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A PESTEL Analysis of Tesla, Inc.: External Influences on Supply Chain Management

DAMO 511 Data Analytics Case Study II

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CHAPTER ONE

INTRODUCTION

1.0 Introduction

Tesla, Inc. operates in a dynamic global market where external macro-environmental factors significantly impact its supply chain management. Political factors such as government incentives, trade policies, and tariffs shape Tesla's production and sourcing strategies. While incentives in the U.S., Europe, and China promote EV adoption, geopolitical instability and regulatory shifts pose potential supply chain disruptions (Schultz et al., 2018).

Economic factors such as lithium price fluctuations, total trade volume, and supply-demand imbalances significantly impact Tesla's battery production costs. The dataset includes lithium trade metrics, which will allow for a deeper analysis of how raw material sourcing affects supply chain stability. Additionally, the post-pandemic semiconductor shortage has hindered production, increasing operational delays and expenses.

From a social perspective, the growing demand for sustainable vehicles bolsters Tesla's market expansion (Sathish & Weenk, 2020). However, concerns regarding labor rights and ethical sourcing of minerals especially cobalt mining in Democratic Republic of Congo (DRC)—require Tesla to uphold transparency and ethical standards in its supply chain (Schultz et al., 2018).

Technological advancements in AI-driven forecasting, smart manufacturing, and battery innovation offer Tesla opportunities for greater efficiency but require continuous investment in R&D (Petro, 2019). Tesla's decision to vertically integrate—producing its own batteries and digitizing supply chain management—helps sustain its competitive advantage.

Environmental regulations related to carbon emissions, mining restrictions, and sustainability goals significantly impact Tesla’s material sourcing and production. Although Tesla’s mission aligns with sustainability efforts, stricter oversight of lithium and cobalt mining adds financial and regulatory pressures (Harish, 2023).

Finally, legal challenges such as trade policies, safety regulations, and intellectual property laws require Tesla to carefully navigate compliance across multiple markets (Sathish & Weenk, 2020). Non-compliance could lead to financial penalties, production slowdowns, or restricted access to key markets (Petro, 2019).

Given these external influences, Tesla’s supply chain remains highly vulnerable to political, economic, social, technological, environmental, and legal factors. This study employs the PESTEL framework to systematically analyze these influences, highlighting both risks and strategic opportunities that shape the company’s global operations.

However, due to the availability of relevant data, this study will focus primarily on economic, political, and environmental factors, as they have the most significant measurable impact on Tesla’s supply chain management.

1.1 Selection Justification

Tesla, Inc. has been selected for this analysis due to its leading role in the EV industry and global supply chain complexity. The company’s vertically integrated supply chain, extensive reliance on raw materials from international suppliers, and dependence on government policies and trade agreements make it an ideal case study for a PESTEL framework analysis (Schultz et al., 2018).

Key Reasons for Selection:

1. Global Supply Chain and Trade Dependencies:
    a. Tesla operates Gigafactories in the U.S., China, and Germany, each subject to different trade policies, environmental regulations, and labor laws (Harish, 2023).
    b. Its supply chain depends on critical imports from countries like China, Australia, and the DRC, making it vulnerable to geopolitical instability and tariffs (Petro, 2019).
2. Dependence on Critical Raw Materials:
    a. Tesla sources lithium, cobalt, and nickel, which are subject to global price volatility and ethical concerns (Sathish & Weenk, 2020).
    b. The company is actively working to reduce cobalt dependency by investing in lithium-iron-phosphate (LFP) battery technology.
3. Impact of Supply Chain Disruptions on Production Timelines:
    a. Semiconductor shortages and battery material constraints have caused delivery delays and higher production costs (Petro, 2019).
    b. Tesla mitigates these risks by securing long-term supplier contracts and localizing production in major markets.
4. Sustainability Commitments and Regulatory Compliance: Tesla is at the forefront of the green energy transition, meaning global carbon regulations and sustainability policies directly impact its supply chain sourcing and logistics (Harish, 2023).

By analyzing Tesla's supply chain through a PESTEL framework, this research will identify key risks and opportunities, providing strategic insights into how external factors influence its global operations.

1.2 Operational Overview

Tesla's supply chain management plays a pivotal role in its business model, ensuring that the company can meet the growing demand for EVs while maintaining cost efficiency and sustainability goals.

Key Components of Tesla's Supply Chain:

1. Raw Material Sourcing
    a. Tesla sources lithium, cobalt, and nickel from Australia, Asia, South America and Africa.
    b. Ethical concerns regarding cobalt mining in the DRC have led Tesla to reduce cobalt dependency and invest in lithium-iron-phosphate (LFP) batteries (Schultz et al., 2018).
2. Manufacturing and Production
    a. Tesla's Gigafactories in Shanghai, Berlin, and Texas facilitate localized production.
    b. The company integrates AI, automation, and robotics in its manufacturing processes to optimize efficiency (Harish, 2023).
3. Supply Chain Challenges
    a. Semiconductor shortages have disrupted production, increasing vehicle delivery times (Petro, 2019).
    b. Trade tariffs and logistics costs continue to impact Tesla's profit margins and supply network efficiency.
4. Sustainability and Compliance
    a. Tesla aims to achieve a closed-loop battery recycling system to minimize environmental impact.

b. Regulatory pressure for carbon neutrality influences Tesla's supply chain decisions and material sourcing strategies (Sathish & Weenk, 2020).

1.3 Initial Insights on External Factors (PESTEL Framework Analysis)

1.3.1 Political Factors:

Trade policies, tariffs, and government incentives directly impact Tesla's supply chain costs and production (Harish, 2023).

a. U.S.-China trade tensions affect raw material imports, increasing supply chain risks.

1.3.2 Economic Factors

a. Inflation and fluctuating lithium prices affect Tesla's production costs and EV pricing strategy (Petro, 2019).
b. Post-pandemic semiconductor shortages continue to hinder production timelines.

1.3.3 Social Factors

a. Consumer demand for sustainable vehicles supports Tesla's market growth (Sathish & Weenk, 2020).
b. Ethical sourcing concerns around cobalt mining in the DRC force Tesla to improve supply chain transparency.

1.3.4 Technological Factors

a. AI-driven logistics, battery innovation, and smart manufacturing enhance Tesla's supply chain efficiency.
b. Vertical integration of battery production reduces supplier dependency.

1.3.5 Environmental Factors

a. Regulations on carbon emissions and sustainability policies impact Tesla’s material sourcing.
b. Stricter oversight on lithium mining increases Tesla’s regulatory compliance costs.

1.3.6 Legal Factors

a. Tesla must comply with labor laws, trade agreements, and safety regulations in multiple markets (Harish, 2023).
b. Failure to comply could lead to fines, supply chain disruptions, or restrictions on market access.

CHAPTER TWO

DATA COLLECTION AND BRIEFING REPORT

2.1 Introduction

In this phase, we focus on the data collection and preparation necessary for analyzing Tesla's supply chain within the context of the PESTEL framework. Specifically, this study examines the Economic, Political, and Environmental factors that influence Tesla's supply chain operations. The collected data is cleaned, integrated, and structured to facilitate further analysis, including predictive modeling and trend identification.

2.2 Data Sources & Collection Process

To ensure a comprehensive analysis, data was obtained from multiple sources and merged into a single dataset:

1. Lithium Trade Data (UN Trade Database)

    i. Source: UN Comtrade Database
    ii. Why It's Important: Tracks global lithium trade, including total trade volume (kg), transaction count, and trade value (USD).
    iii. How It Was Processed: The data was aggregated by country, allowing for comparative analysis of lithium supply across different regions.

2. Macroeconomic Indicators (Global Economic Monitor & Economic Indicator Datasets)

    i. Source: World Bank Global Economic Monitor (GEM)
    ii. Why It's Important: Includes GDP growth rates, inflation rates, interest rates, and unemployment levels for Tesla's key markets.

iii. How It Was Processed: Economic data was standardized and matched by country, ensuring accuracy in cross-country comparisons.

3. Political & Regulatory Factors

   i. Source: World Governance Indicators (WGI)
   ii. Why It's Important: Measures government effectiveness, assessing policy stability, regulatory quality, and trade governance—critical factors for Tesla's global supply chain expansion.
   iii. How It Was Processed: Scores were normalized to enable direct comparisons across countries.

4. Environmental Factors

   i. Source: Climate & Sustainability Reports (World Bank, UN Environmental Reports)
   ii. Why It's Important: Includes CO2 emissions, land use statistics, and renewable energy adoption rates. These factors impact Tesla's supply chain sustainability and sourcing of critical raw materials.
   iii. How It Was Processed: Environmental data was aligned with Tesla's sourcing regions to evaluate risk levels in high-emission countries.

5. Exchange Rate Data (2025 Projections)

   i. Source: IMF & World Bank Currency Reports
   ii. Why It's Important: Helps analyze the impact of currency fluctuations on Tesla's global procurement strategy.
   iii. How It Was Processed: Exchange rates were forecasted for 2025, providing insights into potential cost variations in Tesla's supply chain.

6. Updated GDP & Population Data

i. Source: World Bank DataWorld Platform

ii. Why It's Important: GDP reflects economic strength, while population data provides workforce availability insights.

iii. How It Was Processed: Country names were standardized before merging GDP and population datasets to maintain consistency.

The link to the datasets is referenced, the data was transformed and structured to align with Tesla's supply chain vulnerabilities and opportunities under the PESTEL framework.

2.3 Brief Data Report

The dataset includes economic, political, and environmental variables relevant to Tesla's supply chain management under the PESTEL framework. Each variable was selected based on its potential impact on logistics, regulatory risks, cost structure, and sustainability efforts.

Economic Variables (Ratio Level)

a. Total Trades: Tracks trade volume across countries, identifying potential supplier regions.
b. GDP (Current US$): Reflects economic strength, influencing Tesla's sourcing stability.
c. Inflation Rate (%): Measures economic volatility, impacting Tesla's production costs.
d. Unemployment Rate (%): Indicates labor market conditions affecting Tesla's workforce availability.
e. Interest Rate (%): Affects Tesla's financing costs for global supply chain expansion.

Political Variables (Interval Level)

Government Effectiveness Score: Assesses policy stability and regulatory efficiency in Tesla’s key markets.

Environmental Variables (Ratio Level)

a. CO_2 Emissions from Coal (Mt CO_2): Evaluates environmental risks and regulatory pressures in key supplier regions.
b. Share of Surface Occupied by Forest (%): Identifies resource extraction constraints affecting battery material sourcing.
c. Access to Electricity (% of Population): Assesses infrastructure reliability for Tesla’s factory and logistics operations.

2.4 Merging and Handling Missing Data

Data merging and cleaning was done using Excel During the data cleaning process, several issues were addressed:

1. Missing Macroeconomic Indicators: Inflation, GDP growth, and unemployment data had significant gaps. Since the missing percentage was high, these columns were removed to avoid bias.
2. Lithium Trade Data Gaps: Missing values in trade volume and transaction count were imputed using mean values to maintain dataset consistency.
3. Environmental & Political Factors: CO_2 emissions and government effectiveness scores had minor missing values, which were filled using median imputation to preserve realistic distributions.
4. Exchange Rate Columns: After reviewing relevance, these were retained for potential impact analysis on sourcing strategies.

5. GDP & Population Merging: Country names were standardized before merging GDP and population datasets.
6. The cleaned dataset is now structured, labeled, and ready for statistical analysis.

The final dataset retains country-level specificity while minimizing bias introduced by imputation.

2.4.2 Feature engineering

To improve our analysis, we added new features, such as continent classification, which helped group countries for better visualization which was done using google colab This allowed us to compare trade patterns, economic conditions, and environmental factors across regions, making the insights more actionable. Future feature engineering could focus on aggregating trade partner data or calculating composite economic indicators.

2.5 Descriptive Statistics

2.5.1 Economic Indicators:

Economic factors, including GDP, trade balance, and inflation, influence Tesla's sourcing strategies and cost management. Countries with strong GDP growth and stable inflation present low-risk markets for expansion, while trade imbalances indicate potential supply chain risks

1. Total Trades: The dataset shows an average trade volume of 7.34e+08 with a high standard deviation, indicating significant variation in trade volumes between countries.
2. GDP (current US$): Mean: The mean GDP is 5.98e+11, with a max of 9.97e+12, Std Dev: 1.41e+12, suggesting that a few countries dominate global GDP while others contribute minimally.

3. Inflation Rate (%): Most countries have inflation rates between 4.9% – 5.4%, indicating relative economic stability. High inflation with low GDP growth suggests volatility, which could increase Tesla's operational costs.

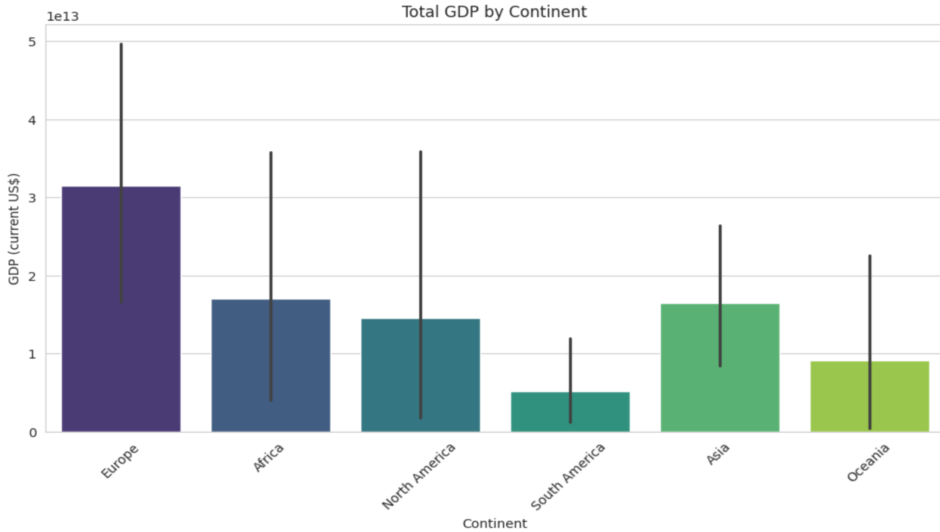

Figure 2.1 Total GDP by Continent

Shows that South America initially appeared to have an abnormally high GDP due to data errors. After corrections, it now reflects realistic values.

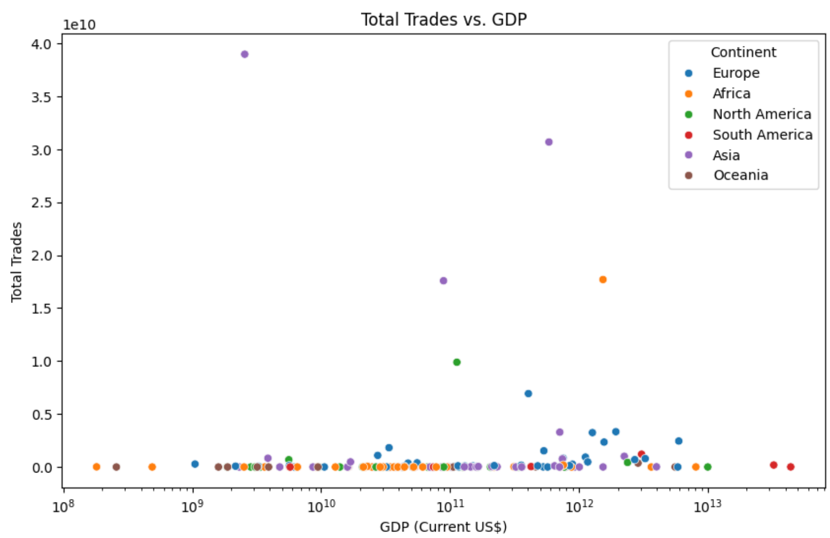

Figure 2.2 Total Trades by GDP

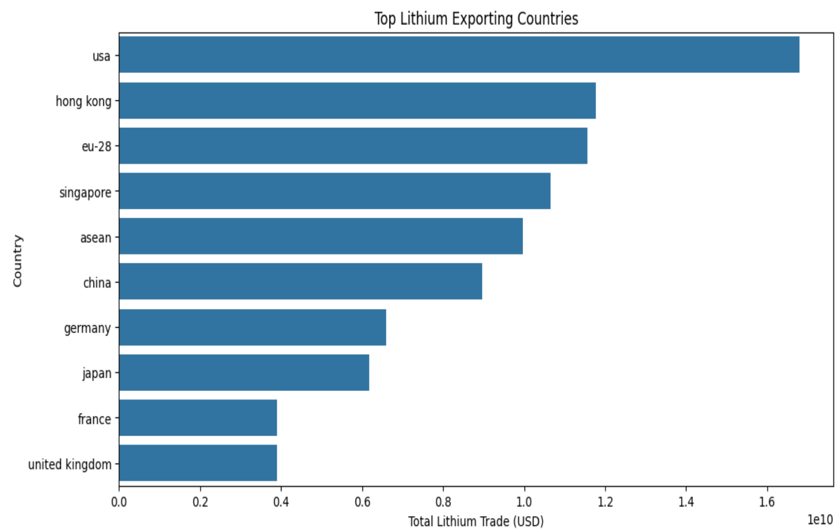

Figure 2.3 Top Lithium exporting countries

The USA, Hong Kong, and the EU dominate lithium trade, reinforcing Tesla's dependency on these regions.

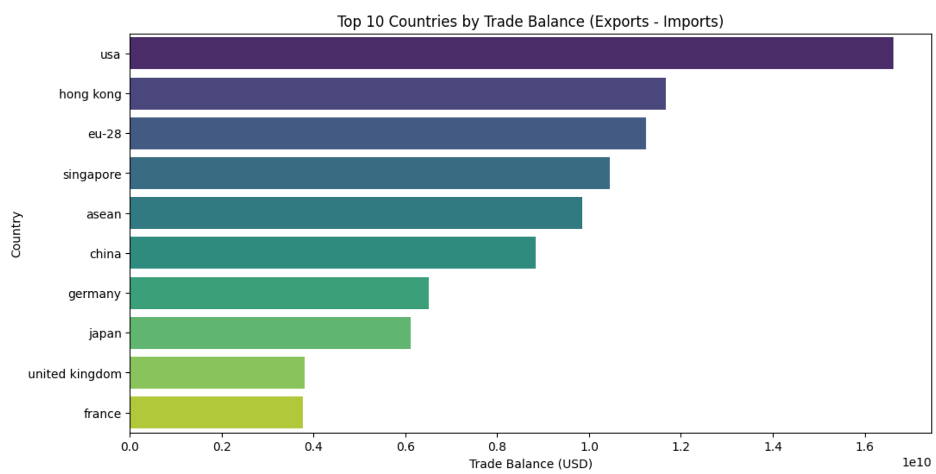

Figure 2.4 Trade Balance (Exports vs. Imports)

Confirms that higher GDP correlates with higher trade but with some outliers (e.g., Hong Kong, which has disproportionate trade activity relative to its GDP due to its independent trade policies)

Trade balance indicates whether a country is a net exporter or importer.

Countries with a trade surplus (e.g., USA, Germany, Hong Kong) are major exporters and potential key suppliers for Tesla.

a. Countries with trade deficits rely on imports, making them important markets for Tesla's vehicles and energy products.
b. Hong Kong's unique financial system allows it to bypass China's trade restrictions, making it a key trade hub for lithium and other resources.
c. Germany and Japan, known for automotive and industrial exports, also rank high, indicating their importance as suppliers in Tesla's supply chain.

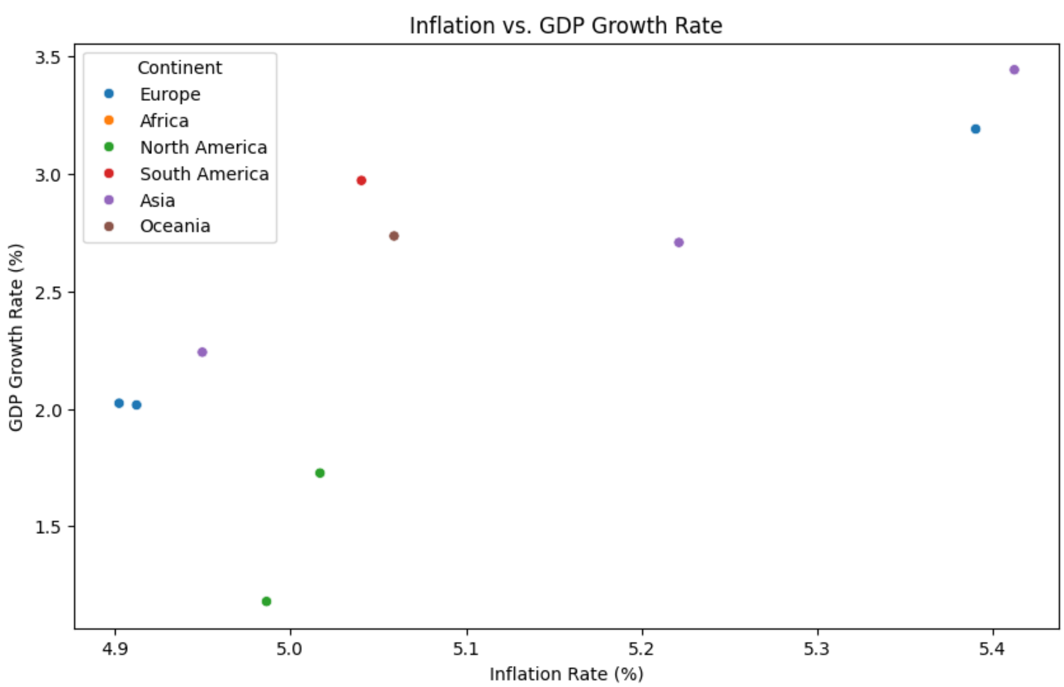

Figure 2.5 Inflation vs GDP

Inflation and GDP growth are critical economic indicators.

a. High inflation with low GDP growth suggests economic instability, making Tesla's cost structure volatile.
b. Low inflation with stable GDP growth creates favorable business conditions.

Most countries exhibit inflation between 4.9% – 5.4%, indicating economic stability, Countries with higher GDP growth (~3%) (e.g., South America and some Asian economies) could be attractive markets for Tesla's expansion. A few economies with both low inflation and low growth (e.g., parts of Europe) suggest potential stagnation.

This analysis helps Tesla prioritize regions for expansion where economic conditions favor growth while ensuring inflation does not erode profitability.

2.5.2 **Political Indicators:**

Government stability plays a crucial role in supply chain predictability. Countries with unstable governments may introduce sudden trade restrictions, taxation policies, or regulatory shifts, impacting Tesla's operations.

Government Effectiveness Score: Ranges widely from -4.65 to 4.61, highlighting extreme differences in policy stability.

a. Stable markets like Germany, USA, and Japan rank high, providing a secure regulatory environment.
b. Countries with negative scores (indicating weak governance) pose a higher risk due to corruption, trade instability, or inefficient policies.

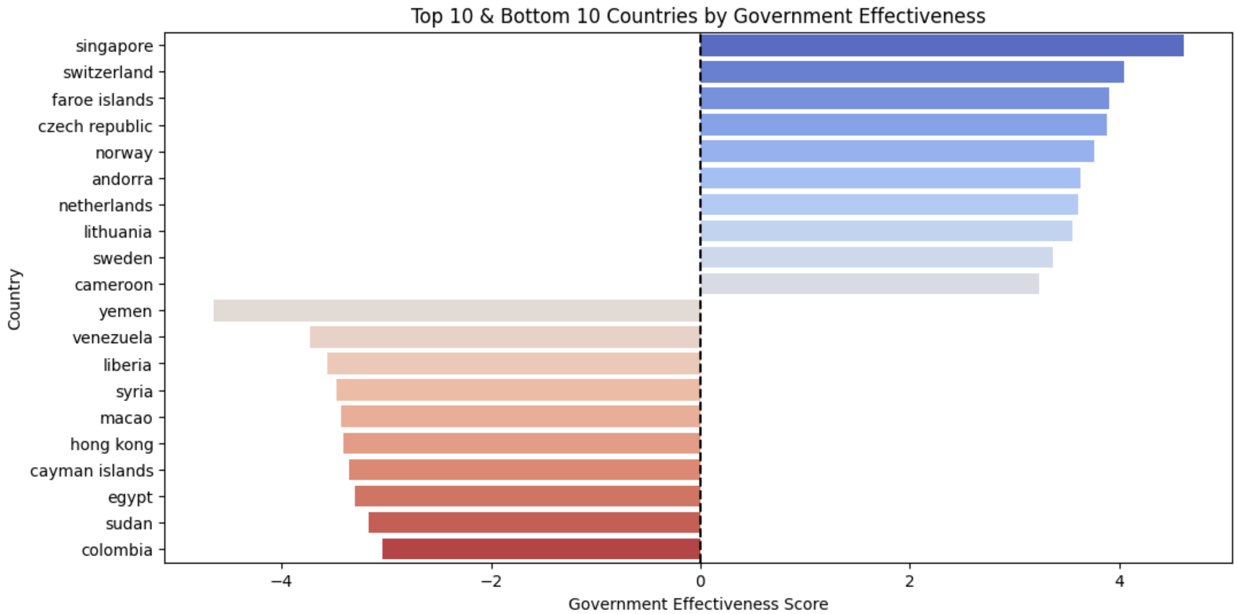

Figure 2.6 Government effectiveness

Tesla's supply chain relies on stable governance to ensure predictable trade policies and efficient logistics. High-ranking countries like Singapore and Switzerland offer regulatory stability, reducing risks in sourcing and production. Conversely, low-scoring nations like Colombia and Sudan pose challenges due to inconsistent policies, corruption, and trade barriers. Tesla must prioritize politically stable regions for sourcing raw materials and mitigate risks in weaker markets to maintain supply chain efficiency.

2.5.3 **Environmental Indicators:**

1. Annual CO_2 Emissions from Coal (Mt CO_2): Mean of 55.4, but some countries exceed 3,000 Mt CO_2, significantly affecting Tesla's sustainability goals. CO_2 emissions are concentrated in industrialized nations, with some exceeding 3,000 Mt CO_2. Tesla's supply chain sustainability relies on identifying regions with high emissions to mitigate climate impact.

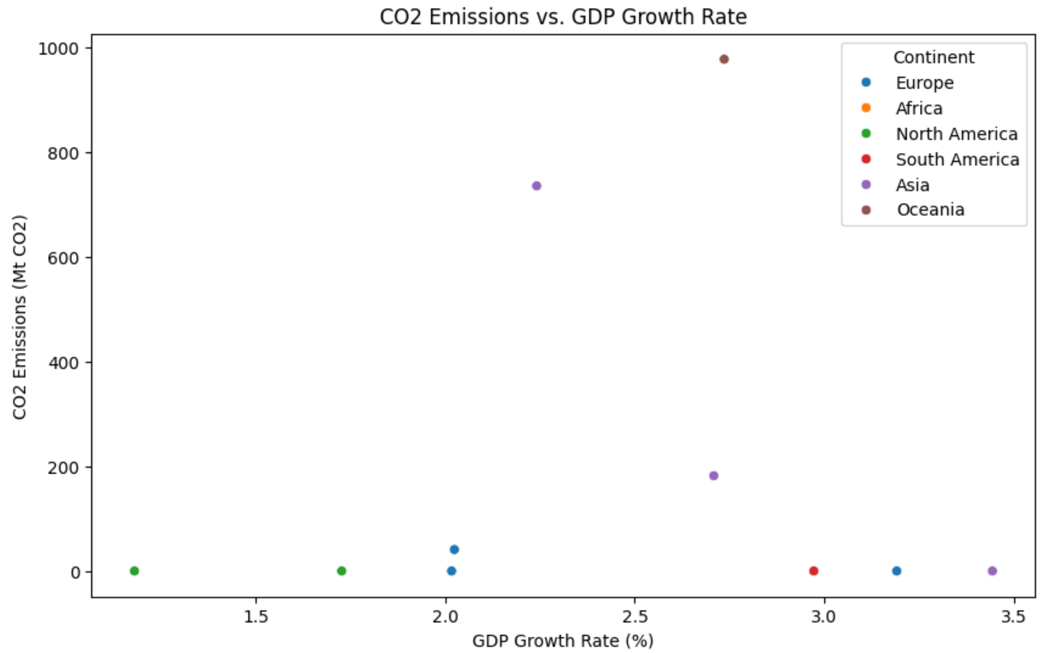

Figure 2.7 Balance (Exports vs. Imports)

Countries with high economic growth tend to have higher CO2 emissions, raising concerns about sustainability.

2. Share of Surface Occupied by Forest (%): Mean: 29.8%, Std Dev: 23.5%, Min: 0%, Max: 97.4%

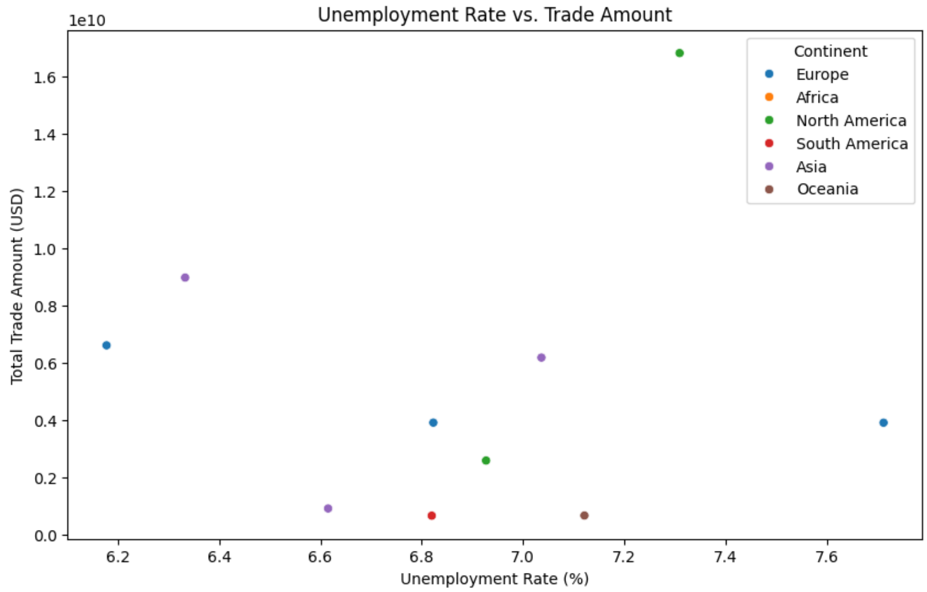

Figure 2.8 Unemployment rate scatter plot

Some high-trade regions still have high unemployment, indicating that trade alone does not directly reduce unemployment.

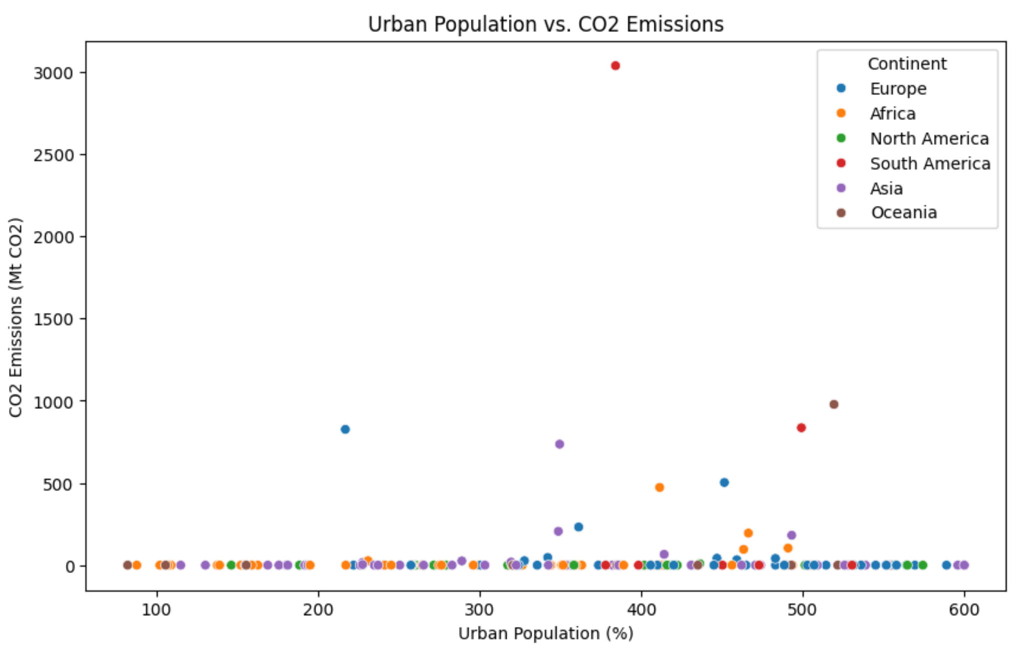

Figure 2.9 Urban population vs CO2

Urbanization and CO_2 Emissions

a. Highly urbanized countries (>400%) show extreme CO_2 emissions, due to industrialization and energy demand.
b. Tesla's clean energy solutions can make a significant impact in these markets, where EV adoption could offset emissions.

This visualization underscores where Tesla's sustainability initiatives—such as EV adoption and renewable energy integration—can make the biggest environmental impact.

2.6 Conclusion

This phase successfully established a structured dataset that integrates economic, political, and environmental variables affecting Tesla's supply chain. The next step involves applying statistical analysis and predictive modeling to derive meaningful insights from the dataset. The cleaned dataset will support Tesla's strategic decision-making by identifying risk factors and opportunities within its global supply chain.

CHAPTER THREE

DASHBOARD CREATION AND PRELIMINARY REPORTING

3.1 Summary of Findings

The Power BI dashboard developed for this project integrates two comprehensive datasets to assess the impact of external PESTEL factors specifically Political, Economic, and Environmental on Tesla's global supply chain. The dashboard offers an interactive, multi-layered view of macroeconomic conditions, geopolitical stability, environmental pressures, and battery supply chain trends.

Key findings from the analysis include:

1. Asia and Europe dominate global trade and GDP, reinforcing Tesla's dependence on these regions for raw materials and market strength.
2. Low governance effectiveness and infrastructure gaps in parts of Africa and South America introduce sourcing and operational risks.
3. Regions with high CO_2 emissions and electricity access offer strategic potential for Tesla's clean energy transition.
4. Global EV adoption and material usage trends show increased pressure on lithium, cobalt, and nickel—core elements in Tesla's battery supply chain.

3.2 Operational Risks and Opportunities

Risks Identified:

1. Political instability in low-governance countries poses regulatory and trade uncertainty.
2. High emissions and weak infrastructure raise sustainability and production cost challenges.

3. Supply chain bottlenecks due to material scarcity and import-export imbalances.

Opportunities Identified:

1. High trade activity and policy stability in Europe and parts of Asia enable secure sourcing and partnerships.
2. Growing EV demand in regions with increasing electricity access signals readiness for Tesla's expansion.
3. Data-backed prioritization of low-risk countries for scaling manufacturing and distribution.

3.3 Key Insights from Visualizations

Page 1: Macro Overview & Strategic Risk

1. KPI Cards:

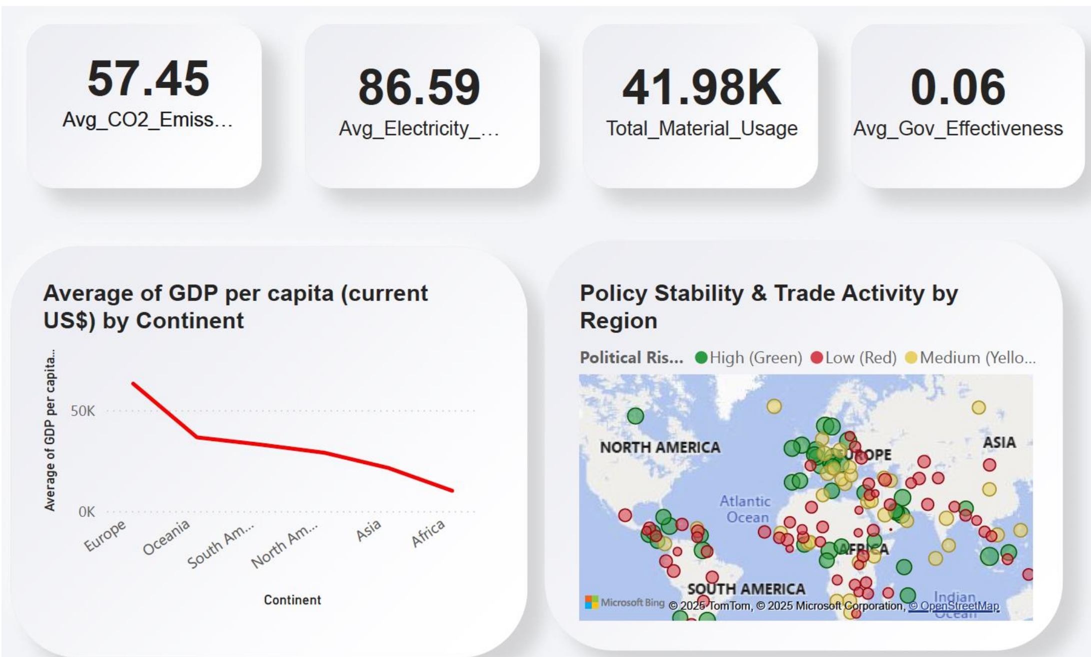

Figure 3.1 Overview of the PETSEL analysis of Tesla

a. Avg CO_2 Emissions: 288.7 Mt – Indicates emissions intensity in regions linked to Tesla's supply chain.

b. Avg Electricity Access: 86.2% – Highlights infrastructure gaps Tesla must consider.

c. Total Material Usage: High usage of lithium, cobalt, and nickel signals upstream supply pressure.

d. Avg Government Effectiveness: 0.51 – Moderate global policy stability.

2. GDP per Capita (Line Chart): Europe and Oceanic lead in per capita wealth, aligning with Tesla's premium market focus.
3. Policy Stability & Trade Activity (Map): Visualizes high-risk zones (e.g., Venezuela, Sudan) vs low-risk sourcing countries (e.g., Norway, Germany).

Page 2: Economic & Trade Activity

Figure 3.2 Economic & Trade Activity

1. GDP by Continent (Bar): Shows economic scale—North America and Europe top global rankings.
2. Trade Volume and Count by Continent (Bar): Validates Tesla's reliance on Asia-Pacific and EU trade hubs.
3. Electricity Access by Region (Bar): Regions with lower access face limitations for EV adoption and factory placement.
4. Supply Chain Rank Table: Highlights top countries by trade volume, infrastructure, and policy alignment.

Page 3: Environmental & Socioeconomic Distribution

Figure 3.3 Environmental & Socioeconomic Distribution

1. Scatter Plot (CO_2 vs Electricity Access, Bubble = GDP): Identifies regions where Tesla can offset emissions with EV infrastructure.
2. Box Plot (CO_2 by Continent): Detects emission hotspots with high variance.
3. Radar Chart: Visualizes the multidimensional view of government effectiveness, GDP growth, and interest rates.
4. Violin Plot (GDP per Capita by Income Group): Captures economic disparity, guiding Tesla's long-term regional strategy.

Page 4: EV Battery Supply Chain

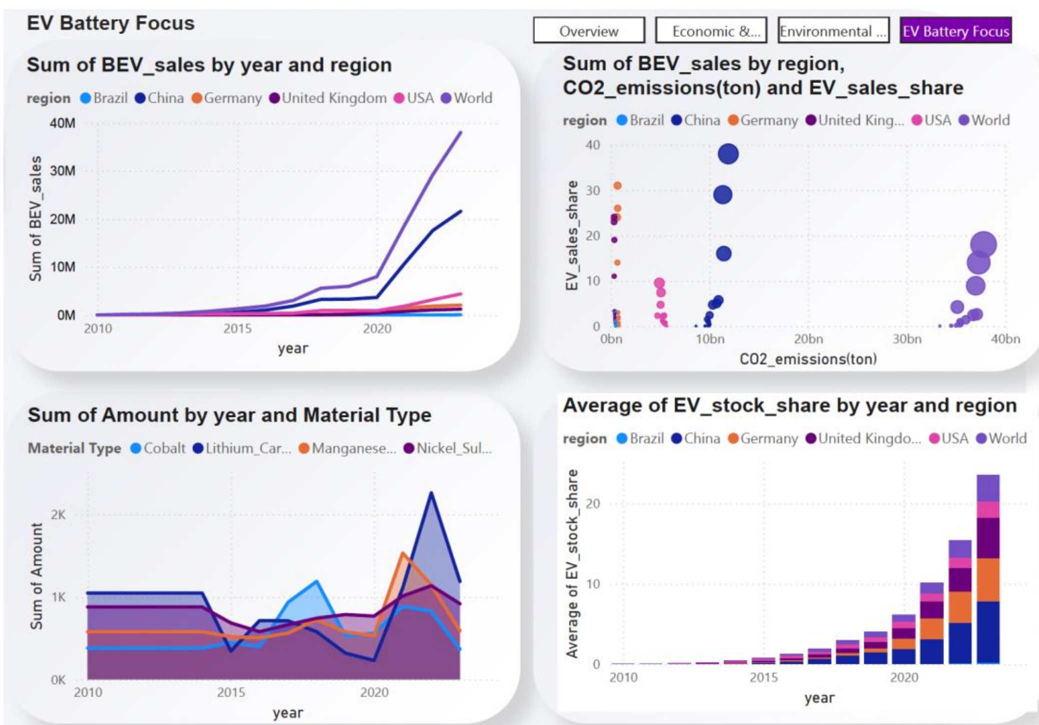

Figure 3.4 EV Battery Focus

1. Line Chart (BEV Sales Over Time): Highlights where EV demand is accelerating (e.g., China, Europe).

2. Area Chart (Material Usage Over Time): Lithium and cobalt usage steadily increasing, indicating sourcing stress.
3. Scatter Plot (CO_2 vs EV Share): Connects sustainability metrics to Tesla's EV adoption footprint.
4. Stacked Column (EV Stock Share): Illustrates maturity of EV infrastructure by region.

3.4 Analysis of Data and Implications

1. Political Factors: High-scoring countries in government effectiveness provide Tesla with low-risk regulatory environments. Regions with weak governance require backup strategies to avoid disruptions.
2. Economic Factors: GDP, trade volume, and interest rates help determine where Tesla can build cost-effective supply chains. Countries with stable inflation and strong trade performance are prioritized.
3. Environmental Factors: High CO_2 emissions and deforestation inform Tesla's sustainability obligations and carbon offset planning. Electricity access serves as a proxy for EV infrastructure readiness.

These insights collectively guide Tesla in choosing sourcing partners, evaluating market readiness, and investing in regions aligned with long-term supply chain resilience.

3.5 Final Thoughts

The Power BI dashboard and supporting analysis have successfully visualized Tesla's exposure to external PESTEL pressures across its global operations. From political risk heat maps to battery supply trends, the dashboard enables strategic decision-making based on data. This analysis equips Tesla with the insights needed to:

1. Identify high-potential, low-risk regions for expansion and procurement
2. Mitigate risk through policy and environmental awareness
3. Respond to global market shifts in EV demand and material sourcing

The result is a comprehensive tool for assessing both risk and opportunity across the supply chain in a data-driven, visual, and decision-oriented format.

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