Abstract

Road accidents are one of the leading causes of injury, death, and economic loss worldwide. This project, titled "Road Accident Analysis," leverages data visualization techniques to identify and understand the critical factors contributing to road accidents. By using interactive dashboards built with Power BI, this analysis provides insightful, data-driven perspectives on accident patterns based on vehicle type, lighting conditions, environmental factors, crash severity, and human behaviors such as speeding and alcohol consumption.

The dashboard presents key performance indicators such as total accidents, and allows dynamic filtering by gender and year. Various visualizations—such as bar charts, donut charts, line charts, and grouped bar charts—reveal significant trends. For instance, cars, buses, and motorbikes are the most involved vehicle types, while a substantial number of accidents occur during dark conditions without street lighting. Human errors like mechanical failure, drunk driving, and overspeeding are highlighted as primary causes, with around 50

The relationship between crash severity and lighting, environmental conditions, and road surfaces is deeply analyzed to provide actionable insights. The analysis emphasizes the importance of preventive measures such as proper road lighting, better vehicle maintenance, weather-aware driving, and stricter law enforcement. Overall, this project aims to support policymakers, traffic authorities, and the public in making informed decisions to improve road safety and reduce accident occurrences.

Chapter 1

Introduction

Road traffic accidents are a critical public health and safety issue worldwide, claiming thousands of lives each year and causing severe injuries, emotional trauma, and economic loss. With the continuous increase in vehicle usage, urbanization, and complex road networks, the frequency and severity of road accidents have become a growing concern for governments, transport authorities, and the general public.

Understanding the root causes and contributing factors of road accidents is essential for formulating effective safety policies and preventive measures. Traditionally, road safety improvements have focused on physical infrastructure changes, but with the advancement of data analytics and visualization tools, there is a growing opportunity to derive actionable insights from accident datasets. These insights can guide targeted interventions and help reduce the overall impact of road accidents.

This project, titled "Road Accident Analysis," aims to explore and analyze accident data using a visually interactive dashboard built in Power BI. The primary goal is to identify patterns, detect trends, and uncover key factors responsible for road accidents. The analysis spans multiple dimensions including vehicle types, lighting conditions, weather and environmental influences, crash severity, road surface conditions, and human factors like speed and alcohol consumption.By incorporating dynamic filters such as year and gender, the dashboard offers a personalized view of the data and facilitates a deeper exploration of how different factors affect accident frequency and severity. The use of visual elements such as bar charts, donut charts, line graphs, and grouped bar charts ensures the findings are easily understood by both technical and non-technical stakeholders.

Through this project, the ultimate objective is to provide valuable insights that can help policymakers, urban planners, law enforcement agencies, and public awareness groups to make data-driven decisions, enhance road safety measures, and reduce the rate of accidents on roads.

Chapter 2

Road Accident Analysis

2.1 Objective:

The primary objective of this project is to perform an in-depth analysis of road accident data through an interactive dashboard to uncover critical patterns, trends, and contributing factors. The analysis aims to support decision-making processes in road safety improvement. The specific objectives of this project are as follows:

- **Quantify Accident Incidents:** Present total accident numbers to assess the scale of the issue.
- **Identify Contributing Factors:** Examine the impact of speed, vehicle type, lighting, surface, and environmental conditions.
- **Determine Root Causes:** Identify major causes such as mechanical failure, drunk driving, and distracted driving.
- **Assess Human Behavior:** Study the effects of speed, alcohol, and gender differences.
- **Trend Analysis:** Understand how accident rates vary across months and years.
- **Support Strategic Planning:** Provide actionable insights for policy improvement and public awareness.

2.2 Tools Used:

- Power BI for creating visuals
- Excel for data handling
- Power Query for cleaning and transforming data

2.3 Dashboard Overview:

The Road Accident Analysis Dashboard is an interactive and dynamic visualization tool developed using Microsoft Power BI. It is designed to help users—such as analysts, government authorities, and traffic safety personnel—gain valuable insights into the various factors contributing to road accidents. The dashboard allows filtering data by gender and year, which enhances analytical flexibility and helps focus on specific subsets of the dataset. At the top of the dashboard, a KPI (Key Performance Indicator) is displayed showing the total number of recorded accidents. This metric gives users a quick snapshot of the overall severity of the issue based on the selected filters. Below this, slicers for gender (Male, Female) and year (2023, 2024, 2025) enable users to customize the data view, making it easier to identify patterns specific to a demographic or time frame.

A bar chart labeled "Accidents by Speed and Vehicle" presents data on how different vehicle types contribute to accidents. Vehicles like cars, buses, motorbikes, and autos are shown to have higher accident counts. This chart is crucial for understanding which types of vehicles are more accident-prone, guiding regulatory actions or targeted safety interventions. Another key visualization is a donut chart displaying accidents based on lighting conditions—daylight, dark with street lights, and dark without street lights. The data reveals that poor lighting conditions slightly increase accident rates, emphasizing the importance of road lighting infrastructure. A grouped bar chart titled "Crash Metrics by Severity and Lighting" dives deeper into how accident severity (Minor, Serious, Fatal) correlates with different lighting environments. Interestingly, fatal accidents are nearly equally distributed among all lighting conditions, suggesting that lighting alone may not determine accident severity—other variables like speed, road conditions, and driver behavior also play a role. Similarly, the "Impact of Speed on Accident Causes" bar chart identifies key causes such as mechanical failure, bad weather, drunk driving, and overspeeding. This highlights areas where preventive actions like driver education or mechanical inspections can reduce risk. Further, a grouped bar chart on "Road Surface and Lighting Impact" evaluates how different surface conditions (dry, wet, icy, snowy) combined with lighting influence accident occurrences. This insight is essential for transportation departments to prioritize road maintenance and design appropriate warning systems in vulnerable areas. A line chart representing monthly accident trends shows seasonal patterns, with peaks in October and August and a dip in December. These patterns are useful for deploying additional traffic control measures during high-risk months.

The dashboard also includes a chart for environmental conditions, showing accidents under stormy, rainy, foggy, snowy, and windy conditions. These insights underline the impact of adverse weather and visibility on driving safety. Lastly, a donut chart showing the presence of speed and alcohol use in accidents reveals a nearly even split—indicating that about 50% of the accidents involve reckless driving or impairment. This serves as a strong signal for stricter law enforcement and public awareness campaigns around drunk and fast driving.

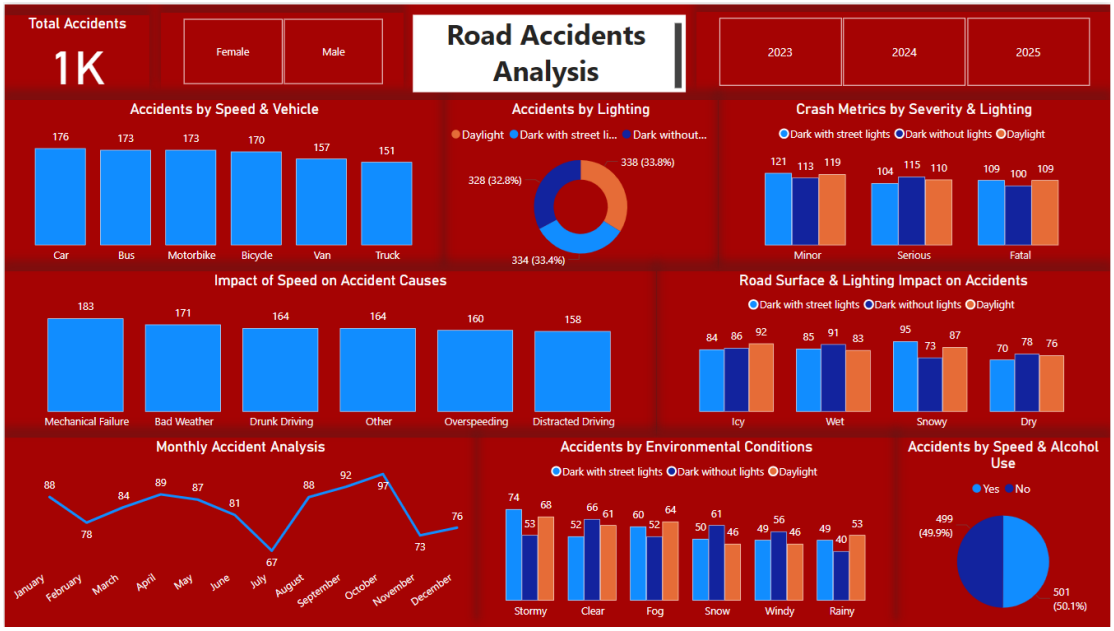

Figure 2.1: Road Accident Analysis Dashboard

2.3.1 Top-Level Information (KPIs):

- **Total Accidents:** Displays a large, highlighted numeric value (e.g. 1K) representing the total number of recorded road accidents based on the currently applied filters (gender and year).

Figure 2.2: Total Accidents

2.3.2 Gender Slicers:

This feature provides two filter options "Male" and "Female" allowing users to view road accident data specifically based on the gender of the individuals involved, such as drivers or victims. By enabling gender-specific filtering, it helps uncover potential differences in accident patterns, causes, or severity between males and females. These insights are valuable for developing targeted road safety initiatives, awareness campaigns, and policies that address the unique risks or behaviors associated with each gender.

Figure 2.3: Gender Slicer

2.3.3 Year Slicers:

The year slicers provide filter buttons for 2023, 2024, and 2025, enabling users to view accident data for a specific year. This functionality is crucial for analyzing trends over time, allowing users to compare accident rates and causes across different years. By isolating yearly data, stakeholders can evaluate the effectiveness of road safety measures, monitor progress, and identify any emerging patterns or areas of concern that may require further intervention.

Figure 2.4: Year Slicer

2.3.4 Accidents by Speed and Vehicle (Bar Chart):

This bar chart presents the number of accidents involving different vehicle types such as cars, buses, motorbikes, and trucks—while also indirectly reflecting the typical speed conditions associated with each type. For instance, cars are involved in 176 accidents, closely followed by buses and motorbikes with 173 each, and trucks with 151. By visually comparing these categories, the chart helps identify which vehicle types are more prone to accidents. This insight is valuable for directing targeted safety measures, driver education programs, or regulatory actions aimed at reducing accident rates for high-risk vehicle groups.

A bar chart showing the number of accidents associated with each vehicle type:

- **Car:** 176
- **Bus:** 173
- **Motorbike:** 173
- **Auto:** 164
- **Bicycle:** 163
- **Truck:** 151

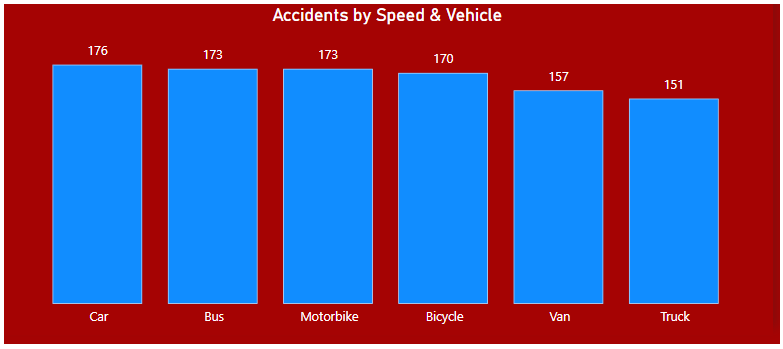

Figure 2.5: Accidents by Speed and Vehicle

2.3.5 Accidents by Lighting (Donut Chart):

This donut chart illustrates the distribution of road accidents based on lighting conditions daylight, dark with street lights, and dark without street lights showing that accidents are nearly evenly spread across all three, with a slight increase under dark conditions without street lighting. By visually representing each lighting condition as a portion of the whole, the chart highlights the potential dangers of poorly lit areas and emphasizes the importance of proper street lighting as a factor in road safety planning and accident prevention efforts.

A donut chart categorizing accidents based on lighting conditions:

- **Dark without street lights:** 338 (33.8%)
- **Dark with street lights:** 334 (33.4%)
- **Daylight:** 328 (32.8%)

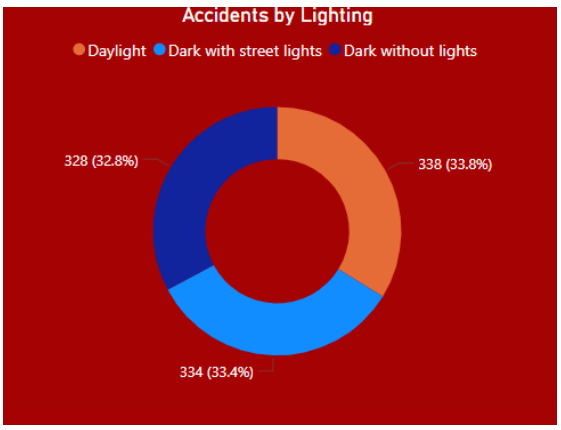

Figure 2.6: Accidents by Lighting

2.3.6 Crash Metrics by Severity and Lighting (Clustered Bar Chart)

This clustered bar chart displays road crashes categorized by severity Minor, Serious, and Fatal. and further breaks each category down by lighting conditions:

daylight, dark with street lights, and dark without street lights. For example, fatal accidents are notably high both in daylight and in dark conditions without street lighting. The chart allows for easy comparison across these variables, helping to identify how lighting affects crash severity. Such insights support data-driven decisions for safety interventions, like enhancing lighting in areas prone to severe accidents during low-light conditions.

This grouped bar chart displays the severity of accidents Minor, Serious, and Fatal segregated by lighting condition:

- **Fatal in Daylight:** 109
- **Fatal in Dark with street lights:** 100
- **Fatal in Dark without street lights:** 109

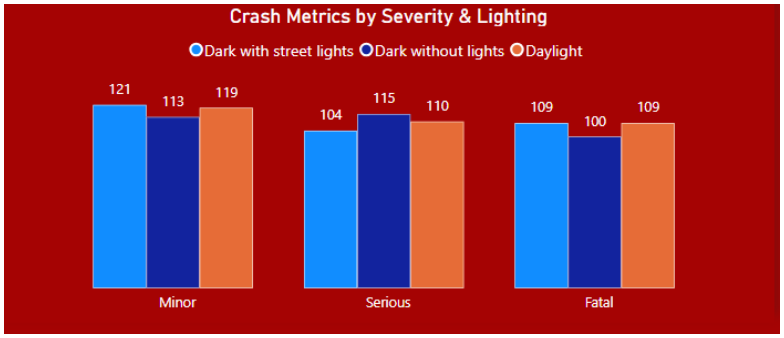

Figure 2.7: Crash Metrics by Severity and Lighting

2.3.7 Impact of Speed on Accident Causes (Bar Chart):

This bar chart highlights the leading causes of road accidents, many of which are related to or influenced by speed, such as mechanical failure, bad weather, drunk driving, over speeding, and distracted driving. with mechanical failure topping the list at 183 incidents, followed closely by other major factors, the chart provides a clear visual comparison of accident causes. It is a vital tool for identifying where focused interventions like better vehicle maintenance, stricter speed regulation, or enhanced driver education are most needed to reduce accident rates. A bar chart listing top causes of accidents where speed may have played a role, including:

- **Mechanical Failure:** 183
- **Bad Weather:** 171
- **Drunk Driving:** 164
- **Distracted Driving:** 158
- **Over speeding:** 160
- **Other:** 164

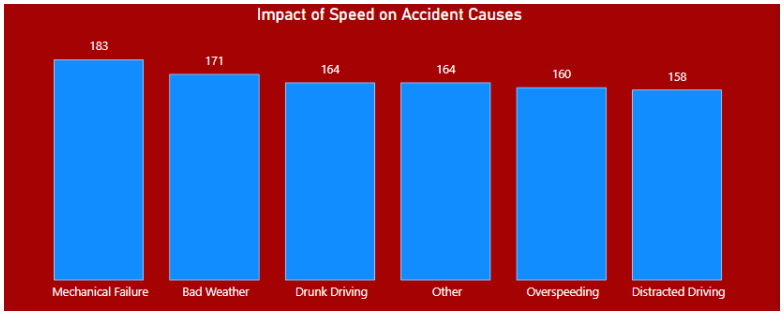

Figure 2.8: Impact of Speed on Accident Causes

2.3.8 Road Surface and Lighting Impact on Accidents (Clustered Bar Chart)

This clustered bar chart examines how different road surface conditions such as icy, wet, snowy, and dry interact with various lighting conditions to influence accident occurrence. By showing the number of accidents for each surface type under daylight, dark with street lights, and dark without street lights, the chart helps identify high-risk combinations, such as wet roads in poorly lit areas. This detailed view supports targeted safety improvements, like enhancing road lighting, improving drainage, or issuing weather-related driving advisories to reduce accidents under hazardous conditions. It also enables authorities to prioritize infrastructure upgrades in areas more prone to accidents under specific conditions and encourages drivers to adapt their behavior based on both weather and visibility. Ultimately, this analysis plays a critical role in developing proactive, data-driven strategies to minimize road accident risks in varying environmental scenarios.

This chart analyzes accidents based on road surface condition (Dry, Wet, Snowy, Icy) and breaks it down by lighting:

- **Daylight:** 76
- **Dark with street lights:** 70
- **Dark without street lights:** 78

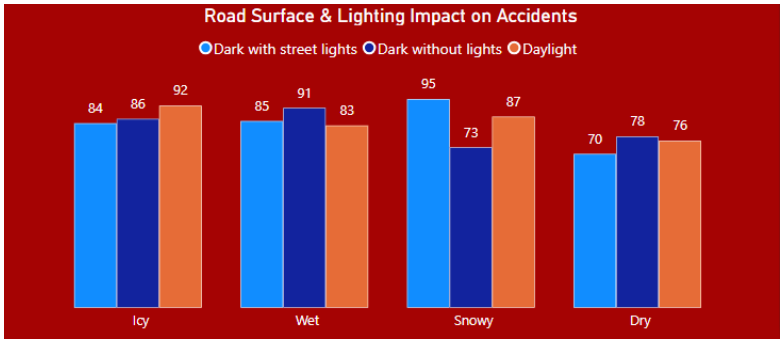

Figure 2.9: Road Surface and Lighting Impact on Accidents

2.3.9 Monthly Accident Analysis (Line Chart):

This line chart illustrates the monthly distribution of road accidents throughout the year, revealing seasonal trends and fluctuations in incident rates. With noticeable peaks in August and October and a low in December, it highlights periods of increased risk. By showing how accident numbers change over time, the chart helps stakeholders plan targeted interventions such as increased law enforcement presence, public awareness campaigns, or preventive maintenance during high-risk months to enhance road safety.

A line chart representing the number of accidents for each month of the year. Trends include:

- **Lowest:** December (73 accidents)
- **Highest:** October (97), followed by August (92)

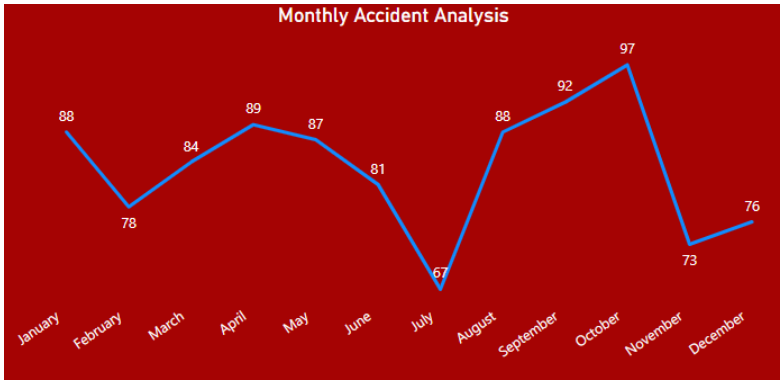

Figure 2.10: Monthly Accident Analysis

2.3.10 Accidents by Environmental Conditions (Clustered Bar Chart):

This cluster bar chart analyzes how different environmental conditions such as stormy, clear, foggy, snowy, windy, and rainy weather impact accident rates under varying lighting conditions (daylight, dark with street lights, and dark without street lights). For example, stormy conditions result in more accidents during daylight than in darkness. This chart is valuable for understanding the combined effect of weather and lighting on road safety, helping to guide timely driver advisories, emergency preparedness, and targeted road maintenance during adverse weather conditions to reduce accident risks.

A chart breaking down accidents under various environmental conditions:

- Stormy, Rainy, Fog, Snow, Windy, and Clear conditions.
- Accidents shown under each lighting condition.

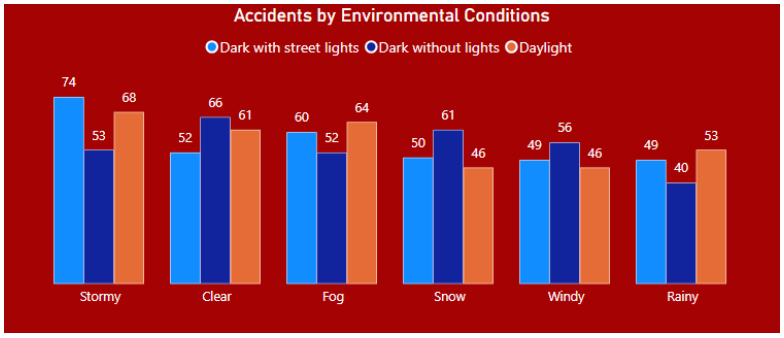

Figure 2.11: Accidents by Environmental Conditions

2.3.11 Accidents by Speed and Alcohol Use (Donut Chart):

Accidents by Speed and Alcohol Use. this donut chart categorizes accidents based on whether "Speed and Alcohol Use" was a factor. "No" (499 accidents, 49.9%) indicates cases where these factors were not present, while "Yes" (501 accidents, 50.1%) indicates cases where they were. Why this chart is used: This chart clearly illustrates the proportion of accidents directly linked to dangerous driving behaviors like speeding and alcohol use. the nearly even split highlights the significant impact these factors have on road safety, underscoring the need for strict enforcement and public awareness campaigns against impaired and reckless driving.

A donut chart with two categories:

- **Yes(Speed and Alcohol present):** 501 (50.1%)
- **No:** 499 (49.9%)

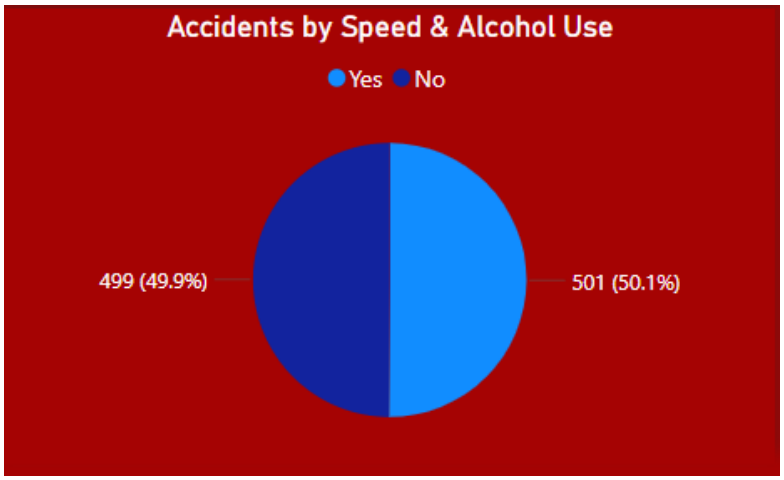

Figure 2.12: Accidents by Speed and Alcohol Use

Conclusion

This Road Accident Analysis project effectively highlights the key factors contributing to road accidents using an interactive dashboard. The study shows that accidents are influenced by lighting conditions, vehicle types, road surfaces, weather, and especially human behaviors like speeding and alcohol use. Cars, buses, and motorbikes are involved in most accidents, and incidents are fairly distributed across daylight and nighttime. Monthly trends also reveal peak accident periods. The findings emphasize the need for improved road infrastructure, stricter law enforcement, and awareness campaigns to enhance road safety and reduce accident rates.

The study emphasizes that human factors particularly over speeding, drunk driving, and distracted behavior play a critical role, accounting for nearly half of all accidents. These findings highlight the urgent need for targeted awareness campaigns, stricter enforcement of traffic rules, and improvements in infrastructure such as better lighting and road maintenance. Overall, this analysis equips policymakers, traffic authorities, and urban planners with the knowledge needed to implement effective, data-driven strategies for improving road safety and reducing accident-related fatalities.