Road Safety Awareness: Australian Road Crash Case Study

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Abstract.

Road transportation accidents are a significant public health and safety issue worldwide. In Australia, regarding transport-related deaths, the age-standardized rate was higher in one specific year compared to the preceding year. This study aims to make visualization of crash data in Australia play a crucial role in understanding the country's current state of road safety and developing strategies to improve it. Data visualization techniques are essential in understanding and addressing road safety in Australia. New South Wales has the highest number of accidents in Australia, with 16,293 cases. Accidents in New South Wales are projected to decline gradually over the next three years. The peak time for accidents is 3 PM on weekdays, with males being more involved than females. Drivers are the most involved road users in accidents. Implementing targeted road safety initiatives, gender-specific awareness campaigns, and driver safety programs can help reduce accidents in New South Wales and create a safer environment for all road users. By analyzing accident data visually, patterns and trends can be identified, leading to targeted interventions and improved safety measures to reduce the number of accidents and fatalities on the roads.

Keywords: *Road transportation accidents, data visualization techniques, New South Wales, road safety initiatives and road safety awareness.*

I. INTRODUCTION

Road safety awareness refers to the knowledge, understanding, and consciousness of potential hazards and safe practices while using the roads [1]. It involves educating and informing individuals about the risks associated with road travel and promoting responsible behavior to prevent accidents and injuries. Road safety awareness aims to increase public awareness of road safety rules, regulations, and best practices, ultimately reducing road accidents and fatalities.Road safety awareness is essential due to its multifaceted benefits for individuals, communities, and society [2]. It plays a crucial role in preventing road accidents and injuries. By educating people about potential road hazards and safe practices, individuals become more cautious and alert while using the roads, reducing the likelihood of accidents. This proactive approach to safety helps save lives and minimizes the number and severity of injuries resulting from road incidents.Neglecting road safety awareness leads to a lot of problems, such as increased accidents, fatalities, healthcare strain, economic losses, reduced community trust, a hindrance to sustainable development, risky driving habits, escalated distracted driving incidents, traffic congestion, and high social costs [3], [4]. That is why prioritizing road safety awareness is crucial for safer roads and overall well-being.Road transportation accidents are a significant public health and safety issue worldwide. In Australia, Between 2017-18 and 2021-22, the age-standardized rate of hospitalizations caused by transport injuries experienced a consistent annual decrease of 1.2%. In contrast, from 2011-12 to 2016-17, there was an average yearly increase of 1.0% in such hospitalizations. Regarding transport-related deaths, the age-standardized rate for 2020-21 was 2.0% higher than the preceding year [5].It is essential to understand the factors contributing to road accidents and develop evidence-based policies and interventions to improve road safety to address this issue. Data visualization refers to using graphical representations to present complex data in a way that is easy to understand [6].

Visualizing data, complex datasets, and trends can be shown in a more understandable and insightful format, allowing for better comprehension and decision-making. Besides, data visualization can also be used to monitor performance [7]. Visualizing crash data makes it easier to identify patterns, monitor performance, and trends in road safety, such as the types of vehicles involved in accidents, the locations where accidents occur, and the factors contributing to them.Previous studies have high lighted the importance of utilizing visualization techniques to accentuate factors pertinent to road safety awareness. By visually representing data and insights, these studies have demonstrated the power of visual communication in conveying complex information and highlighting crucial elements that impact road safety. State recognition emerges as a critical factor in these studies when it comes to enhancing road safety [8]. Acknowledging different states' specific conditions and challenges can enable targeted interventions and policies to address their unique road safety needs. This recognition is instrumental in tailoring safety initiatives to suit local contexts and ensuring maximum effectiveness. Moreover, the frequency of crashes is identified as a central consideration in assessing road safety [9]. Understanding the frequency and patterns of accidents can shed light on high-risk areas and times, guiding the allocation of resources and interventions to mitigate potential hazards. By focusing on crash frequency, stakeholders can prioritize accident-prone locations and implement preventive measures accordingly.Additionally, these studies delve into various factors that influence road safety outcomes.

The time of accidents holds significance as it reveals when specific periods might witness higher accident rates [10], allowing for targeted enforcement and awareness campaigns during those times. The day of the week is crucial in understanding traffic patterns and potential risk factors associated with specific days, providing valuable insights for road safety planning [11]. Gender-based analysis is also explored about road safety, emphasizing how different genders may be affected differently by accidents. Understanding gender-specific risk factors enables policymakers to design targeted programs that address the unique safety concerns of various road users [12]. Furthermore, the type of road users is considered when analyzing road safety. Different road types pose distinct challenges and risks, and comprehending these variations can aid in developing road safety measures tailored to specific road environments [13].Tableau is a widespread tool for data visualization [14]. In alternative research, the merits of Tableau are elucidated, culminating in the deduction that A meaningful and visually appealing map can be created in Tableau by incorporating State/Province information and utilizing Tableau's internal mapping tools [15]. Through this approach, data can be represented geographically, enabling valuable insights to be gained from the map visualization. This study aims to make visualization of crash data in Australia play a crucial role in understanding the country's current state of road safety and developing strategies to improve it. Using Tableau data visualization makes it easier to identify patterns and trends in road accidents, which can be used to target interventions and improve safety measures to reduce the number of accidents and fatalities on Australian roads.

II. METHODS

This study employed the DCOVA & I research framework, which comprises the Define, Collect, Organize, Visualize, Analyze, and Insights stages.

2.1 Define Stage

Visualizing crash data in Australia plays a crucial role in understanding the country's current state of road safety and developing strategies to improve it. Using data visualization techniques makes it easier to identify patterns and trends in road accidents, which can be used to target interventions and improve safety measures to reduce the number of accidents and fatalities on Australian roads. Some research questions can be focused as followings:

Q1: Which state has the highest number of accidents in Australia?

Q2: What are the number of accidents in the future in the state?

Q3: What time does the state have the most significant accidents?

Q4: Which day of the week has the highest number of accidents, and which gender is most involved in these accidents in the state?

Q5: Which type of road user is the most involved in accidents, and how many accidents occurred for each gender in New South Wales?

2.2 Collect Stage

Data is obtained from the website https://www.kaggle.com/datasets/deepcontractor/australian-fatal-car-accident-data-19892021, where this data collection refers to the process of gathering information about fatal car accidents in Australia from 1989 to 2021. This dataset contains data on car accidents resulting in death in Australia during that period. This document outlines the data collection methods for visualization in

Tableau using Kaggle, a popular platform for finding and sharing datasets. By leveraging Kaggle, users can access a wide range of high-quality datasets to create meaningful visualizations in Tableau. The following data collection methods explain how to identify, select, and download Kaggle's datasets for visualization. Observed variables refer to those observed or measured in the dataset of fatal car accidents in Australia. These variables provide information about various aspects of the accidents and can be used for analysis and related research. The dataset may include several observed variables commonly associated with fatal car accidents, as shown in Table 1.

Table 1. Australian Fatal Car Accident Data Description

Variable Name	Description
Crash ID	ID code indicates the accident's date, which helps analyze time-related patterns.
State	Location of the accident.
Month	Month in which the accident occurred.
Year	Year of the accident.
Dayweek	Names of the days (e.g., Monday, Tuesday, etc.).
Time	Time of the accident.
Crash Type	Type of crash, whether it is single or multiple.
Speed Limit	Speed limit involved in the accident.
Road User	vehicles or individuals involved in the accident.
Gender	Gender of those involved in the accident (Male/Female).
Age	Age of those involved in the accident.
National Remoteness Areas	Area of accidents
Day of week	Indicates if the accident happened during the Weekday or weekend.
Time of day	The time of the accident.

2.3 Organize Stage

Analyze the imported dataset within Tableau to identify any data quality issues, missing values, or inconsistencies. Then, utilize Tableau's data preparation tools, such as data blending, joining, filtering, and calculations, to clean and transform the dataset for our visualization requirements. Afterward, it involves selecting and organizing the dataset based on specific criteria. They may have chosen particular subsets of data, such as fatal car accidents with specific characteristics, or included only certain variables deemed necessary to analyze car accidents.

2.4 Visual Stage

With the dataset prepared, start creating visualizations in Tableau using the available data fields and variables. It applies appropriate formatting, labeling, and color schemes to enhance the visual impact and clarity of the visualizations. It utilizes Tableau's interactive features to enable user interactivity and drill-down capabilities.

2.5 Analyse Stage

In the "organize" Stage, four types of analysis are performed using Tableau to gain insights from the data:

a. **Descriptive Analysis**: This methodology involves summarizing and describing the data to understand its characteristics better. Tableau provides various techniques for descriptive analysis, such as aggregating data, calculating summary statistics, and creating charts and graphs. Visualizations are used to explore patterns and trends effectively.
b. **Predictive Analysis**: Tableau supports predictive analysis, where historical data is used to make forecasts about future outcomes. Built-in statistical functions and predictive models can be applied, and trend lines or forecasting models can be used to analyze data and generate predictions.
c. **Exploratory Data Analysis (EDA)**: EDA is a methodology used to explore and understand data before formal analysis. Tableau facilitates this process through interactive visualizations, drag-and-drop functionality, and dynamic filters. Patterns can be identified by visualizing data from different angles, and hypotheses can be generated for further analysis.
d. **Spatial Analysis**: Tableau's spatial analysis capabilities enable examining data based on geographic locations by creating geographical maps. This feature allows for insightful geographical data visualization and analysis.

2.6 Insight Stage

During the Insight stage of data analysis, two fundamental activities take place to derive meaningful conclusions from the data:

a. **Interpret Findings**: In this first activity, analysts thoroughly examine the results of their data analysis efforts. They delve into the outcomes of descriptive, predictive, and exploratory analyses to comprehensively understand the data. By scrutinizing the data for patterns, trends, correlations, and anomalies, analysts strive to uncover valuable insights and hidden relationships within the data. This process involves carefully examining visualizations, statistical summaries, and any relevant metrics produced during the earlier stages of data processing.

b. **Identify Key Insights**: Analysts identify the most critical and relevant findings based on interpreting the data analysis results. These key insights serve as the heart of the analysis, addressing the research questions or business objectives that initiated the data analysis project. Analysts carefully select insights that are actionable and valuable for decision-making processes. These insights are not only relevant but also aligned with the strategic goals of the organization. By focusing on the most pertinent information, decision-makers can make well-informed choices and take actions likely to drive positive outcomes.

III. RESULTS AND ANALYSIS

3.1 Which state has the highest number of accidents in Australia?

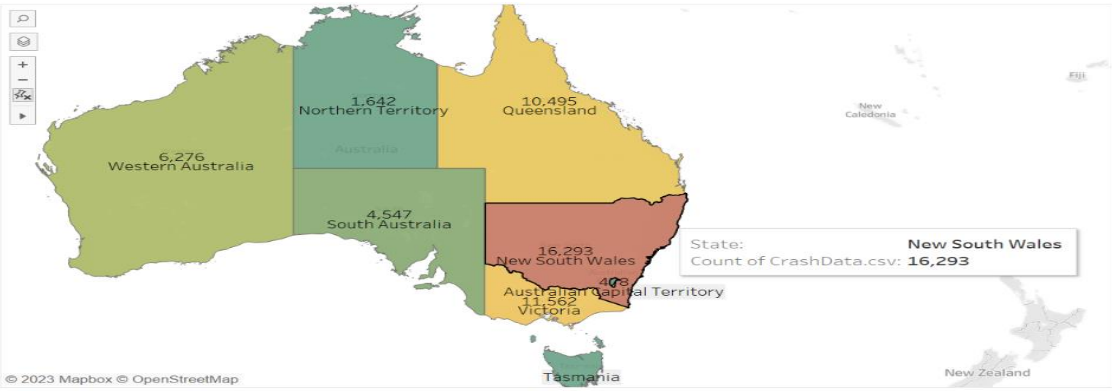

Fig 1. Number of Accidents across States in Australia

As shown in Fig. 1, the states in the data are visualized as parts of Australia. A map of Australia consisting of 8: "Northern Territory," "Western Australia," "South Australia," "Queensland," "New South Wales," "Australian Capital Territory," "Victoria," and "Tasmania." Each state is assigned a different color and accompanied by text labels indicating the state's name along with the number of accident occurrences. Based on the data above, the highest number of accidents is 16,293 in the form of New South Wales. Then, in second place is Victoria, with 11,562 accidents, followed by Queensland, with 10,495 accidents. Western Australia has 6,276 accidents, South Australia with 4,547 accidents, the Northern Territory with 1,642 points, and Tasmania with 1,550 accidents. Finally, the smallest state with the smallest number of accidents is the Australian Capital Territory, with only 478 cases of accidents. There are 16,293 crash cases in New South Wales, the state with the highest crash data count.

3.2 What are the number of accidents in the future in the state?

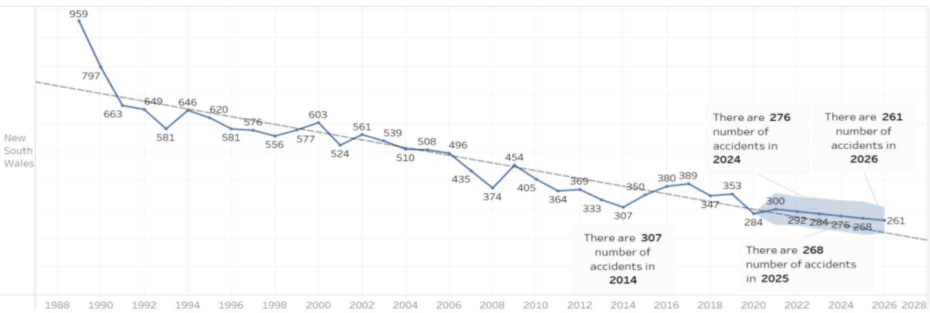

Fig 2. Prediction of Accidents across States in Australia from 2024 to 2026

As shown in Fig 2, there are forecasts for 276 accidents in 2024, 268 accidents in 2025, and 261 accidents in 2026 in New South Wales. The trend for the number of accidents in New South Wales shows a gradual decline over the forecasted years. The number of casualties is projected to decrease from 276 in 2024 to 268 in 2025 and 261 in 2026. This downward trend suggests a potential improvement in road safety measures or a decline in accident-prone conditions during the forecasted period.

3.3 What time does the state have the most significant accidents?

In Fig. 3, the time of the accident is investigated, which can be seen in the line visualization here where the trend line goes up to the right, meaning that the further the line is located, the higher the time in hours. According to the visualization above, the morning (Day) is represented by a blue line. Based on this, I can conclude that the highest number of accident occurrences can be seen at the peak point, which is at 15 or 3 PM, with a total of 1,119 accidents.

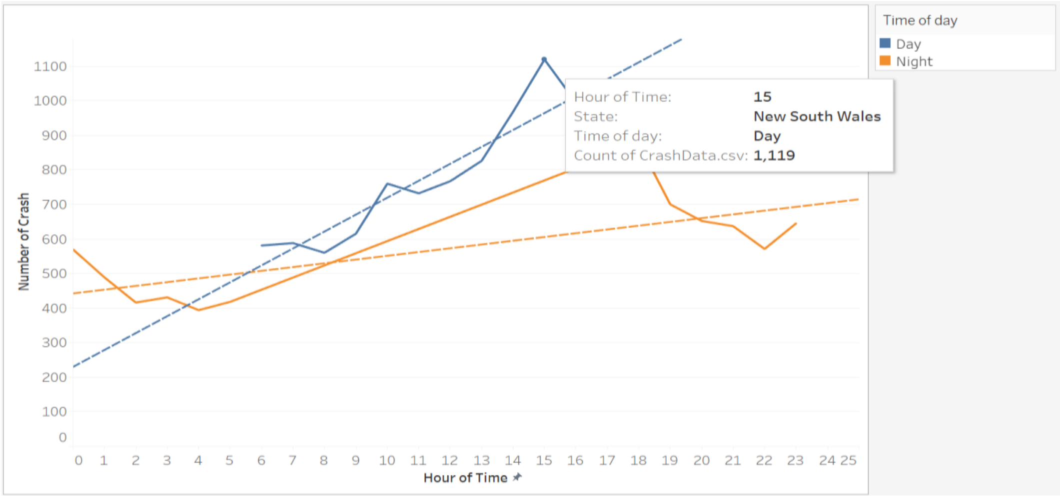

Fig 3. Time of accident

3.4 Which day of the week has the highest number of accidents, and which gender is most involved in these accidents in the state?

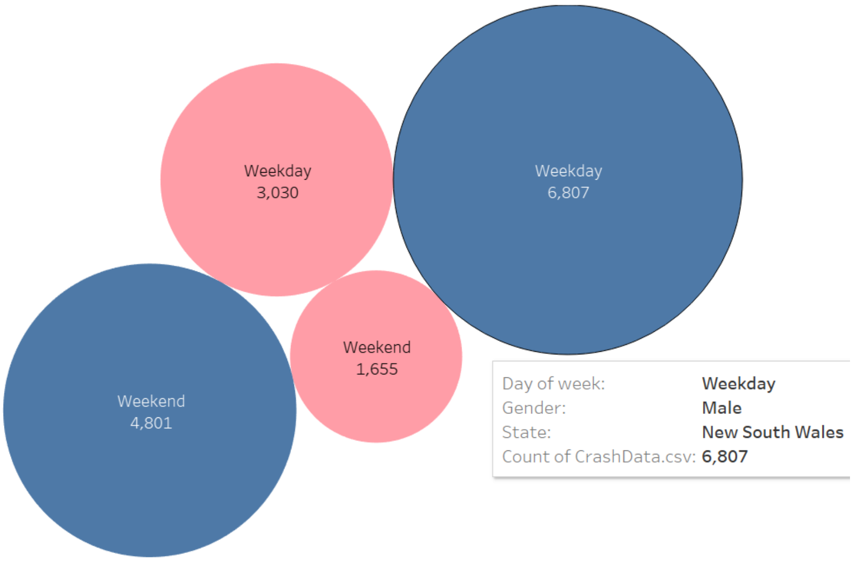

Fig 4. Day of the Week of the Accidents and Gender Involved in New South Wales

The bubble plot in Fig. 4 represents gender, where the plot in blue symbolizes males, and the plot in pink indicates Females because blue is traditionally associated with males. In contrast, pink is usually associated with females. It was found that Weekday has the highest number of accidents, accounting for approximately 6,807 of all reported accidents. In terms of gender involvement, the plot revealed that males are more involved in accidents compared to females, representing around 65% of the total accidents reported across all days of the week.

3.5 Which type of road user is the most involved in accidents, and how many accidents occurred for each gender in New South Wales?

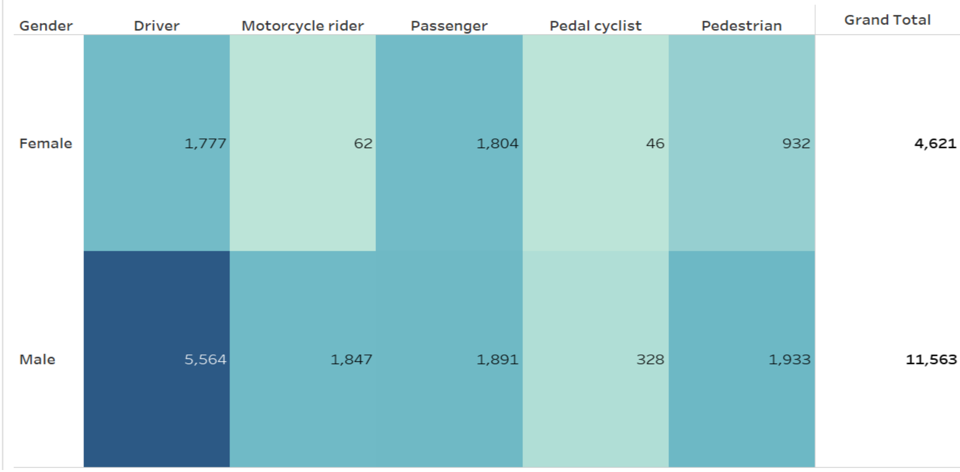

Fig 5. Type of Road User in Accidents in New South

According to Fig. 5, the driver is the most involved type of road user in accidents. From that visualization, the road user with the female gender in the driver position had 1,777 accidents, the motorcycle rider position had 62, the passenger position had 1,804, and the pedal cyclist position had 932. On the other hand, road users of the male gender had 5,564 accidents in the driver position, 1,847 accidents in the motorcycle rider position, 1,891 accidents in the passenger position, 328 accidents in the pedal cyclist position, and 1,933 accidents in the pedestrian position. Regarding gender distribution, out of the total accidents in New South Wales, there were 4,621 accidents involving male drivers and 11,583 accidents involving female drivers. These numbers suggest that males were involved in more accidents than females in New South Wales.

IV. CONCLUSION

In conclusion, New South Wales has the highest number of accidents in Australia, with 16,293 crash cases, followed by Victoria with 11,562 and Queensland with 10,495. The other states have lower numbers, ranging from 6,276 to 478. Accidents in New South Wales are projected to decline gradually over the next three years. The forecasts of 276 accidents in 2024, 268 in 2025, and 261 in 2026 indicate potential improvements in road safety measures or a reduction in accident-prone conditions during this period. According to the line visualization, the highest number of accidents occurs at 3 PM, with 1,119 accidents. Weekdays have the highest number of accidents, with approximately 6,807 incidents. Males are more involved, comprising about 65% of all reported daily accidents. The most involved road user in accidents is the driver. Among female road users, there were 1,777 accidents in the driver position, 62 accidents as motorcycle riders, 1,804 accidents as passengers, and 932 accidents as pedal cyclists. For male road users, there were 5,564 accidents by drivers, 1,847 by motorcycle riders, 1,891 by passengers, 328 by pedal cyclists, and 1,933 by pedestrians.

Overall, New South Wales had 4,621 accidents involving male drivers and 11,583 accidents involving female drivers, indicating more accidents for males than females.Based on the findings, it is suggested to implement targeted road safety initiatives in New South Wales to reduce the highest number of accidents in Australia. Focusing on accident prevention strategies during peak times like 3 PM on weekdays can be effective. Gender-specific awareness campaigns could address the higher involvement of males in accidents. Introducing driver safety programs and enhancing data visualization tools for informed decision-making is vital. Utilizing forecasted accident data can inform policy decisions, and regular evaluation of road safety measures is essential for continuous improvement. These measures can enhance road safety, leading to fewer accidents and a safer environment for all road users.

The limitations of this study include its focus on a specific region (New South Wales) and time, making generalization to other areas challenging. Using historical data and forecasts may introduce uncertainties, and visualization simplification might overlook some details. The study does not investigate the underlying causes of accidents, and external factors such as weather and infrastructure are not fully considered. Therefore, caution is needed in interpreting the findings, and further research is required for a comprehensive understanding of road safety dynamics. For future studies, it is recommended to expand the geographical scope to include multiple states or regions, conduct long-term analyses to identify trends, and investigate the underlying causes of accidents. Comparative analysis with other countries, real-time data integration, and a multivariate approach can provide a comprehensive understanding.

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