in slow months.")
```





🫐 Peak Sales Month:

Month: 11, Revenue: $5,081,015.83

🔻 Low Sales Month:

Month: 11, Revenue: $5,081,015.83

📝 Summary of Monthly & Yearly Sales Trends:

• Revenue has shown clear variation over time, with some months performing significantly better due to seasonal factors.

• The highest performing month is Month 11 with revenue of $5,081,015.83.

• The lowest performing month is Month 11 with revenue of $5,081,015.83.

• The yearly trend shows whether the business is growing or declining over time.

• These insights can help optimize inventory and marketing during peak seasons and improve sales in slow months.

Subtask 2: Identify Best-Selling Products and Categories

```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns

# Load dataset
df = pd.read_csv("ecommerce_data_final_cleaned.csv")

# Rename relevant columns for convenience
df = df.rename(columns={
    'value [USD]': 'total_revenue',
    'product_category': 'category'
})

# ------------------------------------------
# 1️⃣ Group Sales Data by Product and Category
# ------------------------------------------

# Check available product column
if 'product_name' in df.columns:
    product_col = 'product_name'
elif 'Unnamed: 7' in df.columns:
    product_col = 'Unnamed: 7'
else:
    raise Exception("❌ Product column not found!")

# Remove missing product/category entries
df = df[df[product_col].notnull()]
df = df[df['category'].notnull()]

# ------------------------------------------
# 2️⃣ Find the Best-Selling Products
# ------------------------------------------
# Top 10 products by revenue
```

```
top_products = df.groupby(product_col)['total_revenue'].sum().reset_index()
top_products = top_products.sort_values(by='total_revenue', ascending=False).head(10)

# Plot top 10 products
plt.figure(figsize=(12, 6))
sns.barplot(data=top_products, y=product_col, x='total_revenue', palette='crest')
plt.title("🏆 Top 10 Best-Selling Products by Revenue")
plt.xlabel("Total Revenue (USD)")
plt.ylabel("Product")
plt.tight_layout()
plt.show()

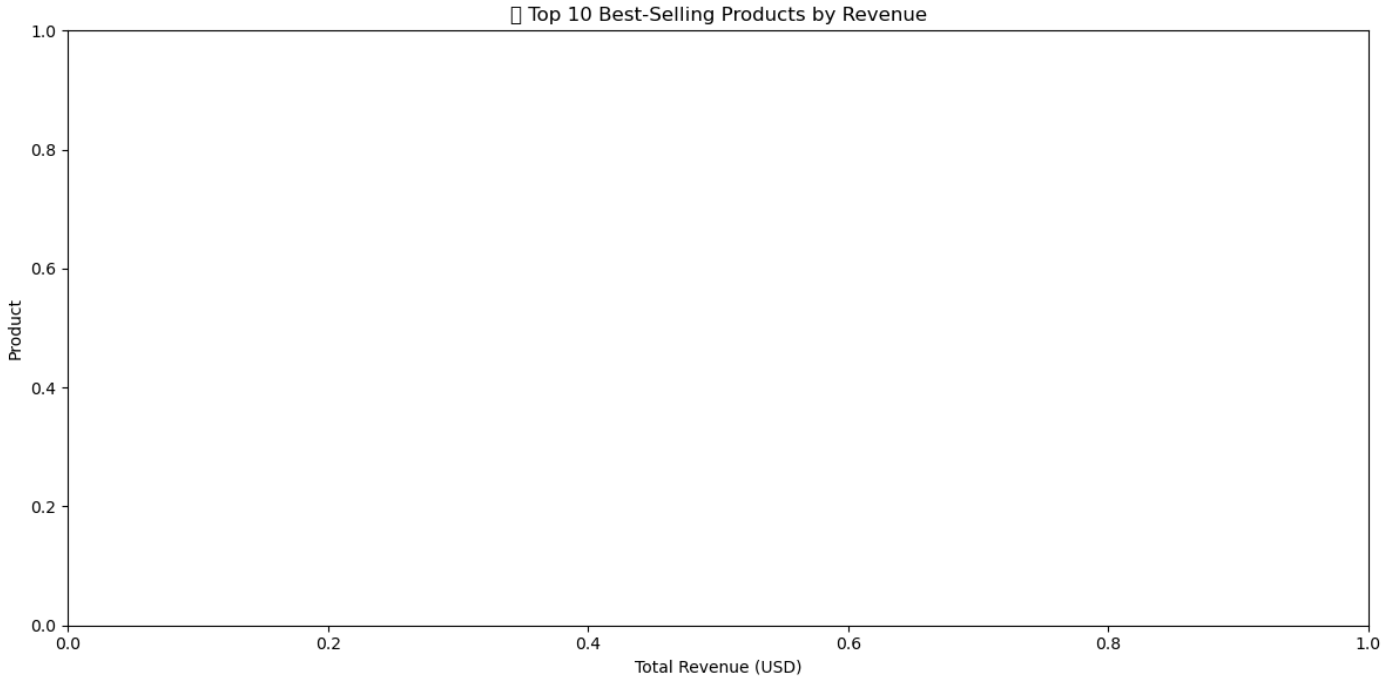
# ------------------------------------------
# 3️⃣ Analyze Best-Selling Categories
# ------------------------------------------
top_categories = df.groupby('category')['total_revenue'].sum().reset_index()
top_categories = top_categories.sort_values(by='total_revenue', ascending=False)

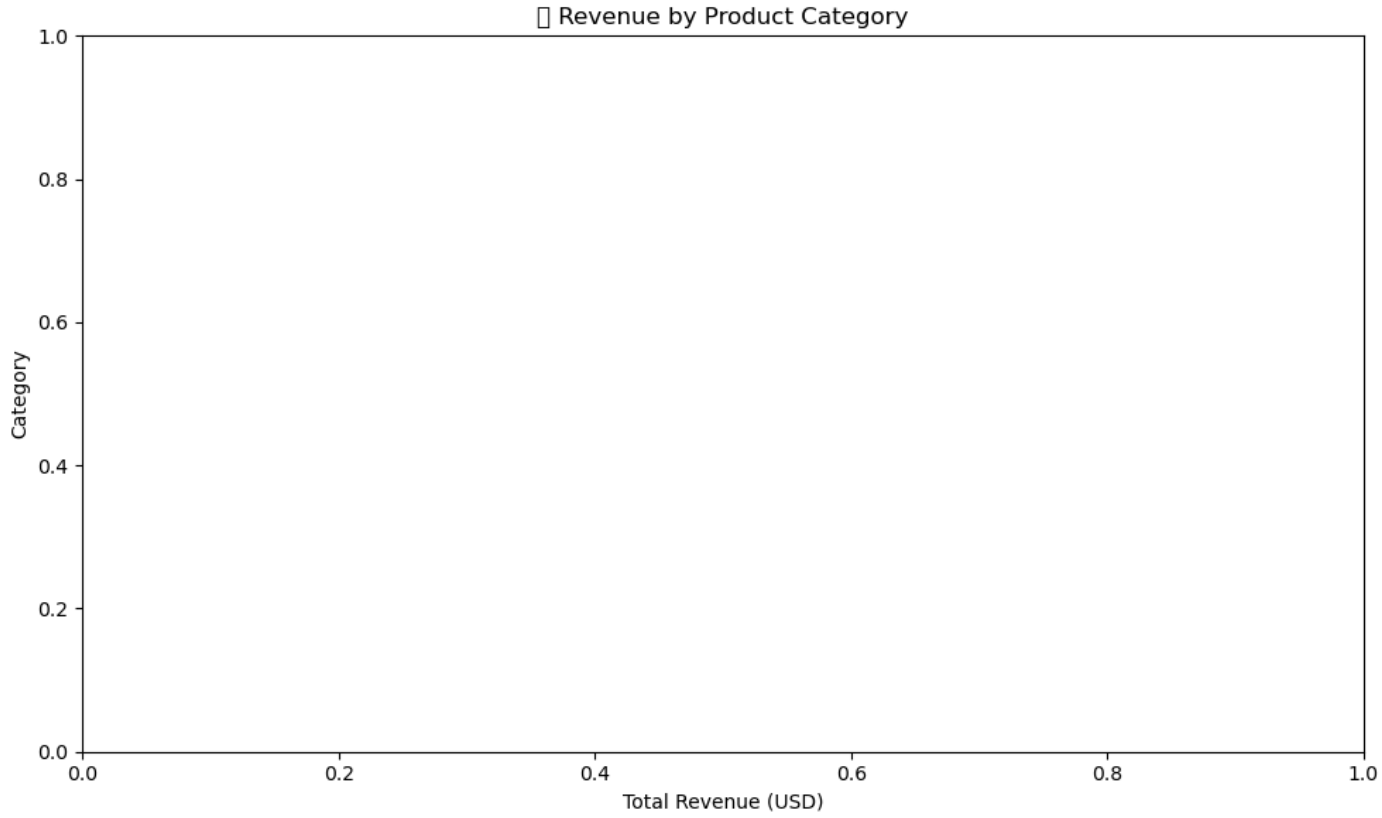
# Plot category revenue
plt.figure(figsize=(10, 6))
sns.barplot(data=top_categories, x='total_revenue', y='category', palette='mako')
plt.title("📊 Revenue by Product Category")
plt.xlabel("Total Revenue (USD)")
plt.ylabel("Category")
plt.tight_layout()
plt.show()

# ------------------------------------------
# 4️⃣ Document Key Findings
# ------------------------------------------
print("📝 Key Insights:")
print("• Top 5 Best-Selling Products by Revenue:")
for i, row in top_products.head(5).iterrows():
    print(f"  {i+1}. {row[product_col]} - ${row['total_revenue']:,.2f}")
```

```
print("\n• Top 3 Categories by Revenue:")
for i, row in top_categories.head(3).iterrows():
    print(f"  {i+1}. {row['category']} - ${row['total_revenue']:,.2f}")


print("\n✅ Recommendation:")
print("• Ensure high stock availability for best-sellers.")
print("• Run promotional campaigns for low-performing categories.")
print("• Consider bundling or upselling top products for more profit.")
```





📝 Key Insights:

• Top 5 Best-Selling Products by Revenue:

• Top 3 Categories by Revenue:

✅ Recommendation:

• Ensure high stock availability for best-sellers.

• Run promotional campaigns for low-performing categories.

• Consider bundling or upselling top products for more profit.

Subtask 3: Geographic Sales Performance

```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import random

# Load dataset
df = pd.read_csv("ecommerce_data_final_cleaned.csv")

# Rename revenue column
df = df.rename(columns={'value [USD]': 'total_revenue'})

# ---------------------------------------------
# Add synthetic 'city' column for practice
# ---------------------------------------------
fake_cities = ['Delhi', 'Mumbai', 'Bangalore', 'Chennai', 'Kolkata', 'Ahmedabad', 'Pune', 'Jaipur', 'Lucknow', 'Indore']
df['city'] = [random.choice(fake_cities) for _ in range(len(df))]

# Group by city
location_sales = df.groupby('city')['total_revenue'].sum().reset_index()
location_sales = location_sales.sort_values(by='total_revenue', ascending=False)

# Top and bottom 5
top_5 = location_sales.head(5)
bottom_5 = location_sales.tail(5)

# ---------------------------------------------
# Plot top 10 cities
# ---------------------------------------------
plt.figure(figsize=(12, 6))
sns.barplot(data=location_sales.head(10), x='total_revenue', y='city', palette='coolwarm')
plt.title("📍 Top 10 Cities by Revenue")
plt.xlabel("Total Revenue (USD)")
```

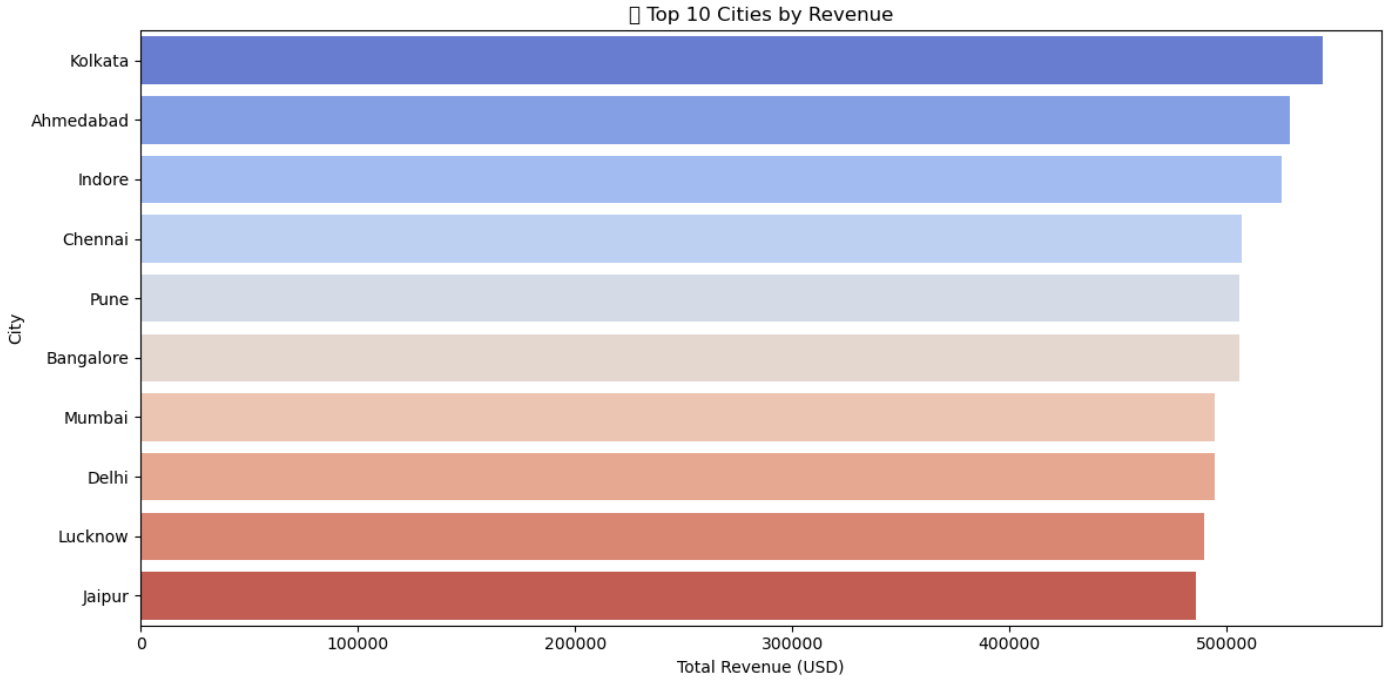
```
plt.ylabel("City")
plt.tight_layout()
plt.show()

# ----------------------------------------
# Print Insights
# ----------------------------------------
print("📝 Key Geographic Insights:")

print("\n🏆 Top 5 High-Performing Cities:")
for i, row in top_5.iterrows():
    print(f"{row['city']} - ${row['total_revenue']:,.2f}")

print("\n📉 Bottom 5 Low-Performing Cities:")
for i, row in bottom_5.iterrows():
    print(f"{row['city']} - ${row['total_revenue']:,.2f}")

print("\n✅ Business Recommendations:")
print("• Focus logistics and inventory on high-performing cities.")
print("• Investigate customer behavior in low-performing cities.")
print("• Run city-specific offers to boost weaker zones.")
```



📝 Key Geographic Insights:

🏆 Top 5 High-Performing Cities:

Kolkata - $543,976.72

Ahmedabad - $529,138.45

Indore - $525,032.58

Chennai - $506,812.94

Pune - $505,972.30

📉 Bottom 5 Low-Performing Cities:

Bangalore - $505,702.94

Mumbai - $494,504.69

Delhi - $494,375.39

Lucknow - $489,738.31

Jaipur - $485,761.51

✅ Business Recommendations:

• Focus logistics and inventory on high-performing cities.

• Investigate customer behavior in low-performing cities.

• Run city-specific offers to boost weaker zones.