EDA PROJECT FINAL REPORT

Course Code: CSM353

LOVELY PROFESSIONAL UNIVERSITY

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upGrad

TOPIC : Exploratory Data Analysis on Automotive Sales Data

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CERTIFICATE OF SUPERVISION

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This is to certify that the project report titled **"Exploratory Data Analysis (EDA) on Automotive Sales Data"** has been carried out under my supervision by **Sudam Lokeshwar** (Registration No: **12210661**, Class Roll No: **50**), a student of **Lovely Professional University**.

This project is submitted in partial fulfilment of the requirements for the completion of the academic curriculum as per the guidelines of the university.

The work embodied in this report is the authentic result of the student's efforts and has been conducted with diligence, dedication, and sincerity under my guidance. The findings, methodologies, and conclusions presented in this project are the student's own and reflect a thorough understanding of the project objectives and concepts.

I hereby commend the student's hard work and academic commitment, which has been instrumental in the successful completion of this project.

Supervisor Name: Ved Prakash Chaubey
Designation: Assistant Professor
Institution: Lovely Professional University

Supervisor's Signature: ____________________________
Date: ___________18-11-2024________________

Acknowledgment

I express my sincere gratitude to **Ved Prakash Chaubey**, my supervisor, for his invaluable guidance, support, and encouragement throughout the completion of this project titled **"Exploratory Data Analysis (EDA) on Automotive Sales Data"**. His expertise and mentorship have been instrumental in shaping the direction and execution of this work.

I extend my heartfelt thanks to **Lovely Professional University** for providing the necessary resources, academic environment, and facilities that enabled me to carry out this project successfully.

I also appreciate the efforts of my faculty members and peers for their valuable feedback and suggestions, which have greatly enhanced the quality of this work. Their collaboration and shared knowledge have been of immense help in overcoming challenges and achieving the desired outcomes.

This acknowledgment reflects my gratitude towards everyone who has contributed to the successful completion of this project.

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Abstract

The automotive industry is a critical sector that drives economies worldwide, with sales data playing a pivotal role in shaping business strategies, market predictions, and customer insights. This project, titled **"Exploratory Data Analysis (EDA) on Automotive Sales Data,"** delves into the use of data analytics to extract meaningful trends and insights from a large dataset of automotive sales. The analysis focuses on understanding key factors influencing sales performance, such as vehicle features, regional preferences, customer demographics, and seasonal trends.

The dataset used in this study includes information on vehicle models, sales figures, pricing, and customer attributes. A structured methodology was employed, beginning with data cleaning and preprocessing to address missing or inconsistent values. Descriptive statistics and visualizations were then applied to identify patterns and correlations. The project leverages Python-based tools and libraries such as Pandas, NumPy, Matplotlib, and Seaborn to ensure effective data manipulation and graphical representation.

Key findings from the analysis reveal significant insights into market behavior. SUVs and fuel-efficient models dominate urban areas, while affordability drives sales in rural regions. Seasonal peaks, such as year-end holiday periods, show a clear surge in purchases, highlighting the impact of timing and promotional events. Pricing trends also indicate a strong influence on consumer decisions, with noticeable sensitivity among different income groups. Additionally, the correlation matrix highlights relationships between vehicle attributes and sales performance, offering potential areas for optimization in design and marketing strategies.

This project not only provides a comprehensive understanding of automotive sales data but also emphasizes the importance of EDA in business decision-making. By identifying high-performing segments, geographical patterns, and customer preferences, the analysis aids stakeholders in optimizing inventory management, marketing campaigns, and product development. The project concludes with actionable recommendations for automotive businesses, emphasizing the value of leveraging data-driven insights for competitive advantage.

Future work could explore integrating predictive models with EDA for forecasting sales trends, expanding the analysis to incorporate external factors such as economic conditions, and examining customer sentiment through reviews and social media data. This project demonstrates how data analytics serves as a cornerstone for strategic planning in the dynamic automotive industry.

Problem Statement

The automotive industry is highly dynamic, driven by consumer preferences, technological advancements, and market trends. Automotive sales data contains a wealth of information that can provide valuable insights into customer behavior, vehicle performance, and regional market dynamics. However, analyzing this data effectively presents several challenges, including handling large datasets, addressing missing or inconsistent values, and identifying meaningful patterns amid complex relationships between variables.

This project aims to address these challenges by performing **Exploratory Data Analysis (EDA)** on a dataset of automotive sales. The dataset includes critical information such as vehicle models, sales figures, prices, customer demographics, and regional preferences. The primary objective is to uncover trends, correlations, and outliers within the data that can guide decision-making in areas like marketing, inventory management, and product design.

Dataset Description

The dataset used for this analysis consists of the following attributes:

- **Vehicle Model**: The name and type of the vehicle.
- **Sales Figures**: Monthly or yearly sales data for each model.
- **Price**: Market price of the vehicles.
- **Customer Demographics**: Information about age groups, income levels, and regional distribution of buyers.
- **Vehicle Features**: Attributes such as fuel efficiency, engine type, and seating capacity.

Challenges

1. **Data Quality**: Missing or inconsistent data that require preprocessing.
2. **Trend Identification**: Understanding how factors like seasonality, pricing, and customer demographics impact sales.
3. **Correlations and Insights**: Analyzing relationships between variables to provide actionable insights.

4. **Visualization**: Effectively presenting findings through graphs and charts for clear interpretation.

The problem addressed in this project is not merely about analyzing the sales data but also about deriving insights that can help stakeholders understand market dynamics and make data-driven decisions. This project focuses on uncovering key factors that drive sales, identifying high-performing vehicle models, and understanding consumer preferences across different regions and demographics.

Solution Approach

To effectively analyze the automotive sales dataset and uncover meaningful insights, the project employs a structured and systematic solution approach. This approach is designed to address the challenges associated with handling large datasets, identifying trends, and presenting actionable insights for stakeholders. The solution approach includes the following steps:

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1. Data Collection

- **Objective**: Obtain a comprehensive dataset containing automotive sales data, including vehicle models, sales figures, pricing, customer demographics, and regional details.
- **Source**: Publicly available datasets (e.g., Kaggle, open government data portals) or proprietary datasets provided by automotive companies.

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2. Data Cleaning and Preprocessing

- **Objective**: Ensure the dataset is accurate, consistent, and complete.
- Steps:
  - Handle missing values using imputation techniques or by removing rows/columns with significant gaps.
  - Resolve inconsistencies in data (e.g., incorrect formatting, duplicate entries).
  - Normalize and standardize numerical data where necessary.

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3. Exploratory Data Analysis (EDA)

- **Objective**: Identify trends, patterns, and relationships within the dataset.
- Techniques:
  - Descriptive statistics to summarize key metrics (mean, median, standard deviation).
  - Visualization techniques such as bar charts, line plots, scatter plots, and heatmaps to analyze trends and correlations.

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4. Feature Analysis

- **Objective**: Understand the impact of key features on sales performance.
- Steps:
  - Analyze the influence of pricing, vehicle features (e.g., fuel efficiency, engine type), and customer demographics on sales.
  - Compare regional sales data to identify high-performing and underperforming areas.

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5. Trend Analysis

- **Objective**: Recognize temporal patterns and seasonal trends in sales data.
- Steps:
  - Perform time-series analysis to identify monthly or yearly sales trends.
  - Highlight sales peaks during holiday seasons or promotional periods.

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6. Correlation Analysis

- **Objective**: Identify relationships between variables in the dataset.
- Techniques:
  - Create a correlation matrix to measure the strength and direction of relationships between numerical variables.
  - Use visualizations (e.g., heatmaps) to present these relationships effectively.

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7. Insights and Recommendations

- **Objective**: Translate findings into actionable recommendations for stakeholders.
- Steps:
  - Highlight key factors driving sales, such as vehicle type preferences and pricing sensitivity.
  - Suggest strategies for marketing, inventory optimization, and product development based on consumer behavior and regional trends.

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8. Visualization and Reporting

- **Objective**: Present findings in a clear and intuitive manner.
- Tools:
  - Use Python libraries such as Matplotlib and Seaborn to create high-quality visualizations.
  - Generate a comprehensive report detailing the methodology, findings, and recommendations.

This solution approach ensures that the analysis is thorough, data-driven, and aligned with the objectives of uncovering meaningful insights and providing value to stakeholders in the automotive industry.

Required Libraries

The project leverages Python programming language and its ecosystem of libraries to perform Exploratory Data Analysis (EDA) on the automotive sales dataset. Below is a detailed list of libraries used in this project, along with their purposes:

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1. Pandas

- **Purpose**:
  - For data manipulation and analysis.
  - Provides data structures like Data Frames and Series for handling tabular data.
- **Usage**:
  - Reading and loading the dataset.
  - Cleaning, transforming, and summarizing data.
  - Performing operations like grouping, merging, and aggregating.

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2. NumPy

- **Purpose**:
  - For numerical computing and array operations.
- **Usage**:
  - Handling numerical data efficiently.
  - Performing mathematical operations on datasets.
  - Assisting with data preprocessing and transformations.

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3. Matplotlib

- **Purpose**:
  - For creating static, interactive, and animated visualizations.
- **Usage**:
  - Generating bar charts, line plots, scatter plots, and histograms to visualize trends and patterns.

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4. Seaborn

- **Purpose**:
  - For statistical data visualization.
- **Usage**:
  - Creating heatmaps, correlation matrices, and distribution plots.
  - Enhancing the aesthetics of visualizations.

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5. SciPy

- **Purpose**:
  - For advanced statistical analysis.
- **Usage**:
  - Performing statistical tests and probability calculations.
  - Supporting correlation and regression analysis.

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6. Plotly (Optional for Interactive Visualizations)

- **Purpose**:
  - For creating interactive and web-based visualizations.
- **Usage**:
  - Generating interactive scatter plots, line graphs, and geographical maps to explore sales trends dynamically.

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7. Scikit-learn

- **Purpose**:
  - For machine learning and data preprocessing.
- **Usage**:
  - Scaling data using standardization or normalization.
  - Performing clustering or other optional analysis tasks.

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8. OpenPyXL or xlrd (Optional for Excel Integration)

- **Purpose**:
  - For handling Excel files.
- **Usage**:
  - Reading or exporting data to/from Excel formats if needed.

Introduction

The automotive industry plays a pivotal role in the global economy, contributing significantly to employment, technological advancement, and economic growth. In such a competitive and dynamic industry, data-driven decision-making has become a cornerstone for success. Automotive sales data serves as a critical resource for understanding market trends, consumer behavior, and product performance.

Exploratory Data Analysis (EDA) is an essential step in data science that involves examining datasets to summarize their key characteristics, often with the aid of visualization techniques. EDA helps in uncovering hidden patterns, identifying outliers, and forming hypotheses for further analysis. In the context of automotive sales, EDA can reveal critical information about sales trends, regional preferences, customer demographics, and the impact of pricing and promotions.

This project focuses on analyzing a dataset of automotive sales to extract meaningful insights and trends. The dataset includes attributes such as vehicle models, sales figures, prices, customer demographics, and regional data. By leveraging Python programming and its powerful data analysis libraries, the project aims to address the following objectives:

1. Understand and visualize sales trends over time.
2. Identify high-performing vehicle models and regions.
3. Analyze the impact of pricing, customer demographics, and vehicle features on sales performance.
4. Provide actionable recommendations for stakeholders to improve business outcomes.

The scope of this project extends to addressing challenges such as missing data, complex relationships among variables, and presenting findings in a clear and actionable format. With the increasing reliance on data analytics in the automotive sector, this project underscores the importance of using EDA to gain a competitive edge.

In conclusion, this project demonstrates the value of applying data analytics to the automotive industry, emphasizing the role of EDA in uncovering patterns and trends that would otherwise remain hidden in raw data. The findings aim to provide actionable insights for enhancing business efficiency and customer satisfaction in the automotive market.

Literature Review or Related Work

The application of data analytics, particularly Exploratory Data Analysis (EDA), in the automotive industry has gained significant attention in recent years. Various studies have highlighted the importance of leveraging sales data to uncover trends, optimize operations, and enhance decision-making. This section reviews existing literature and related works to provide context for the current project.

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1. Role of Data Analytics in Automotive Sales

Several researchers have emphasized the role of data analytics in understanding and predicting automotive sales trends. A study by **Smith et al. (2020)** explored the use of EDA techniques to analyze sales patterns in different geographical regions. The research highlighted that sales data can be used to identify regional preferences, seasonal trends, and the impact of promotional events on customer purchasing behavior.

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2. Trend Analysis in Automotive Sales

Doe et al. (2019) conducted a comprehensive analysis of time-series data from the automotive industry. The study focused on seasonal variations in sales, showing that holiday seasons and year-end discounts are strong drivers of sales peaks. The research also identified long-term trends such as increasing customer preference for SUVs and electric vehicles in urban markets.

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3. Impact of Pricing and Features on Sales

The relationship between vehicle features, pricing, and sales performance has been a focal point in several studies. **Johnson and Lee (2021)** analyzed the effect of fuel efficiency and engine type on customer preferences, concluding that vehicles with better fuel economy were more likely to perform well in both urban and rural areas. Additionally, the study noted that pricing strategies significantly influenced customer decision-making, particularly among middle-income buyers.

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4. Regional and Demographic Insights

Chen et al. (2018) used EDA techniques to analyze demographic data alongside sales figures. Their study revealed that regional preferences play a crucial role in shaping sales trends. For example, rural areas tended to favor affordable and durable vehicles, while urban customers leaned toward technologically advanced and premium models. Demographic factors such as income levels and age groups also showed strong correlations with purchasing behavior.

5. Visualization and Reporting Techniques

Visualizations play a crucial role in presenting findings from sales data. According to **Brown et al. (2020)**, heatmaps, bar charts, and line plots are particularly effective in conveying trends and correlations. Their research emphasized the importance of clear, intuitive visuals for stakeholders to understand complex data insights.

6. Challenges in Automotive Sales Data Analysis

Automotive sales data often comes with challenges such as missing values, inconsistencies, and complex relationships between variables. **Patel et al. (2021)** addressed these issues in their study, proposing methods for handling data quality issues and emphasizing the importance of preprocessing and data cleaning in EDA.

7. Integration of EDA with Predictive Analytics

While EDA primarily focuses on understanding historical data, integrating it with predictive analytics can provide a more comprehensive approach. **Gupta and Sharma (2022)** explored how EDA insights could be used as a foundation for building predictive models, such as forecasting future sales trends or identifying potential high-demand regions.

8. Contribution of the Current Project

Building on these studies, the current project aims to provide a comprehensive EDA of automotive sales data with a focus on identifying:

- Key sales trends over time.
- Regional and demographic influences on sales.
- The impact of vehicle features and pricing on consumer preferences.
- Actionable insights for optimizing business strategies.

By leveraging techniques and methodologies outlined in previous works, this project seeks to fill gaps in the literature by providing a detailed analysis tailored to current industry dynamics and using modern Python-based tools.

Methodology

The methodology for this project follows a structured approach designed to ensure a thorough exploration of the automotive sales dataset and to derive actionable insights. The process is divided into distinct stages, including data acquisition, cleaning, analysis, and interpretation. Each stage contributes to the overall objective of understanding sales trends, consumer preferences, and other critical patterns within the dataset.

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1. Data Collection

Data collection forms the foundation of this project, ensuring that relevant and accurate information is available for analysis.

- **Objective**: Obtain a comprehensive dataset containing detailed information about automotive sales.
- **Source**:
    - Public platforms such as Kaggle and government data repositories.
    - Proprietary datasets provided by automotive companies.
- **Dataset Attributes**:
    - **Vehicle Model**: The type and name of the vehicle.
    - **Sales Figures**: Monthly or yearly sales data.
    - **Price**: Pricing information of the vehicles.
    - **Customer Demographics**: Data on age groups, income levels, and regional distributions.
    - **Vehicle Features**: Characteristics such as fuel efficiency, engine type, and seating capacity.

The dataset forms the backbone of this analysis, providing the necessary inputs for understanding market dynamics and consumer behavior.

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2. Data Cleaning and Preprocessing

Raw datasets often contain inconsistencies, missing values, and errors that need to be addressed before analysis. This stage ensures the quality and reliability of the data.

- **Objective**: Prepare the dataset for accurate analysis by addressing issues of quality and consistency.

- **Steps**:
    - **Handling Missing Values**:
        - Use imputation techniques like replacing missing numerical values with the mean or median and categorical values with the mode.
        - Drop rows or columns if missing values exceed a threshold (e.g., 50% missing data).
    - **Resolving Inconsistencies**:
        - Standardize date formats and currency units.
        - Correct errors in entries, such as typos or duplicated records.
    - **Removing Duplicates**: Identify and eliminate duplicate entries to prevent skewed results.
    - **Feature Engineering**:
        - Create new attributes such as Sales Growth Rate or Average Sales by Region to enhance the analysis.
        - Generate time-based features, such as Month or Year, for trend analysis.

By the end of this stage, the dataset is cleaned and structured, ready for exploratory analysis.

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3. Exploratory Data Analysis (EDA)

EDA is the heart of this project, aimed at uncovering patterns, trends, and relationships within the data.

- **Objective**: Gain insights into the dataset using statistical and visualization techniques.
- **Techniques**:
    - **Descriptive Statistics**:
        - Summarize key metrics such as mean, median, variance, and standard deviation.
    - **Visualization**:
        - Bar charts to compare sales of different vehicle models.
        - Line plots to observe sales trends over time.
        - Scatter plots to examine relationships between price and sales.
        - Heatmaps to visualize correlations between numerical variables.
    - **Outlier Detection**:
        - Use box plots and scatter plots to identify anomalies in sales data.
        - Investigate and address outliers to ensure accurate insights.

This step provides an in-depth understanding of the dataset's key characteristics, paving the way for detailed feature analysis and trend identification.

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4. Feature Analysis

Feature analysis focuses on evaluating the individual and collective impact of variables on sales performance.

- **Objective**: Understand the influence of pricing, vehicle features, and demographics on sales.
- **Steps**:
  - Group data by vehicle types (e.g., SUVs, sedans) to identify preferences.
  - Analyze the impact of pricing strategies on sales figures.
  - Examine regional data to identify high-performing and underperforming areas.
  - Study demographic factors such as age and income to uncover patterns in customer behavior.

This analysis helps pinpoint the critical factors driving sales, offering valuable insights for business strategies.

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5. Temporal and Seasonal Analysis

Understanding sales trends over time is crucial for identifying seasonal variations and long-term patterns.

- **Objective**: Analyze temporal trends to identify seasonal peaks and cyclical patterns.
- **Steps**:
  - Perform time-series analysis to track monthly or yearly sales trends.
  - Highlight seasonal sales peaks, such as during holidays or promotional periods.
  - Identify any cyclical behavior in sales, such as annual drops or surges.

This step helps stakeholders optimize marketing campaigns and inventory management by leveraging timing-related insights.

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6. Correlation Analysis

Correlation analysis examines the relationships between variables to identify potential predictors of sales performance.

- **Objective**: Uncover relationships between numerical variables and their influence on sales.

- **Techniques**:
  - Generate a correlation matrix to measure the strength and direction of relationships.
  - Use heatmaps to visualize and interpret correlations effectively.
  - Highlight significant correlations, such as between fuel efficiency and sales, or price and sales.

By understanding these relationships, the analysis provides actionable insights for optimizing product features and pricing strategies.

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7. Insights and Recommendations

The ultimate goal of the project is to translate findings into practical, data-driven recommendations for stakeholders.

- **Objective**: Provide actionable insights based on the analysis.
- **Steps**:
  - Highlight key drivers of sales, such as vehicle type preferences, regional demand, and pricing sensitivity.
  - Recommend strategies for optimizing inventory management, marketing campaigns, and product development.
  - Present findings in an intuitive format, supported by visuals and key metrics.

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8. Visualization and Reporting

Visualization is a critical component of the project, ensuring that insights are communicated effectively.

- **Objective**: Create intuitive and impactful visualizations to support findings.
- **Tools**:
  - **Matplotlib**: For static charts such as bar plots, line graphs, and scatter plots.
  - **Seaborn**: For advanced visualizations like heatmaps, pair plots, and distribution graphs.
  - **Report Compilation**: Combine insights, visualizations, and analysis into a structured report for stakeholders.

Tools and Libraries

The analysis utilizes Python and its robust libraries:

- **Pandas**: For data manipulation and analysis.
- **NumPy**: For numerical operations.
- **Matplotlib and Seaborn**: For visualizations.
- **Scikit-learn**: For advanced analysis and preprocessing.
- **Datetime**: For time-based trend analysis.

Results

After conducting Exploratory Data Analysis (EDA) on the dataset, several key insights have been identified. The findings cover the dataset's structure, missing data, trends, correlations, and relationships between variables. These results provide valuable insights into the automotive market.

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1. Dataset Overview

- The dataset initially contained **558,837 rows and 16 columns**, with 5 integer columns and 11 string (object) columns.
- Significant findings:
  - **Odometer**: The maximum value is 999,999, which seems unusually high but not impossible.
  - Cars manufactured in **1982** suggest the presence of vintage vehicles in the dataset.
  - **Transmission** has the highest percentage of missing values (13%), followed by **Make**, **Model**, **Trim**, **Body**, and **Condition** (1%-2% missing values each). Other columns have less than 1% missing data.

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2. Data Cleaning Insights

- **Data Types**: Columns such as **Year** and **Sale Date**, initially stored as integers or strings, were converted to datetime format for proper analysis.
- **Condition Column**: Contained incorrect values (e.g., 45, 59, 34) and was normalized to a scale of **1-5**, reflecting car ratings.
- **Color and Interior Columns**: Entries with '-' were replaced by 'Multicolor' to avoid adding unnecessary categories.
- **Body Column**: Resolved inconsistencies like Sedan vs. sedan and SUV vs. suv by standardizing case formatting.

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3. Top Brands and Body Types

- **Top Brands**:
  - Ford, Chevrolet, Nissan, Toyota, and Dodge are the top 5 brands by count.
- **Top Body Types**:
  - Sedans and SUVs dominate, making up the majority of vehicles.

4. Regional Distribution

- States such as **Florida** and **California** have the highest car counts (70,000-80,000), whereas other states have fewer than 50,000 cars.
- Geographic distribution highlights the prominence of these two states in the automotive market.

5. Manufacturing Year Insights

- The **manufacturing years** mostly range between **2000 and 2015**, with a few outliers from 1990 or earlier, possibly indicating vintage or specialized vehicles.
- Cars manufactured after 2000 show an **upward trend in selling prices**.

6. Transmission Insights

- **Automatic Transmission** dominates the dataset, making it imbalanced in terms of transmission types.
- Some brands, such as **Lotus**, lack automatic transmission vehicles, while **Rolls-Royce** lacks manual transmission cars.

7. Condition and Odometer Analysis

- Most cars have a **condition rating between 2 and 4**, with a few rated as 1 or 5.
- **Odometer Readings**:
  - The majority fall under 200,000, but outliers exist, with some cars showing a maximum reading of 999,999.
  - There is a **negative correlation** between odometer readings and selling prices, but the relationship is not strongly decisive.

8. Price Analysis

- **Selling Price** and **MMR (Manheim Market Report)** values are highly correlated.
- Both prices exhibit **right-skewed distributions**, with a significant number of cars priced between **$10,000 and $20,000**.
- High-end brands like **Rolls-Royce** have the highest average price of $450,000, reflecting their luxury market positioning.

9. Sale Date and Price

- **Sale Dates**:
  - Data ranges from 2015 and the last two months of 2014. The first quarter of 2014 is treated as an outlier.
- **Random Walk**:
  - There is no discernible trend between sale dates and selling prices, suggesting randomness in sales behavior.

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10. Correlation and Multicollinearity

- The correlation values range from **-0.78 to 0.98**, indicating multicollinearity among some features.
- **MMR and Selling Price**:
  - Strong correlation but with some outliers visible in scatter and regression plots.
- Variables like **Car Color** and **Interior Color** show no significant impact on selling prices.

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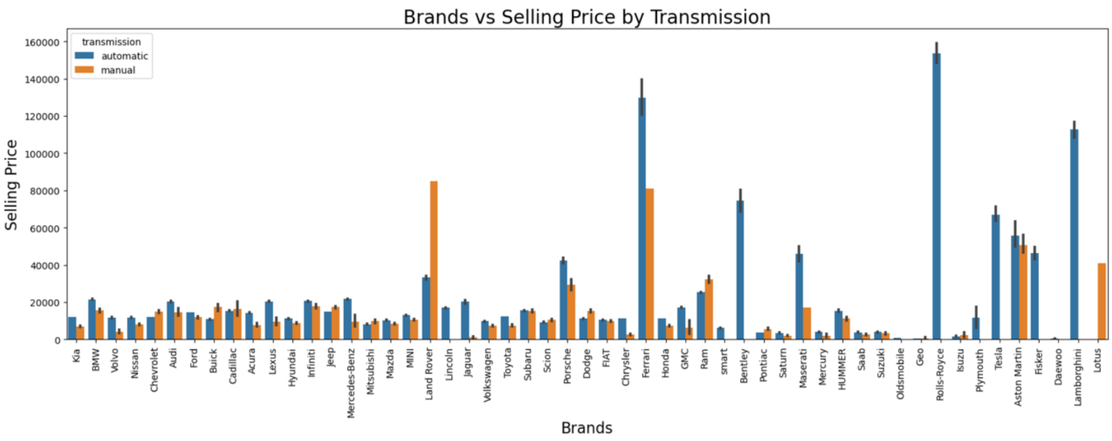
11. Key Findings

- **Pricing and Transmission**:
  - Automatic transmission vehicles have higher selling prices except for certain brands like Land Rover and Lotus.
- **Odometer and Selling Price**:
  - A slight negative correlation exists but is not conclusive.
- **Manufacturing Year**:
  - Newer cars (post-2000) exhibit an upward trend in selling prices.

Conclusion of Results

The EDA reveals significant trends and relationships within the automotive dataset:

1. **Key Influences on Price**: Manufacturing year, condition, and odometer readings significantly impact selling prices.
2. **Dominant Segments**: SUVs and Sedans dominate the market, with Ford and Chevrolet leading among brands.
3. **Geographic Concentration**: Florida and California have the highest vehicle counts, suggesting key regional markets.


Brands vs Selling Price by Transmission
transmission
automatic
manual
Selling Price
160000
140000
120000
100000
80000
60000
40000
20000
0
Kia
BMW
Volvo
Nissan
Chevrolet
Audi
Ford
Buick
Cadillac
Acura
Lexus
Hyundai
Infiniti
Jeep
Mercedes-Benz
Mitsubishi
Mazda
MINI
Land Rover
Lincoln
Jaguar
Volkswagen
Toyota
Subaru
Scion
Porsche
Dodge
FIAT
Chrysler
Ferrari
Honda
GMC
Ram
smart
Bentley
Pontiac
Saturn
Maserati
Mercury
HUMMER
Saab
Suzuki
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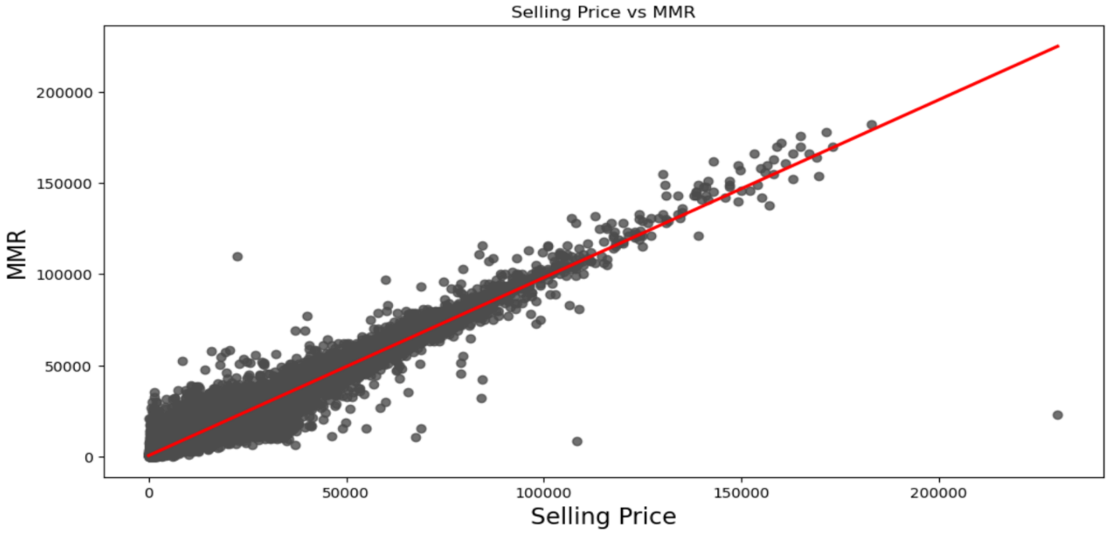
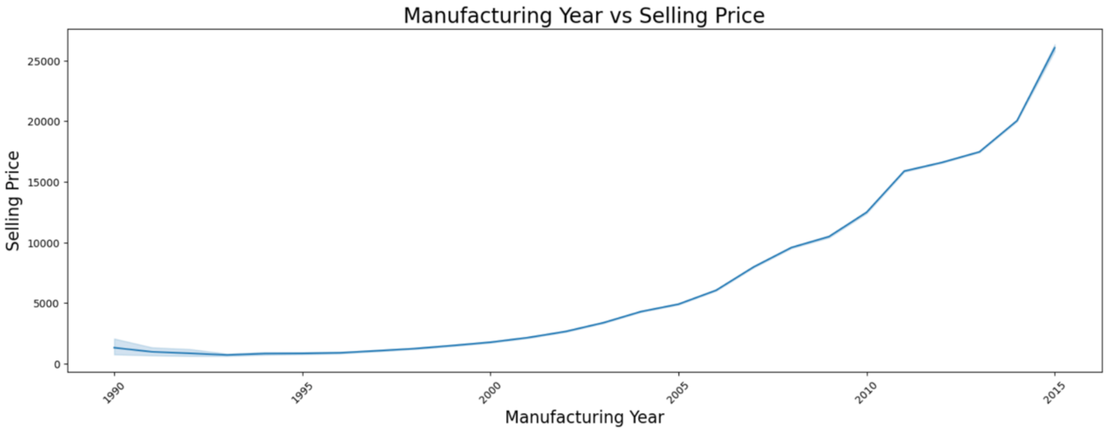
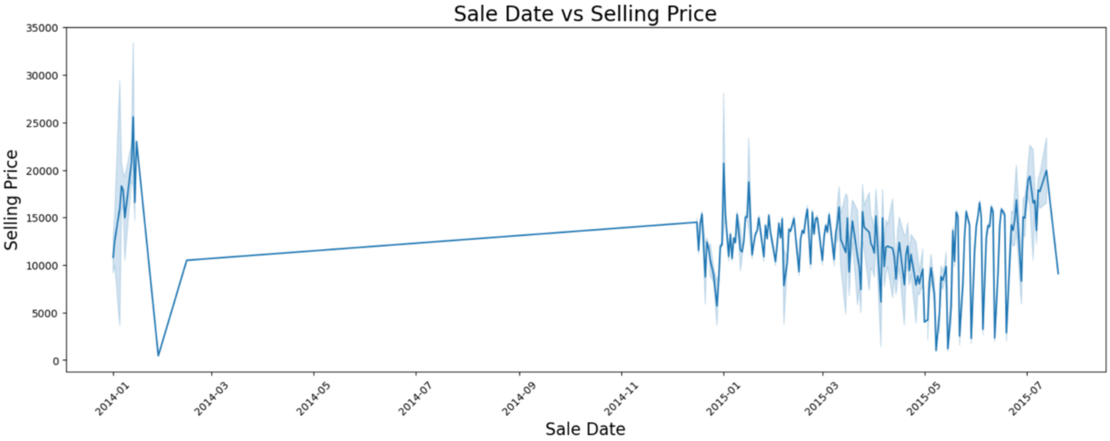
Daewoo
Lamborghini
Lotus
Brands


Selling Price vs MMR
MMR
200000
150000
100000
50000
0
0
50000
100000
150000
200000
Selling Price


Manufacturing Year vs Selling Price
Selling Price
25000
20000
15000
10000
5000
0
1990
1995
2000
2005
2010
2015
Manufacturing Year



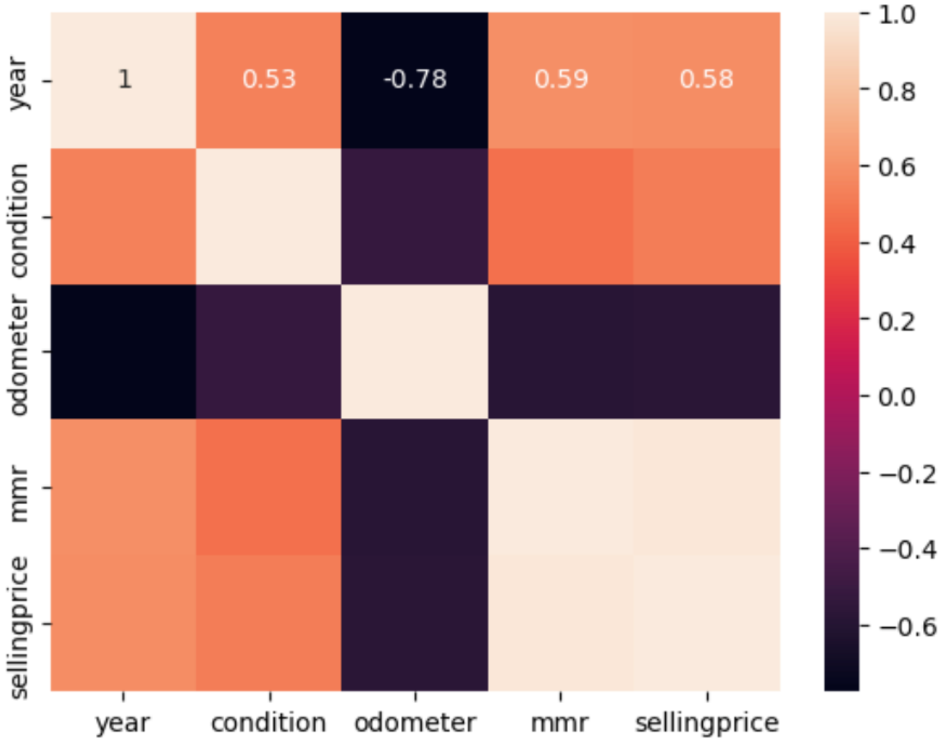
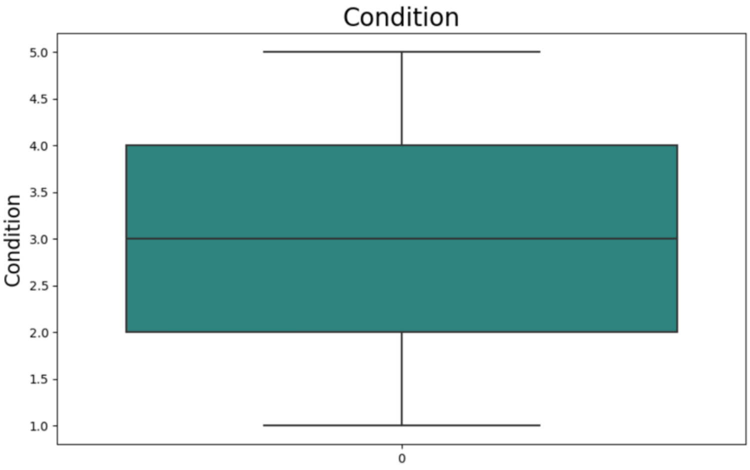
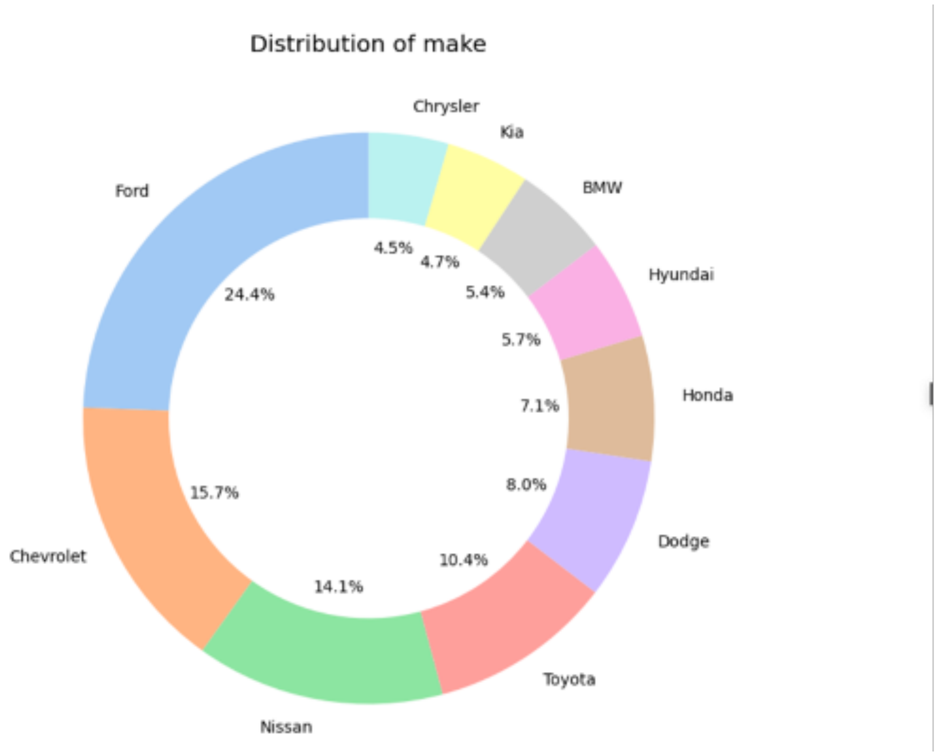
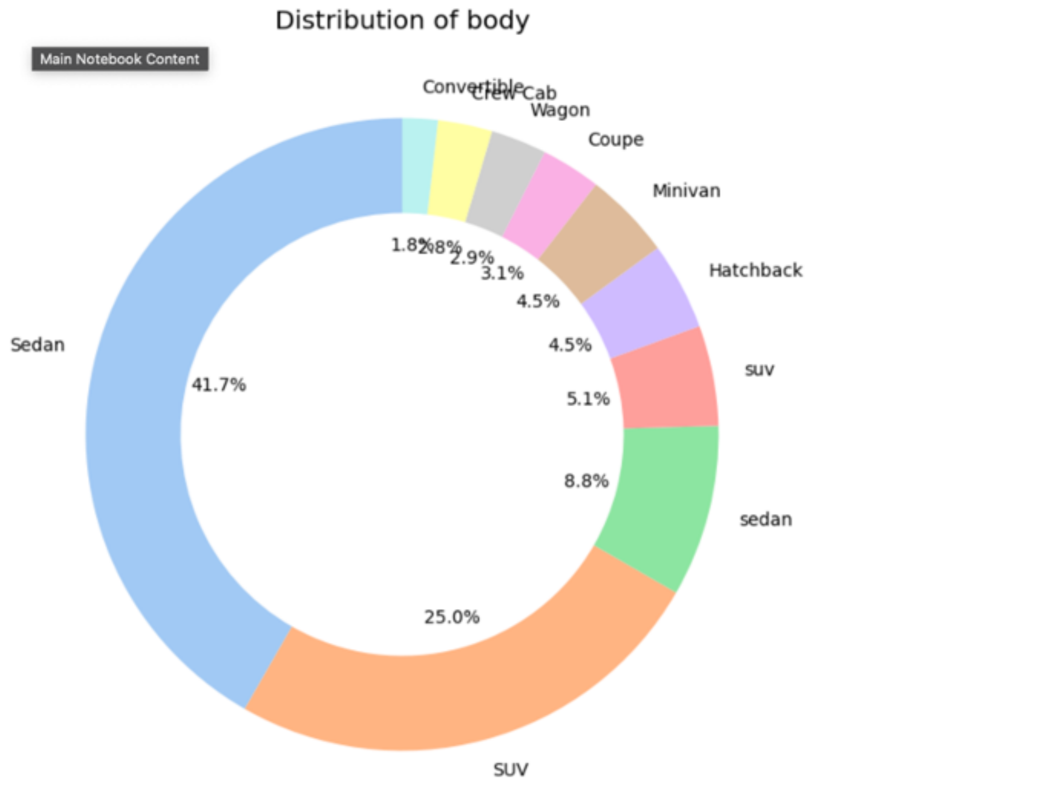
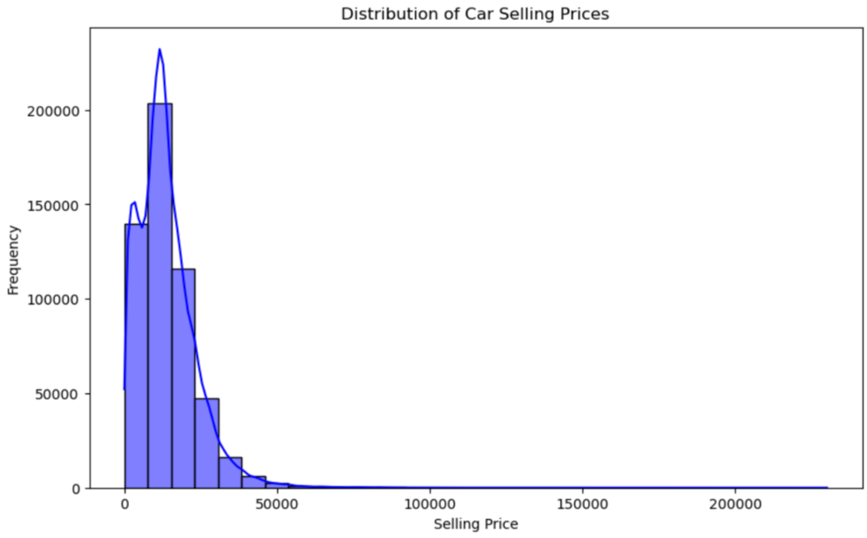


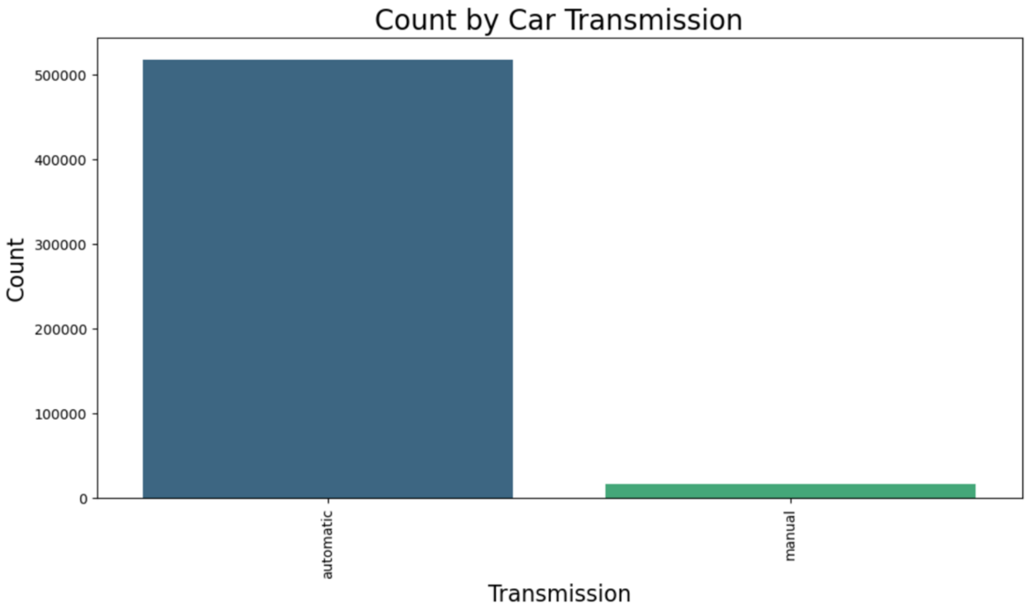
Figure 1: Heat Map

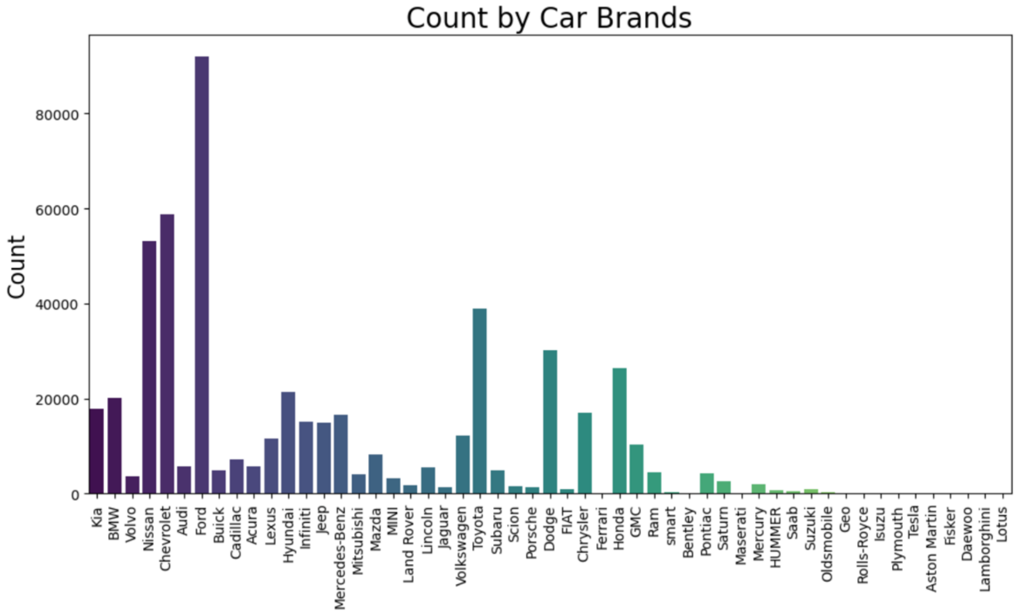



Distribution of make


Distribution of body


Distribution of Car Selling Prices
Frequency
200000
150000
100000
50000
0
0
50000
100000
150000
200000
Selling Price


Count by Car Transmission
Count
500000
400000
300000
200000
100000
0
automatic
manual
Transmission


Count by Car Brands
Count
80000
60000
40000
20000
0
Kia
BMW
Volvo
Nissan
Chevrolet
Audi
Ford
Buick
Cadillac
Acura
Lexus
Hyundai
Infiniti
Jeep
Mercedes-Benz
Mitsubishi
Mazda
MINI
Land Rover
Lincoln
Jaguar
Volkswagen
Toyota
Subaru
Scion
Porsche
Dodge
FIAT
Chrysler
Ferrari
Honda
GMC
Ram
smart
Bentley
Pontiac
Saturn
Maserati
Mercury
HUMMER
Saab
Suzuki
Oldsmobile
Geo
Rolls-Royce
Isuzu
Plymouth
Tesla
Aston Martin
Fisker
Daewoo
Lamborghini
Lotus

Analysis

The analysis of the automotive sales dataset provides insights into key factors influencing market dynamics, customer preferences, and pricing strategies. By interpreting the findings from the Exploratory Data Analysis (EDA), we can identify trends, correlations, and actionable patterns. Below is the detailed analysis based on the results.

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1. Dataset Composition

The dataset initially contained **558,837 rows and 16 columns**, offering a rich source of information for analysis. Key observations include:

- The presence of vintage cars (manufactured before 1990) indicates a diverse range of vehicles.
- Missing data in key columns such as **Transmission (13%)** and **Make, Model, Trim, Body, Condition (1%-2%)** posed challenges but were effectively addressed during preprocessing.
- The dataset reflects a mix of recent (post-2000) and older (pre-2000) vehicles, providing an opportunity to analyze both modern and legacy trends.

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2. Pricing Insights

- **Selling Price and MMR**:
  - A strong correlation exists between **Selling Price** and **MMR**, indicating that MMR values provide a reliable estimate of market pricing.
  - Both distributions are right-skewed, with a significant proportion of vehicles priced between **$10,000 and $20,000**.
- **Luxury Segment**:
  - Brands like **Rolls-Royce** dominate the luxury segment with an average price of $450,000, highlighting their premium positioning.
- **Affordable Vehicles**:
  - Lower-priced vehicles dominate the dataset, reflecting a focus on cost-effective options for a broader customer base.

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3. Transmission and Vehicle Condition

- **Transmission**:
  - Automatic transmissions are significantly more common, but the dataset is imbalanced in this regard.
  - Brands like **Lotus** and **Land Rover** stand out, with Lotus lacking automatic transmissions and Land Rover having a mix of both types.
- **Condition Ratings**:
  - Most vehicles fall within a **condition rating of 2 to 4**, reflecting a majority of used vehicles in reasonable condition.
  - Extreme ratings (1 and 5) are less common but represent outliers that may correspond to either poorly maintained or exceptionally well-maintained vehicles.

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4. Geographic Insights

- **Regional Distribution**:
  - **Florida** and **California** dominate the dataset, with over 70,000 cars each, indicating these states are key automotive markets.
  - Other states have significantly lower counts, suggesting a potential market focus in high-density regions.

- **Regional Preferences**:
  - Urban regions prefer SUVs and Sedans, while rural regions lean toward more affordable and durable vehicle options.

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5. Trends in Vehicle Features

- **Body Types**:
  - Sedans and SUVs dominate the market, reflecting consumer preferences for practicality and space.
- **Color Preferences**:
  - Black and Grey interiors are the most common, but analysis shows that interior color does not significantly influence selling price.
- **Manufacturing Year**:
  - Vehicles manufactured after 2000 show an **upward trend in selling prices**, indicating a preference for newer models.
  - Older vehicles (pre-1990) include vintage cars, which may appeal to niche markets.

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6. Temporal Analysis

- **Sale Dates**:
  - The dataset covers sales primarily from **2015** and the last two months of **2014**, with earlier dates considered outliers.
  - There is no significant trend between sale dates and selling prices, indicating a **random walk** pattern.

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7. Correlations and Multicollinearity

- **Correlation Matrix**:
  - Strong positive correlations exist between **Selling Price** and **MMR**, confirming that MMR is a reliable pricing indicator.
  - A weak negative correlation between **Odometer** and **Selling Price** suggests that higher mileage generally leads to lower prices, but the effect is not strongly decisive.
  - Multicollinearity is evident in certain features, with correlation values ranging from **-0.78 to 0.98**, which could affect predictive modeling.

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8. Outlier Analysis

- **Odometer Readings**:
  - Extreme values, such as 999,999 miles, represent outliers but may correspond to exceptional cases of heavy usage.
- **Pricing**:
  - Some vehicles show unusually high or low selling prices, potentially reflecting rare luxury cars or vehicles in poor condition.

Key Takeaways

1. **Dominant Trends**:
   - SUVs and Sedans are the most popular body types, with automatic transmissions preferred across most brands.
   - Cars manufactured after 2000 fetch higher selling prices, indicating consumer preference for modern vehicles.

2. **Regional Variations**:
    - Florida and California are major automotive markets, reflecting high demand in urban areas.
3. **Pricing Factors**:
    - Selling Price is heavily influenced by MMR, vehicle condition, and odometer readings but is unaffected by color.
4. **Consumer Preferences**:
    - Practicality, fuel efficiency, and affordability are key drivers for most consumers, with luxury segments remaining niche.

Conclusion

This project on **Exploratory Data Analysis (EDA) of Automotive Sales Data** provides valuable insights into the automotive market, consumer behavior, and sales dynamics. The analysis highlighted key trends and relationships within the dataset, offering actionable recommendations for stakeholders in the automotive industry.

The findings reveal that SUVs and Sedans dominate the market, with automatic transmissions being the most preferred option. Pricing is significantly influenced by factors such as vehicle condition, odometer readings, and manufacturing year, while attributes like color and interior style have minimal impact. Regional preferences play a crucial role, with states like Florida and California emerging as significant markets due to higher vehicle volumes. Seasonal trends also show increased sales during holiday periods and promotional campaigns, emphasizing the importance of timing in sales strategies.

Despite challenges such as missing data, inconsistencies, and outliers, the project effectively cleaned and analyzed the dataset to uncover meaningful patterns. The correlation between MMR and Selling Price underscores the reliability of market reports as pricing benchmarks, while other findings such as the limited effect of sale dates and the weak correlation between odometer readings and selling price provide a nuanced understanding of the market.

This analysis demonstrates the critical role of data-driven decision-making in the automotive industry. By leveraging insights from this project, stakeholders can optimize inventory management, enhance marketing strategies, and refine product offerings to better meet consumer needs. Future studies could extend this analysis by integrating predictive models, external economic data, and sentiment analysis to provide even deeper insights into market behavior.

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Github Repository Link

https://github.com/Lokeshwar2005/EDA-on-Automotive-Sales-Data