HANOI UNIVERSITY OF SCIENCE AND TECHNOLOGY

Project Report

Road Traffic Accidents Analysis

Course : IT4023E - Data Visualization

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I. SCENARIO

Road traffic accidents constitute a significant global public health crisis, resulting in an estimated 1.35 million fatalities and 50 million injuries annually. The burden of these accidents disproportionately affects low- and middle-income countries, where rapid urbanization, inadequate infrastructure, and limited road safety measures contribute to elevated risk levels. Ethiopia, as a rapidly developing nation, is not immune to this challenge, with road traffic accidents being a leading cause of death and disability.

Within Ethiopia, Addis Ababa, the nation's capital and largest city, faces a particularly acute situation. The city's population has grown exponentially in recent years, placing immense strain on its transportation infrastructure. This rapid growth, coupled with a surge in vehicle ownership and inadequate road safety provisions, has led to a concerning increase in road traffic accidents within the city.

a. Specifics

To effectively address the issue of road traffic accidents in Addis Ababa, it is crucial to gain a comprehensive understanding of their underlying causes, contributing factors, and prevalent patterns. Data-driven insights are essential for formulating targeted interventions and policies that can mitigate the risks and consequences of these accidents.

In this context, the Addis Ababa Sub-City police departments have meticulously maintained records of road traffic accidents from 2017 to 2020. This dataset serves as an invaluable resource, providing a wealth of information on various aspects of accidents, including driver demographics, vehicle characteristics, environmental conditions, and accident outcomes.

The primary objective of this project is to leverage this dataset to create an interactive data visualization dashboard. This dashboard will empower stakeholders, including policymakers, law enforcement agencies, urban planners, and researchers, with actionable insights into the dynamics of road traffic accidents in Addis Ababa. By presenting data in a visually compelling and accessible manner, the dashboard will facilitate informed decision-making, ultimately contributing to the development of evidence-based strategies to enhance road safety within the city.

b. Related scenario

Several cities and countries have leveraged data visualization to understand and address road traffic accidents. Here are a few noteworthy examples:

- New York City's Vision Zero: This initiative aims to eliminate traffic fatalities and severe injuries through data-driven strategies and targeted interventions. Their interactive dashboard provides comprehensive insights into crash data, helping policymakers and the public identify high-risk areas and trends.
- Transport for London's Safety Data: This platform offers detailed statistics on road casualties and collisions in London. It allows users to explore data by various factors, such as time, location, and vehicle type, facilitating a deeper understanding of accident patterns.

- iRAP's ViDA (International Road Assessment Programme's Visual Dashboard for Analysis): This global tool enables the assessment of road infrastructure safety performance, identifying high-risk roads and prioritizing safety improvements. It leverages data visualization to communicate complex safety information effectively.
- These examples underscore the power of data visualization in transforming raw data into actionable insights. By adapting and building upon these successful approaches, the Addis Ababa road traffic accident dashboard aims to provide a similarly valuable resource for stakeholders in Ethiopia.

II. DATASET

For each section, specific data transformations must be performed. We then leave the guide of transformation for the corresponding sections below.

The dataset employed in this analysis was sourced from the meticulously maintained records of the Addis Ababa Sub-City police departments. These records encompass a comprehensive account of reported road traffic accidents within Addis Ababa over a four-year period, spanning from 2017 to 2020. The data collection process involved the transcription of detailed incident information from physical accident reports into a structured digital format. While this approach facilitated the capture of granular accident details, it is important to acknowledge the potential for human error and inconsistencies introduced during this manual transcription process. The details about the dataset refer to: https://www.kaggle.com/datasets/saurabhshahane/road-traffic-accidents.

The raw dataset, initially designated as "RTA Dataset.csv," comprises 32 distinct features, each meticulously capturing a specific facet of the recorded accidents. These features encompass a wide spectrum of information, including:

- Temporal Information: Precise time and day of the week of each accident occurrence.
- Driver Demographics: Comprehensive data on driver age, gender, educational attainment, driving experience, and their relationship to the vehicle involved.
- Vehicle Information: Detailed categorization of vehicle type, ownership status, service year, and the presence of any mechanical defects.
- Accident Circumstances: Thorough documentation of accident location (area, lanes/medians, road alignment, junction type), road surface type and prevailing condition, ambient light and weather conditions at the time of the incident, nature of the collision, and the number of vehicles involved.
- Casualty Information: A meticulous account of the number of casualties, their demographic profiles (age, gender, work status, fitness level), severity of sustained injuries, and classification as pedestrian, driver, or passenger.
- Accident Outcome: Determination of the primary cause of the accident and an assessment of the overall accident severity.

To ensure the highest degree of data quality and suitability for rigorous analysis, a comprehensive preprocessing phase was undertaken. This critical step involved the meticulous removal of sensitive information to safeguard individual privacy, as well as the thorough cleaning and standardization of data to rectify inconsistencies and errors. The resultant preprocessed dataset, designated as

"cleaned.csv," forms the robust foundation upon which the subsequent data visualization and analysis phases of this project are built.

It is imperative to acknowledge that the original dataset, originating from manual records, may contain inherent limitations, including missing values or inconsistencies. While concerted efforts have been made to address these issues during the preprocessing stage, it is essential to recognize that some degree of imperfection may persist. A detailed and transparent examination of data quality, including any remaining gaps or uncertainties, will be conducted as an integral part of the comprehensive analysis process.

III. DASHBOARD DEVELOPMENT

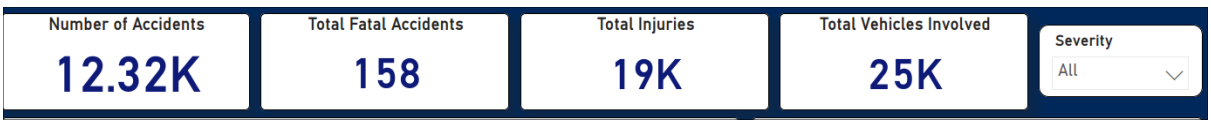
The design of the Addis Ababa road traffic accident dashboard is guided by three core principles:

- **User-Friendliness:** The dashboard prioritizes intuitive navigation and ease of use. It employs clear labeling, logical organization, and interactive elements to enable users of varying technical backgrounds to explore the data effortlessly.
- **Clear Visual Hierarchy:** Information is presented in a structured manner, with the most critical insights prominently displayed. Visual elements are carefully chosen to enhance readability and guide the user's attention to key takeaways.
- **Actionable Insights:** The dashboard goes beyond simply presenting data; it aims to provide actionable insights that can inform decision-making. This is achieved by highlighting trends, correlations, and outliers, enabling stakeholders to identify areas where interventions can be most effective.

The dashboard is developed using Microsoft Power BI, a robust and versatile business intelligence platform renowned for its interactive data visualization capabilities. Leveraging Power BI's extensive library of pre-built visuals and its intuitive drag-and-drop interface, the development process prioritizes efficiency and ease of maintenance.

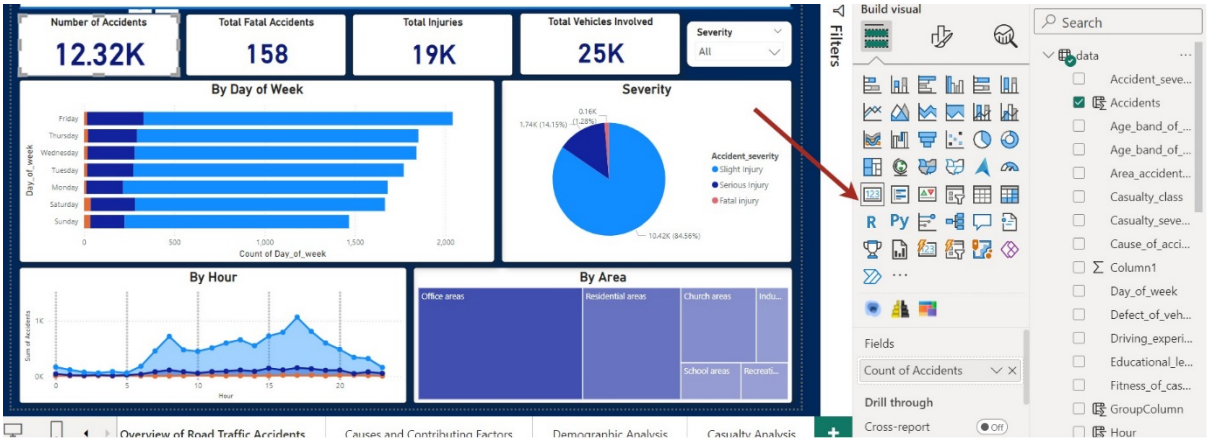
III.1. Overview of Road Traffic Accidents

a. Card Visualizations for key metrics:

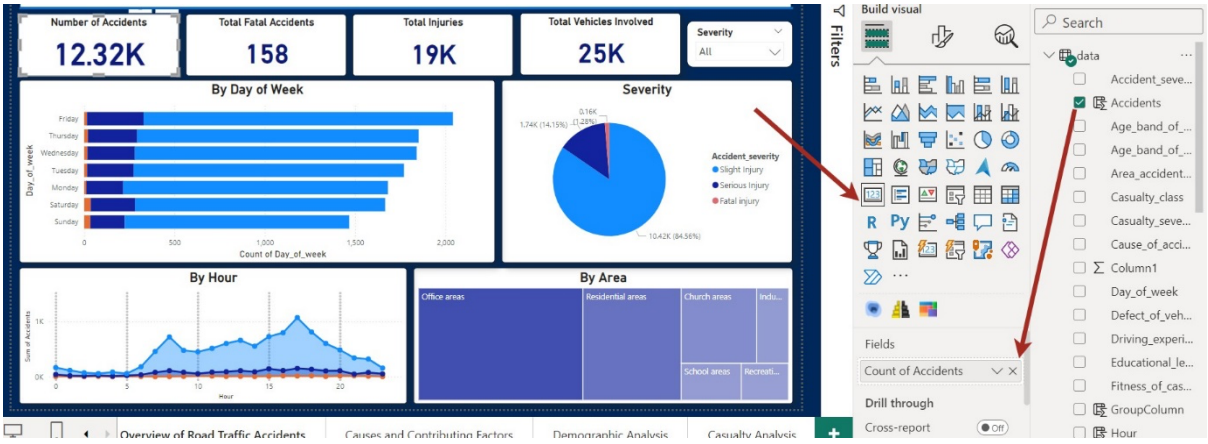


We want to display the Number of Accidents, Total Fatal Accidents, Total Injuries, Total Vehicles Involved for each type of Severity (All, Fatal, Slight, Serious). To create card visualization, we follow these steps:

Step 1: Click on the button “Card” in Visualizations (as shown in the figure below).

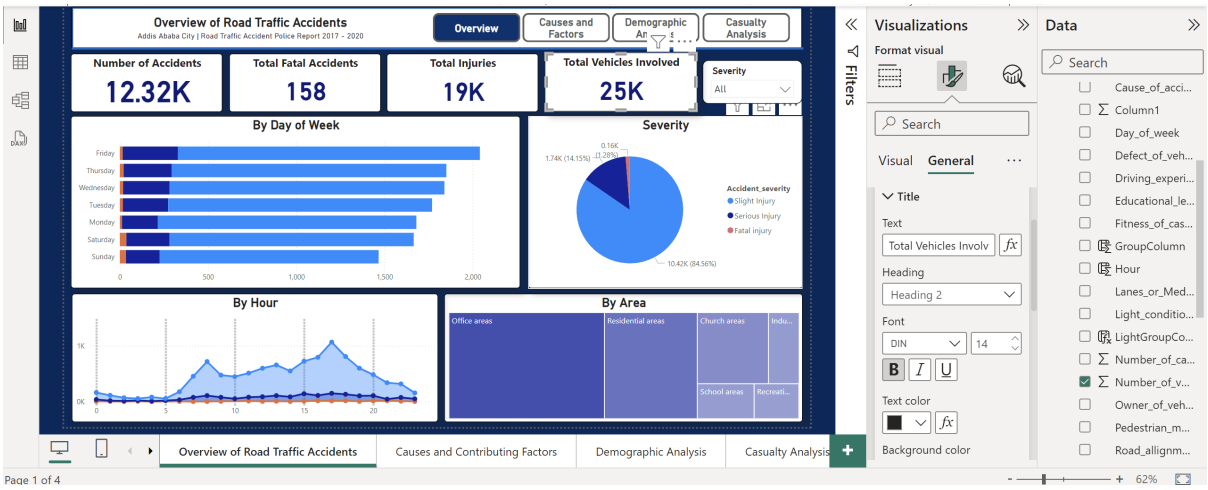


Step 2: Choose the "**Accidents**" Feature then drag to "**Fields**".

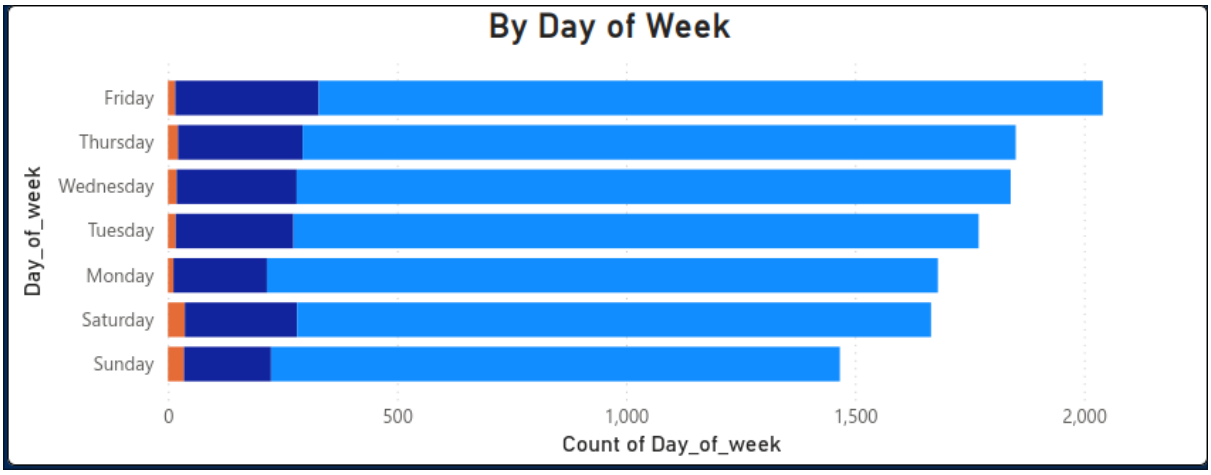


Step 3: Adjust the font size of value by editing attributes in Callout Value

Step 4: Adjust font size and color of title by editing attributes in General / Title:

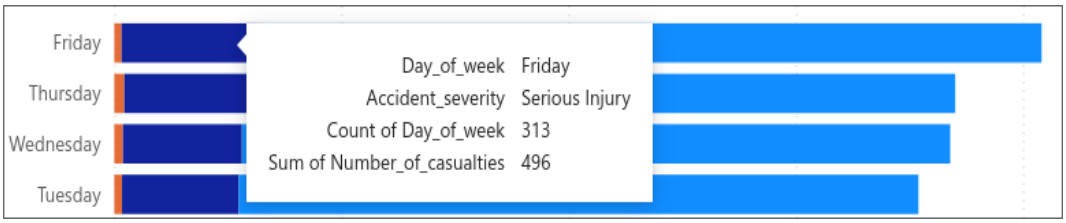


b. Total Accidents Over Day in the Week:



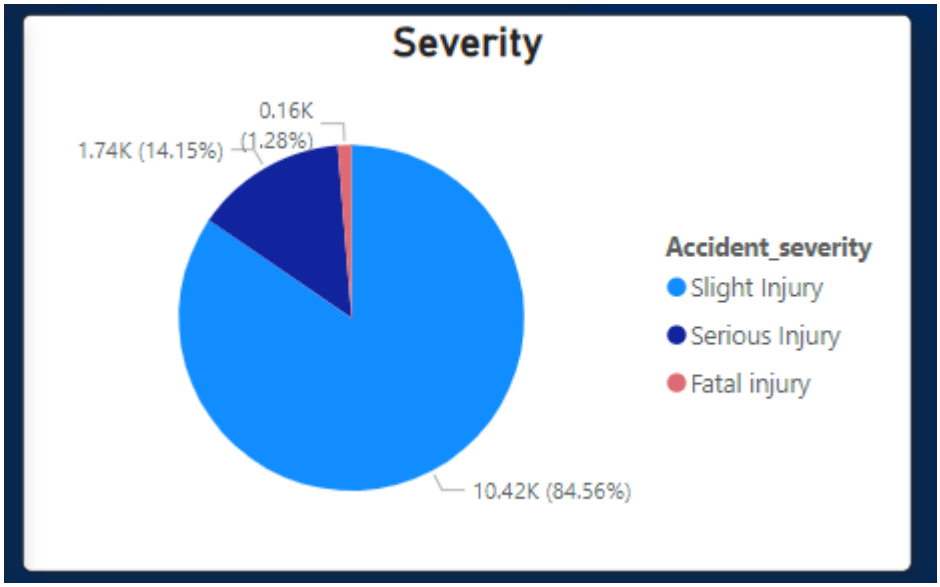
In this section, we visualize the trend in total number of incidents, and number of incidents of each severity over the week. We visualize all the information above using a stacked bar chart.

- How this work:
  - When user hover any bar, there will be a popup displaying the day of the week, and exact number of accidents of that severity.



  - User can click on a day of the week to highlight accident happenings on that day.
  - Also user can click on any bar to hightlight only accidents of a certain severity during according day.

c. An accident Severity Breakdown:



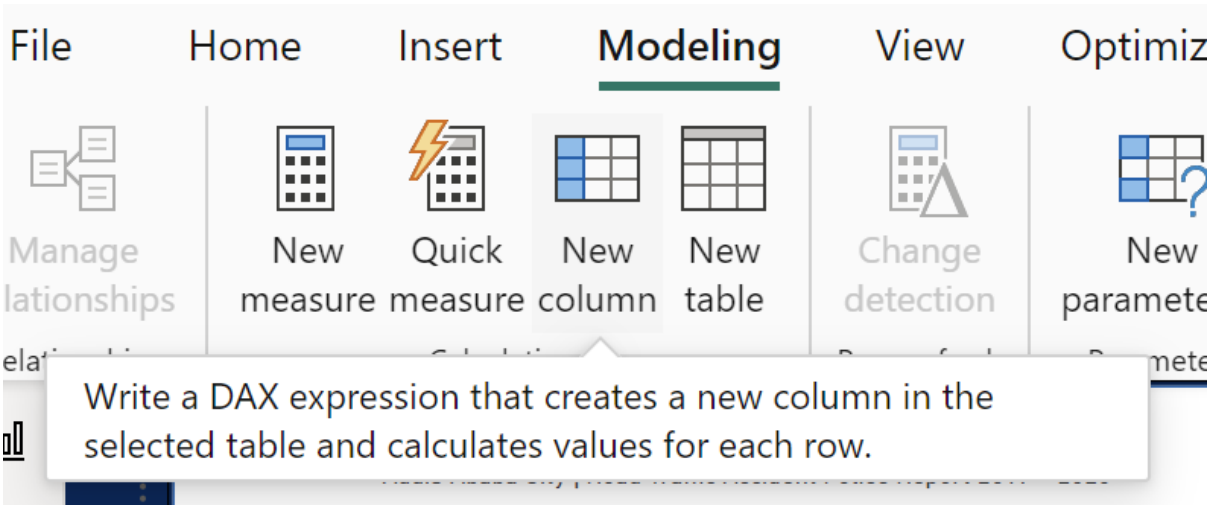
For the Severity Breakdown, we use a Pie Chart with **Accident_severity** as Values and **Count of Accident_severity** as Legend.

d. Accidents by Time of Day:

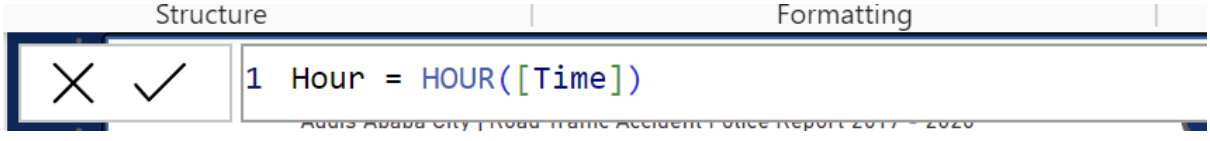
We created a new column named “Hour” based on existing column “Time”.

Step 1:

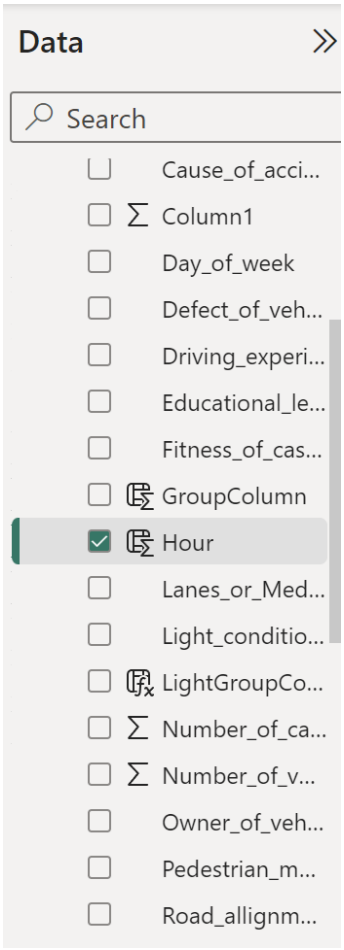
Choose Modeling, then choose New column



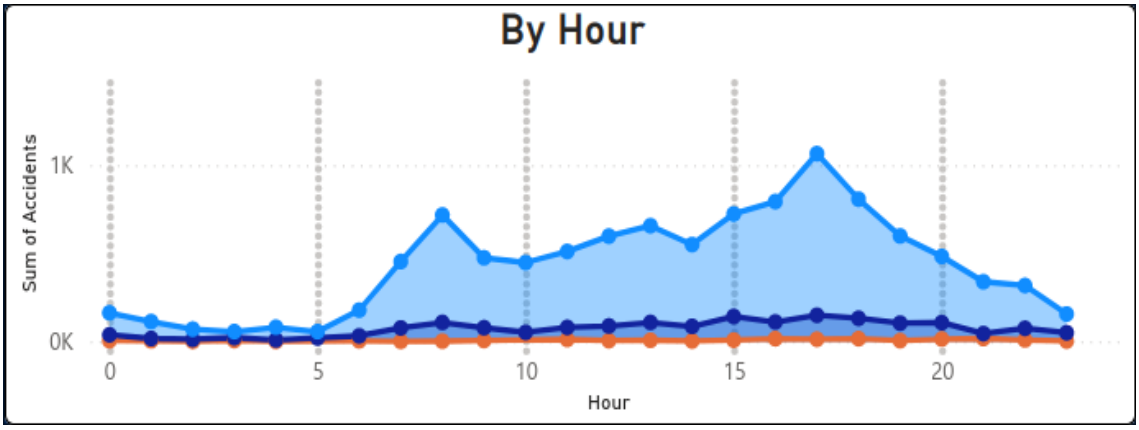
Step 2: Type in formula for column “Hour”:



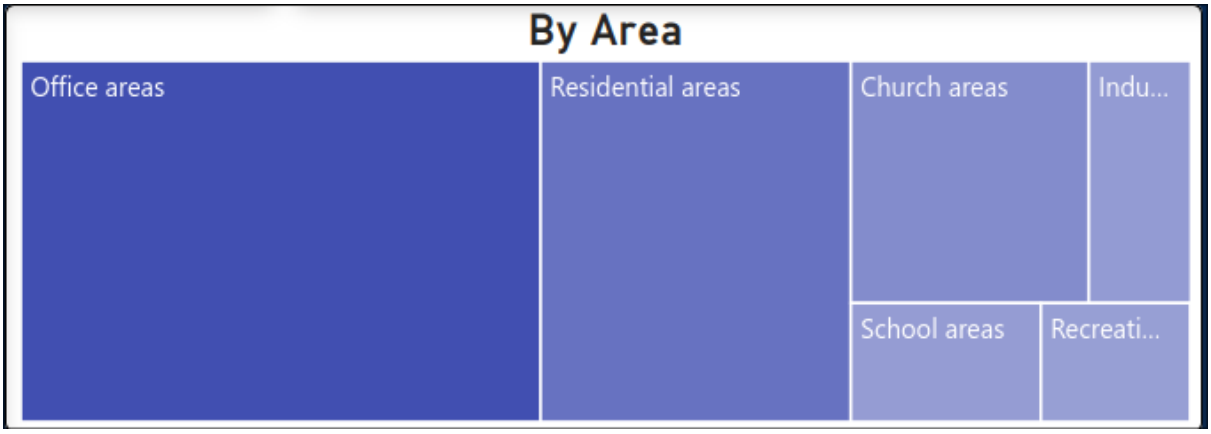
Result: “Hour” attribute is now shown in Data tab:



We show the number of accidents by time of day using a line chart from Build visual of Power BI. Besides, the incident types are displayed on locations using an area chart built in the software. We add the “Hour” feature as X-axis and Sum of Accidents is Value. Other properties are set up the same.



e. Accident Distribution by Sub-City:



We use a tree map from Power BI to Visualize the number of Incidents by area with the **category** of **Area_incident_occured**.

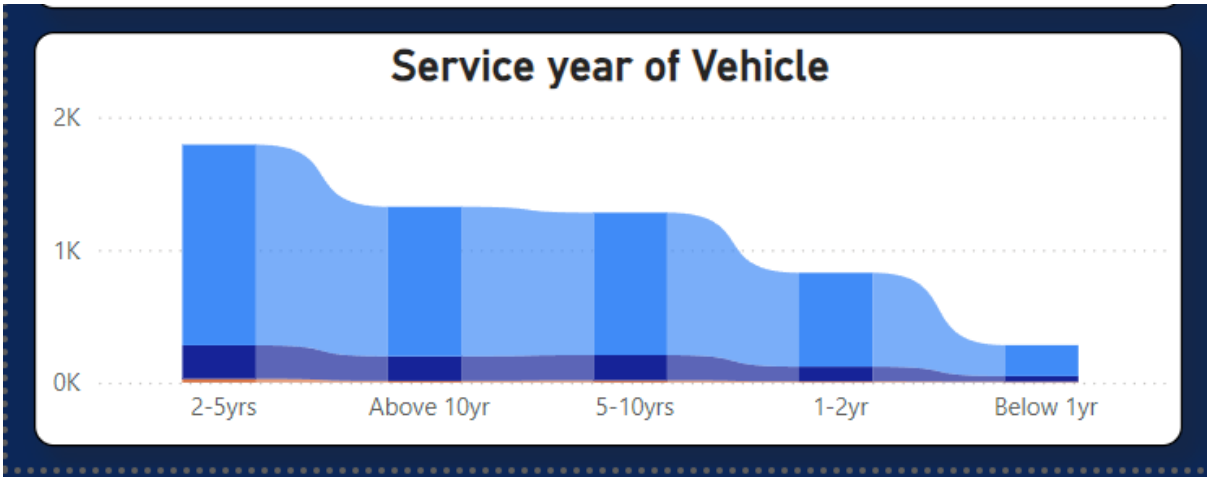
For the drop-down menu of Severity, we select slicer from Power BI and add **Accident_severity** to the **Fields**.

III.2. Causes and Contributing Factors

In this dashboard, we want to study the causes and conditions that lead to traffic collisions. Therefore, we decide to visualize the relationship of some most notable causes and conditions with the most important characteristic of incidents - severity. We track severity with 3 categories: Slight Injury, Serious Injury, and Fatal Injury.

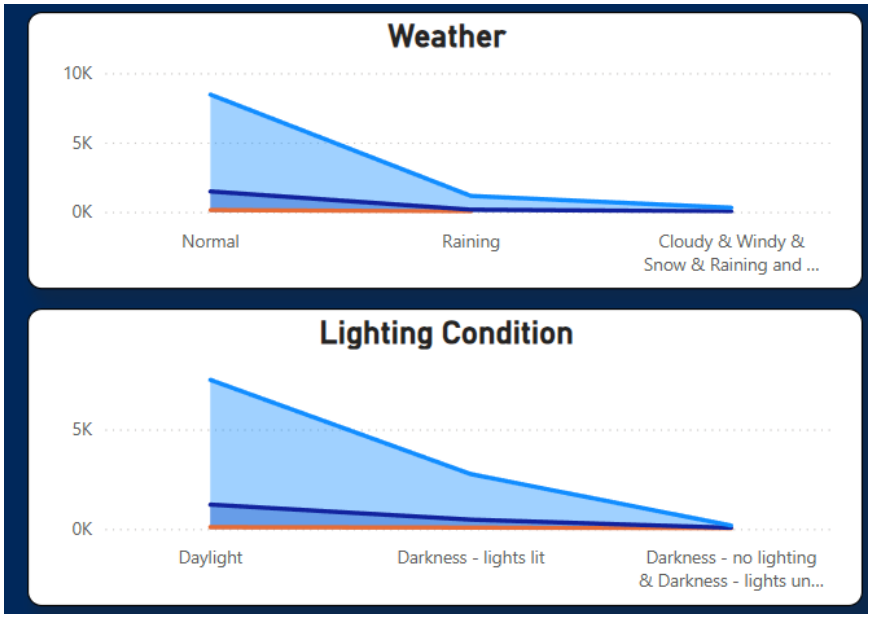
We also created a new column called “Accidents” for counting the number of accidents, with this formula:

```
1  Accidents = 1
```

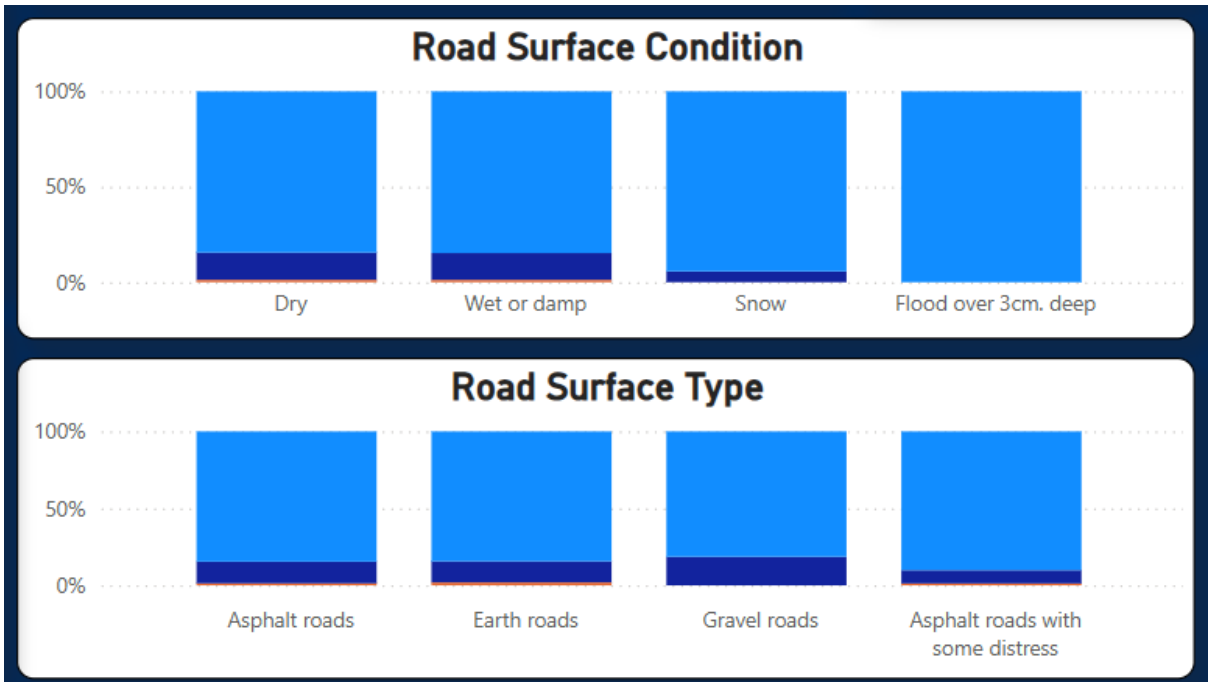


To create this chart and our other ribbon charts in general, we did as follow:

Choose Ribbon cart in Visualization / Build visual, then drop **Service_year_of_vehicle** to X_axis, and drop **Accidents** to Y_axis, and **Accident_severity** to Legend.

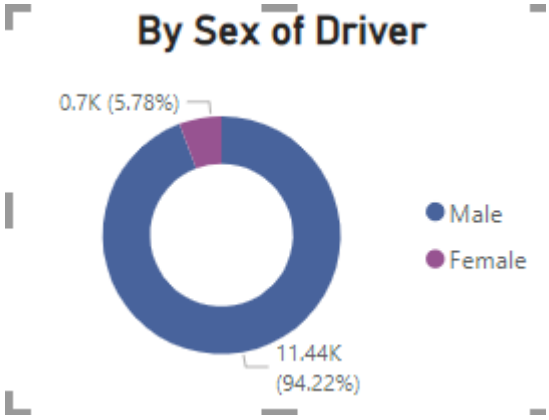


For the "Road Surface Condition" chart, we use **road_surface_condition** as X-axis and **total accidents** as y-axis, while legend is **accident_severity**. And for the Road Surface Type, the X-axis is changed to **Road_surface_type**.

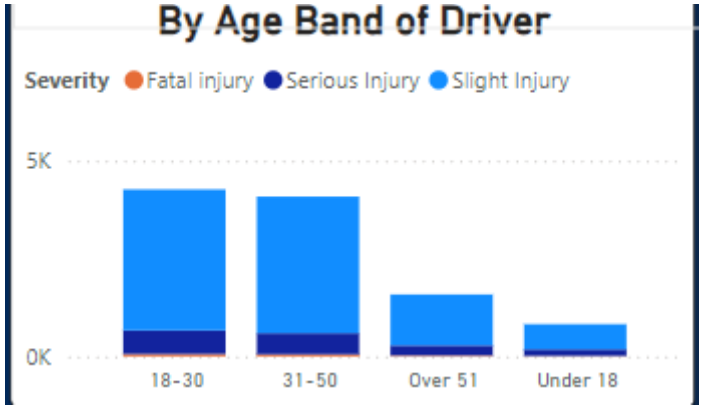


III.3. Demographic Analysis

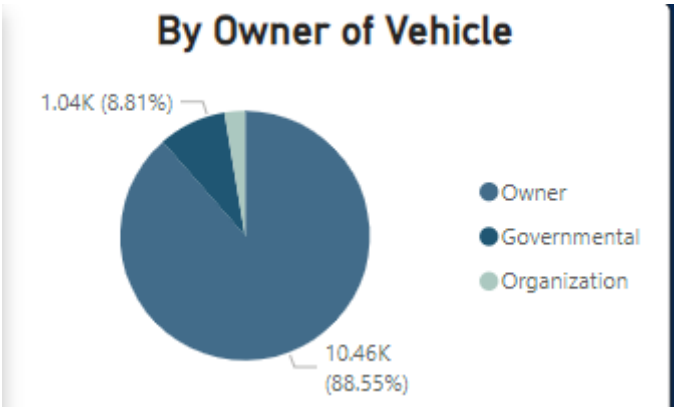
1. Donut chart:
    - For the "**By sex of Driver**" chart, we use a donut chart with legend as **Sex_of_driver** and **Values as Count of sex_of_driver.**



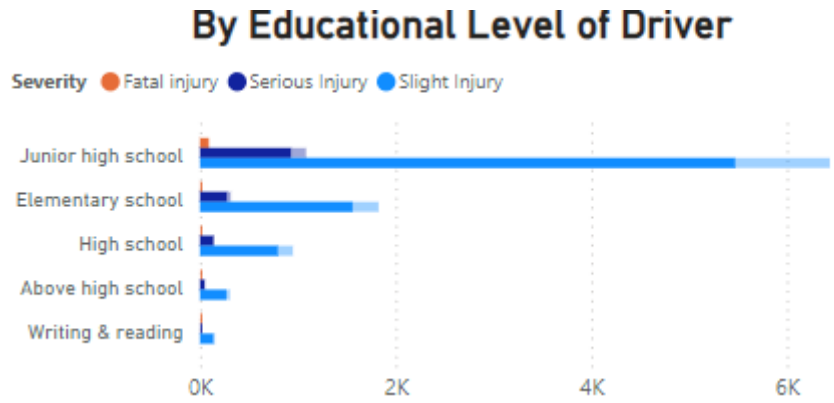
2. Stacked Age band of Driver column chart : In the "Severity By Age Band of Driver" stacked column chart, we drag **Age_band_of_driver** to X-axis, **Count of Age_band_of_driver** to y-axis, **accident_severity** to legend.



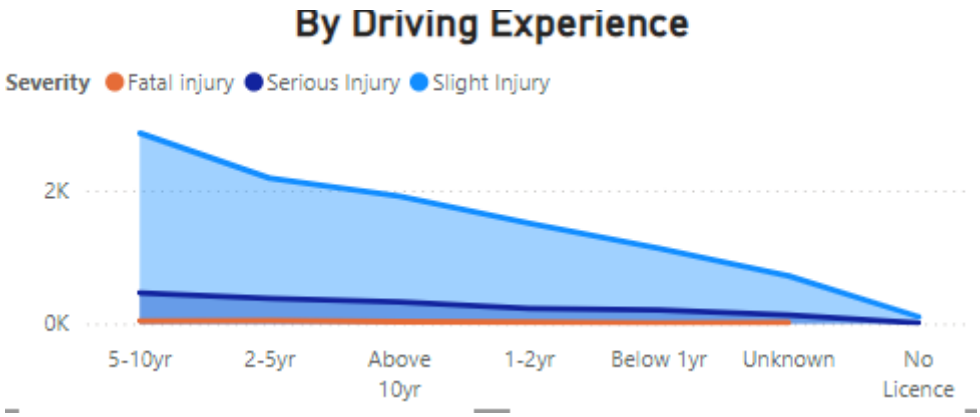
3. Chart represents **Owner of the Vehicle**: For the "By Owner of the Vehicle" table, we use a pie chart with Legend as **Owner_of_vehicle** and **Values as Count of Owner_of_vehicle**.



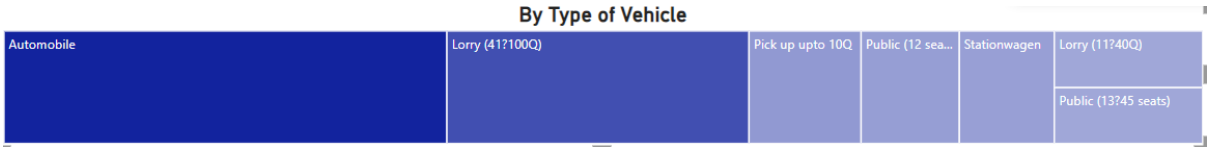
4. For the "By Educational level of Driver" chart, we use a stacked bar chart with y-axis as **Educational_level** and X-axis as **Count of Educational_level.**



5. For the "Serevity By Driving Experience" chart, we use an area chart in Visualization of Power BI with X-axis as **Driving_experience** and y-axis as **Count of Driving_experience,** with **Accident_serevity** as Legend.

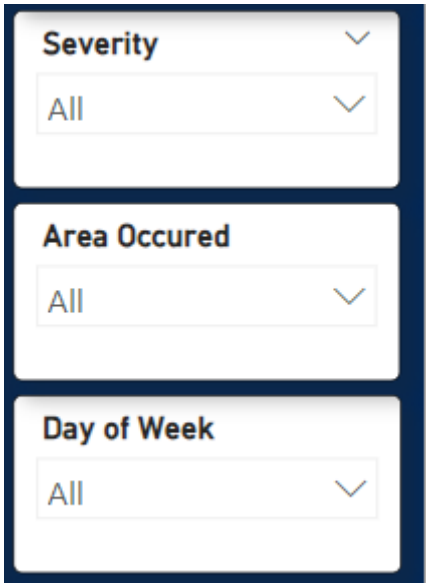


6. For the "Type of Vehicle" chart, we use a tree map with **Type_of_vehicle** as Category and **Count of Type_of_vehicle** as Values.

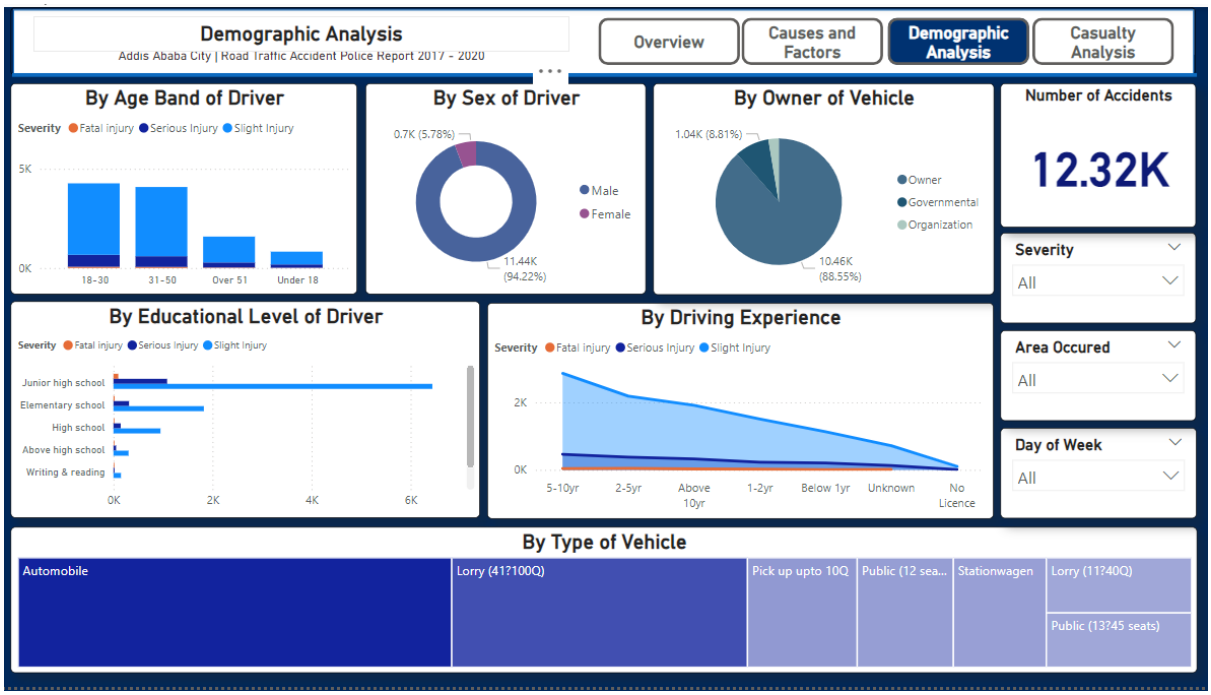


7. The number of accidents card has the same setting as above:

8. And we have some other slicers which are filtered with Area occurred and Day of Week:

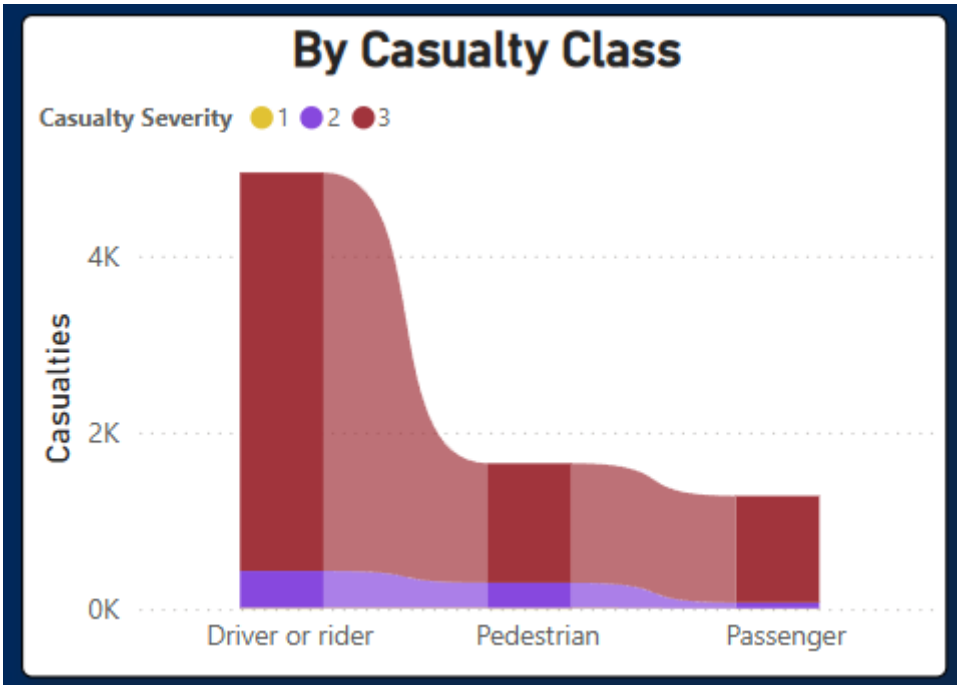


In conclusion, this is our final result of this dashboard:

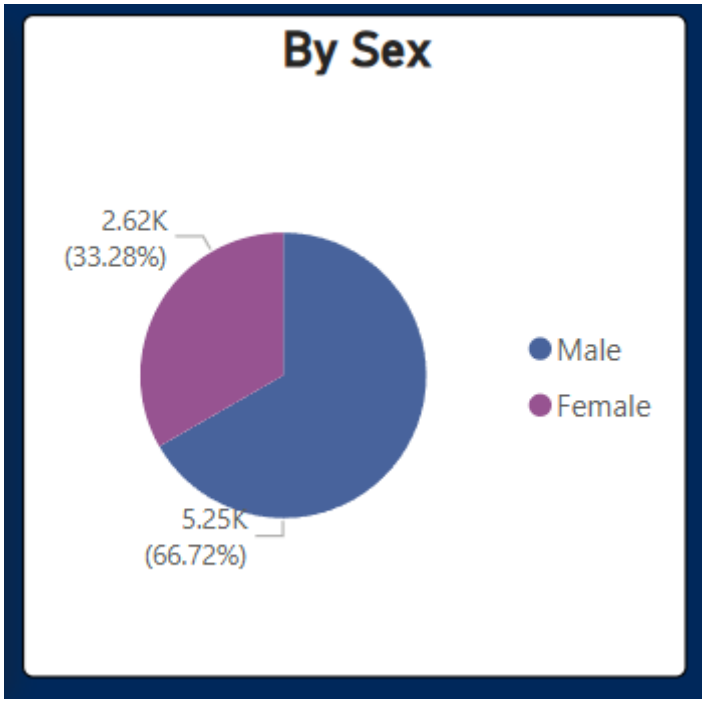


III.4. Casualties Analysis

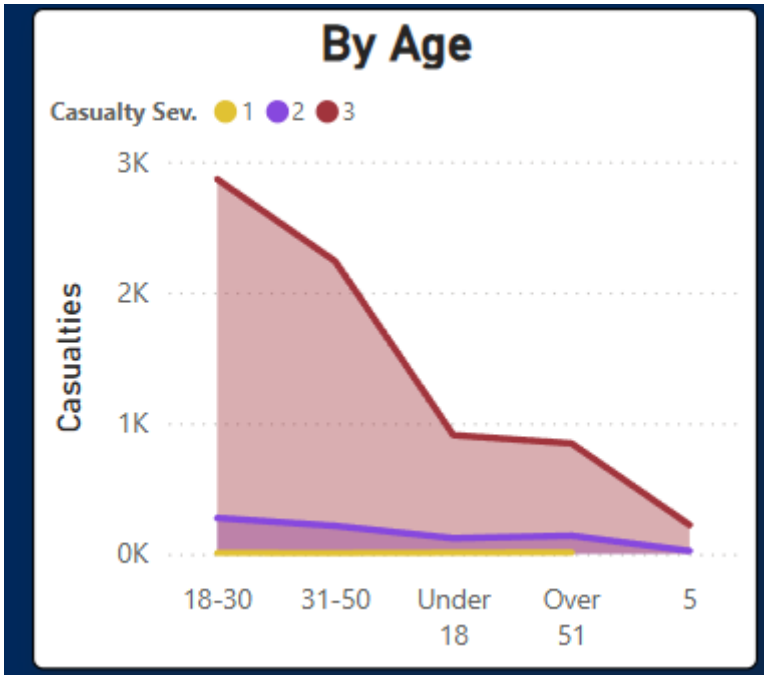
For the “By Casualty Class”, we use a ribbon chart, where the x-axis is represented by **casualty_class**, the y-axis is represented by represented by **Count of casualty_class,** followed by **casualty_serevity** as legend.



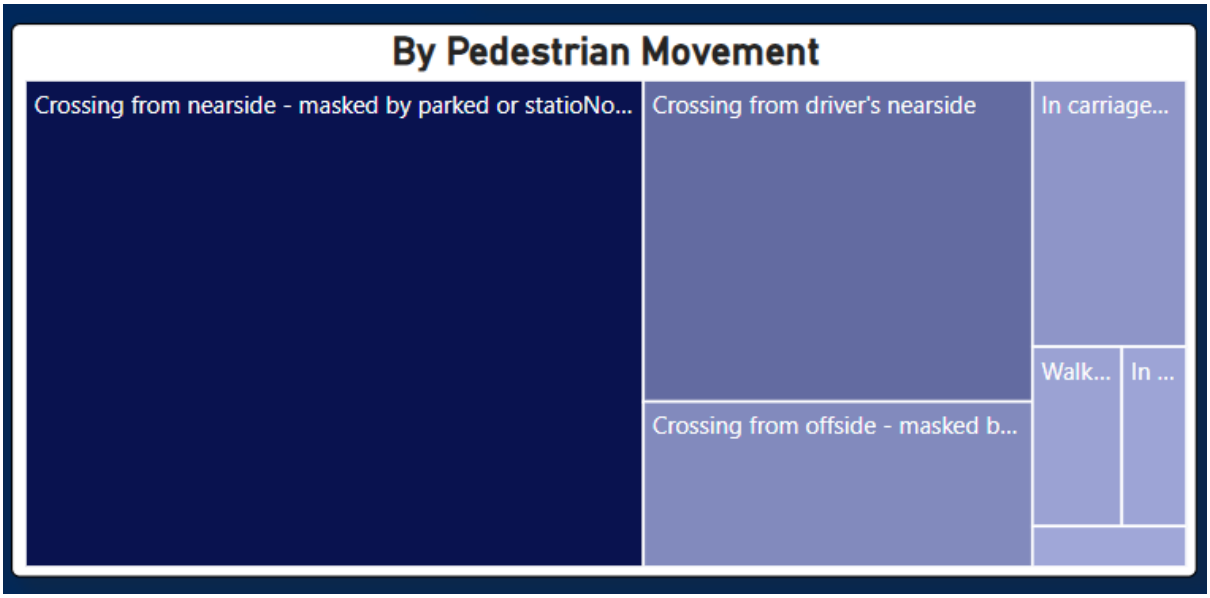
For the “By Sex” chart, a pie chart is used the legend and values are represented by **Sex_of_casualty** and **Count of sex_of_casualty**, respectively.



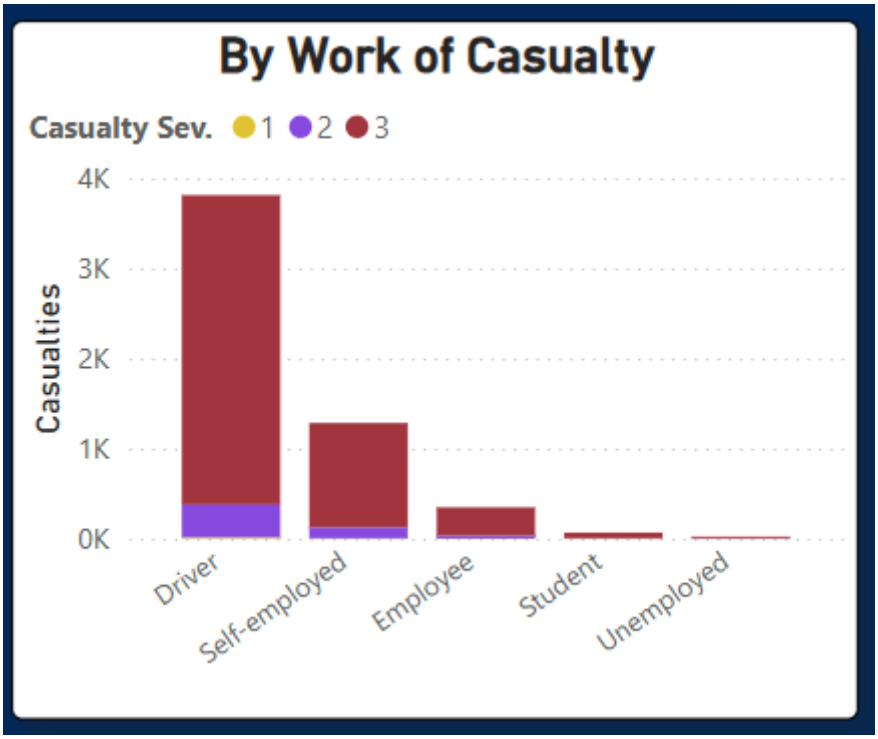
For the “By Age” chart, an area chart is used, the X-axis is represented by **Age_band_of_casualty** and the y-axis is represented by **Count of Age_band_of_casualty,** with **Casualty_severity** as legend.



For the “By Pedestrian Movement”, we use a tree map, where **Pedestrian_movement** represents category, and the values are **Count of Pedestrian_movement**.

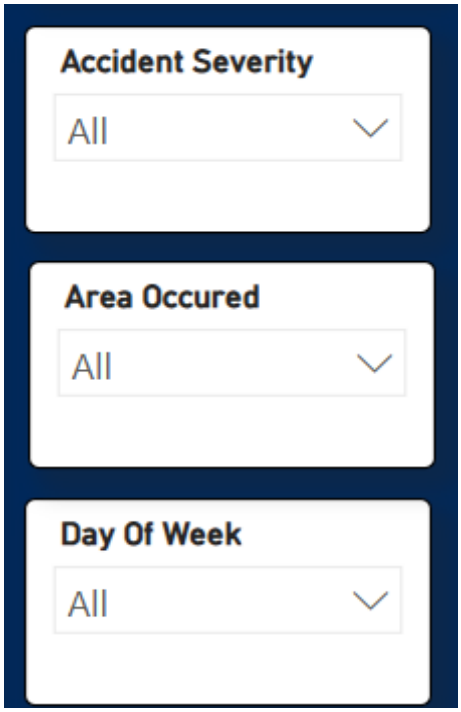


For the “By Work of Casualty”, we use a stacked column chart, where the x-axis represents **Work_of_casualty**, while the y-axis is showed by **Count of Work_of_casualty**, while **Casualty_severity** is legend.



The number of casualty and number of vehicle involved card has the same setting as above, with number of casualties is the sum of **number_of_casualties**.

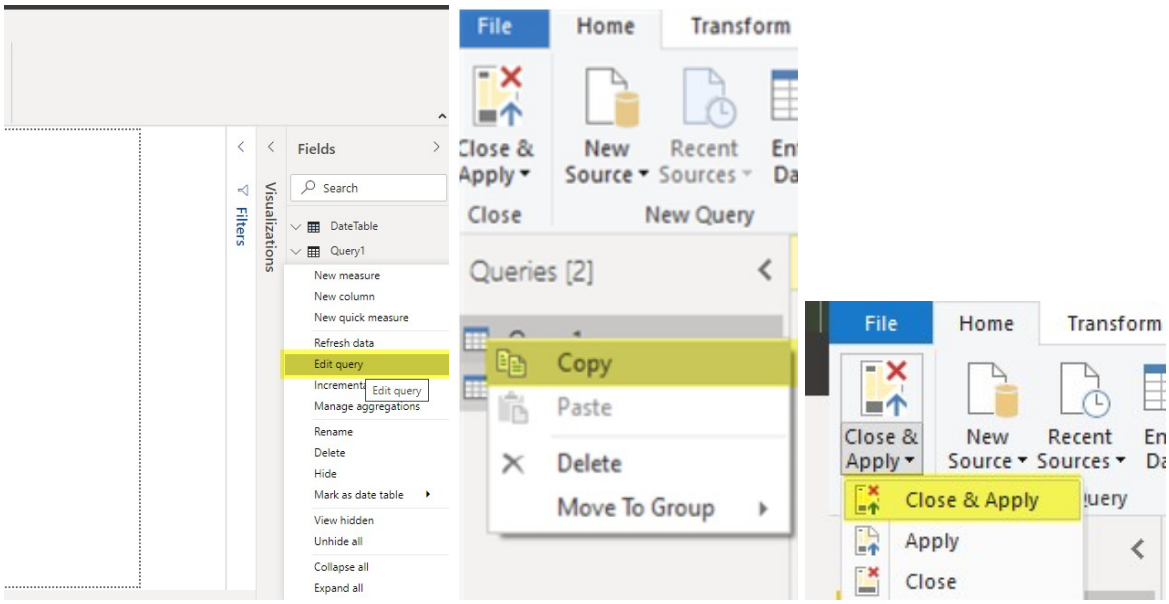
And we also have some slicers which are filtered with **Accident Severity**, **Area occurred** and **Day of Week**, for better clarity:



III.5. Merging all the dashboard and changing template

The final dashboard will merge all the previous dashboard into one single file. Firstly, each dashboard corresponds to one table of unique transformation rules. Some dashboard requires creating additional measures to support the visualization. The measures are pasted to the final dashboard using Tabular Editor 3.

Firstly, open the dashboard needs to be merged to the final dashboard.



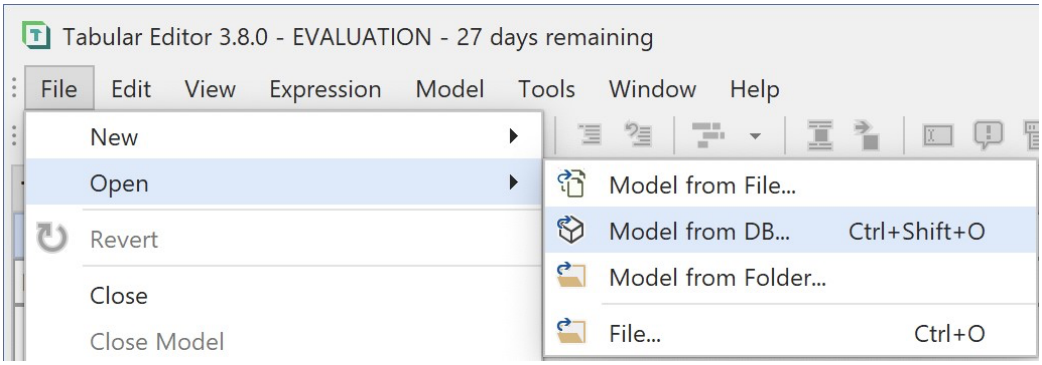
Click on the dataset and choose “Edit query”, then right click to the table on the left panel, choose “Copy”.

Going over to the final dashboard, open the dataset and choose “Edit query” similarly. Now choose “Paste” on the left panel. Finally, click “Close & Apply” on the toolbar above.

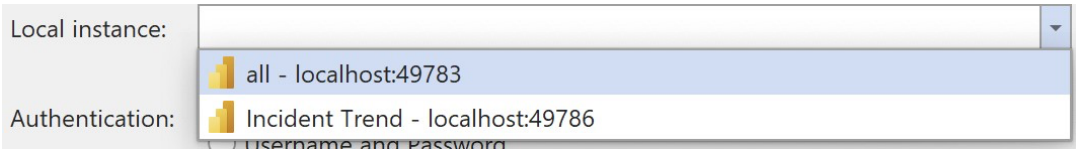
Now we can choose the visualization to be merged, copy it and paste to the final dashboard. To paste the measures on the data as well, first open two Power BI files, one containing the dashboard needs to be merged, and one for the final dashboard.

Now open two Tabular Editor sessions. Each session will be linked to one dashboard as follows:

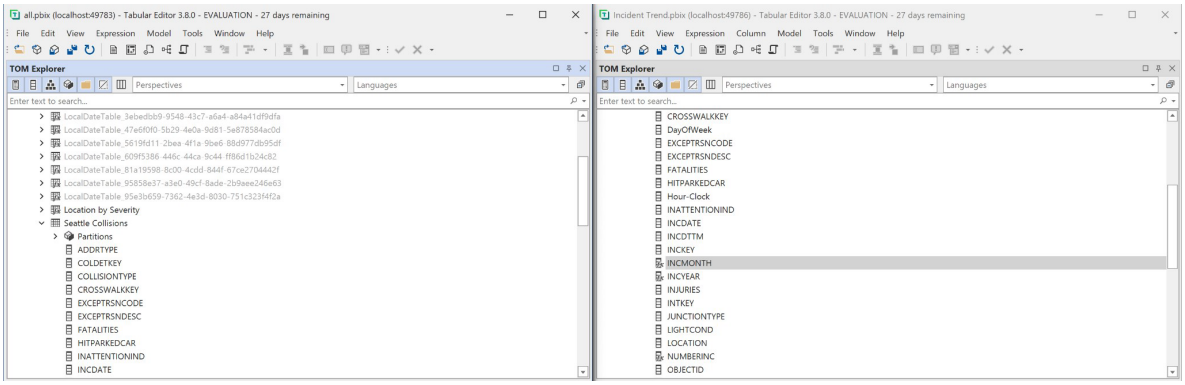
- Choose File > Open > Model from DB



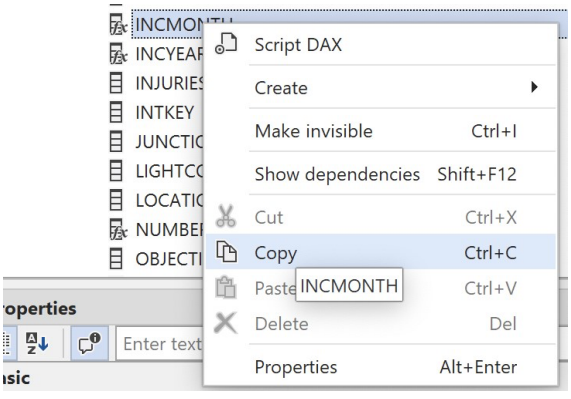
- Choose the corresponding Power BI file in Local instance drop-down menu.



- Repear for 2 files, now we have two sessions as below



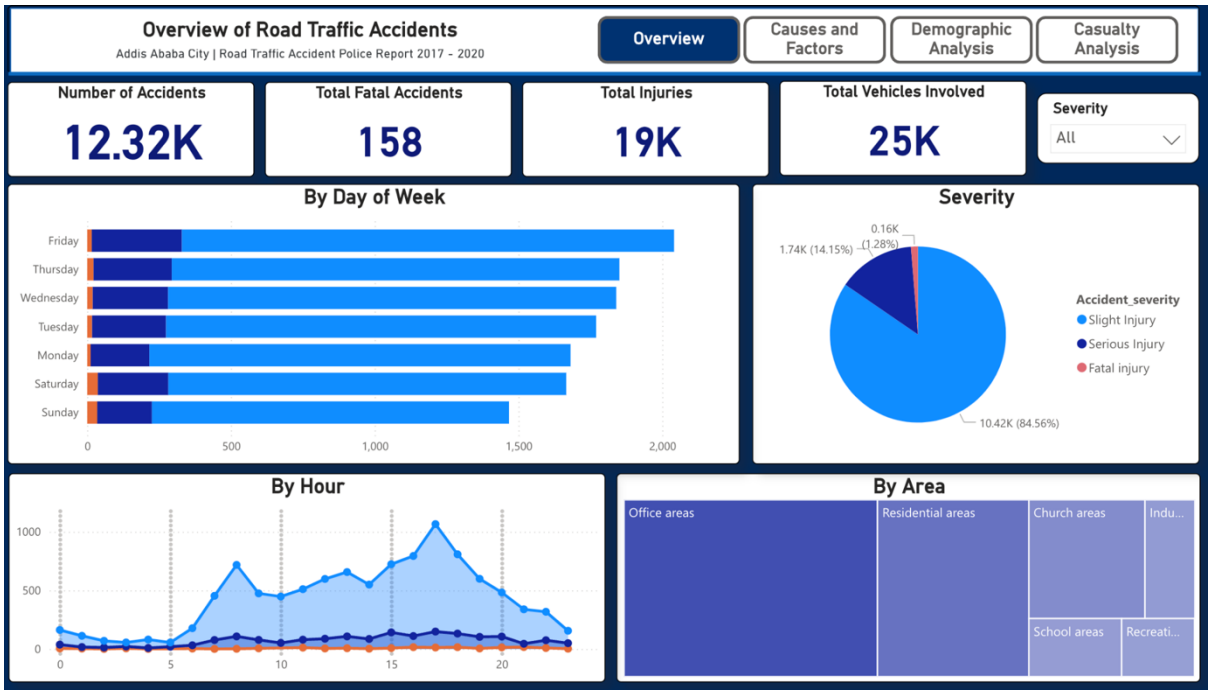
- Find the measure you want to merge, right click and choose “Copy”. Now paste it to the corresponding table of the final dashboard



The merging completes!
After that, the dashboard theme is changed to a consistent theme. Each feature in one separated dashboard is encoded into one color, any the same features across the dashboards are encoded into the same color.

IV. THE FINAL DASHBOARD

IV.1. Dashboard 1: Overview of Road Traffic Accidents



Summary of Key Metrics

1. **Total Number of Accidents:** 12.32K
2. **Total Fatal Accidents:** 158
3. **Total Injuries:** 19K
4. **Total Vehicles Involved:** 25K

This dashboard provides a high-level summary of road traffic accidents in Addis Ababa from 2017 to 2020. It includes key metrics such as the total number of accidents, fatal accidents, injuries, and vehicles involved. It also provides insights into the distribution of accidents by time, area, and severity.

Visual Analysis

1. **Total Number of Accidents (Card Visual):**

- **Insight:** A total of 12,320 accidents were recorded, reflecting the extent of traffic incidents in the city.

- **Implication:** This high number indicates a significant road safety issue that needs addressing. The city should consider comprehensive traffic safety strategies, including education campaigns and stricter enforcement of traffic laws.

2. **Total Fatal Accidents (Card Visual):**

    - **Insight:** There were 158 fatal accidents, highlighting the severe consequences of some incidents.

    - **Implication:** Fatal accidents, while relatively fewer in number, have a significant impact on public safety and healthcare systems. This underscores the need for urgent measures to enhance road safety and emergency response mechanisms to reduce fatalities.

3. **Total Injuries (Card Visual):**

    - **Insight:** With 19,000 injuries, this metric underscores the physical harm caused by these accidents.

    - **Implication:** This highlights the need for improved medical emergency response systems and preventive measures to reduce injuries. The high number of injuries indicates a considerable burden on the healthcare system, emphasizing the need for preventive strategies and first-aid training for road users.

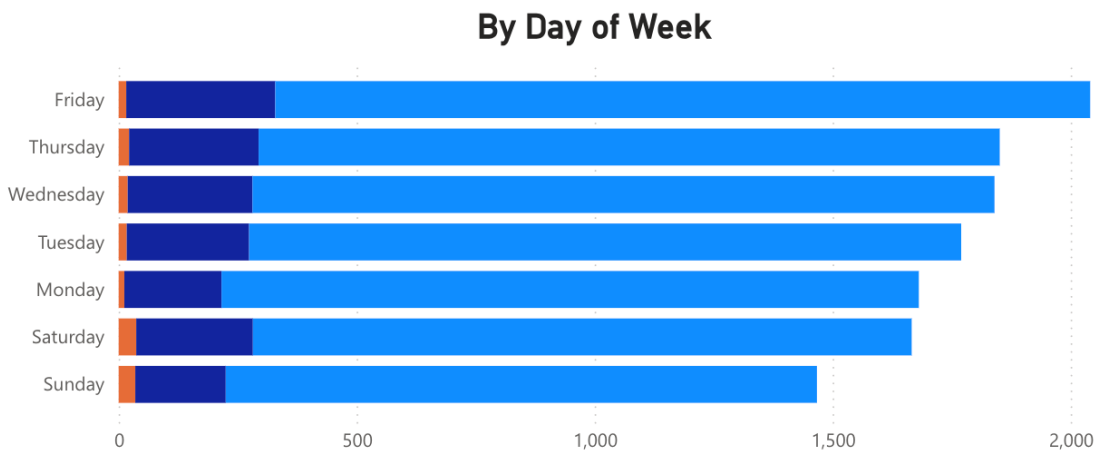
4. **Total Vehicles Involved (Card Visual):**

    - **Insight:** 25,000 vehicles were involved in accidents, indicating the broad impact across different vehicle types.

    - **Implication:** This suggests the necessity for widespread vehicle safety inspections and regulations. Regular vehicle maintenance and safety checks should be mandated to ensure that vehicles on the road are in good condition, thereby reducing the likelihood of accidents.

Detailed Visual Breakdown

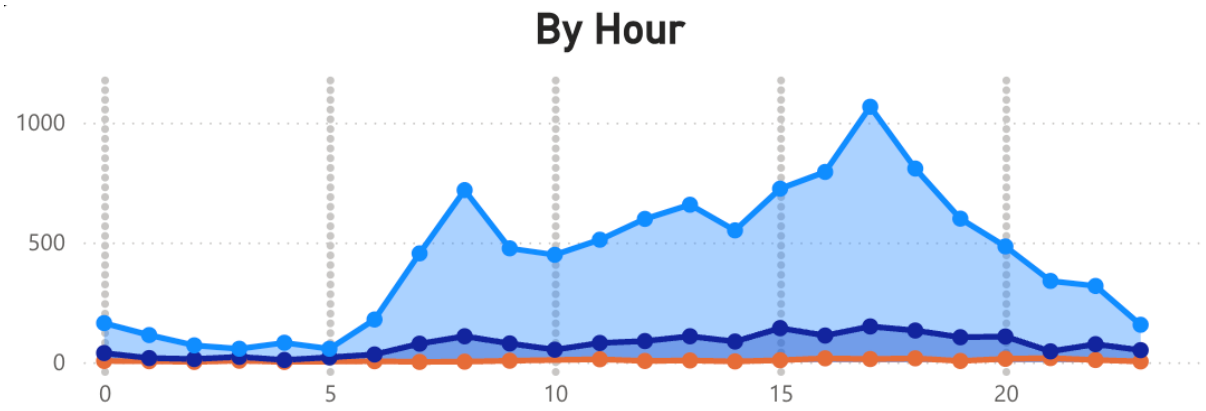
1. **Accidents by Day of Week (Column Chart):**



- **Insight:** Accidents are most frequent on Fridays, followed by Thursdays and Wednesdays.

- **Implication:** This pattern may be influenced by higher traffic volumes towards the end of the workweek. The spike in accidents on these days could be attributed to increased social activities, fatigue from the workweek, or heightened stress levels. Implementing targeted road safety campaigns and increased enforcement on these days could help reduce accidents. Measures such as public awareness campaigns, increased patrols, and encouraging alternative transportation methods on these high-risk days could be beneficial.

2. **Accidents by Hour (Line Chart):**

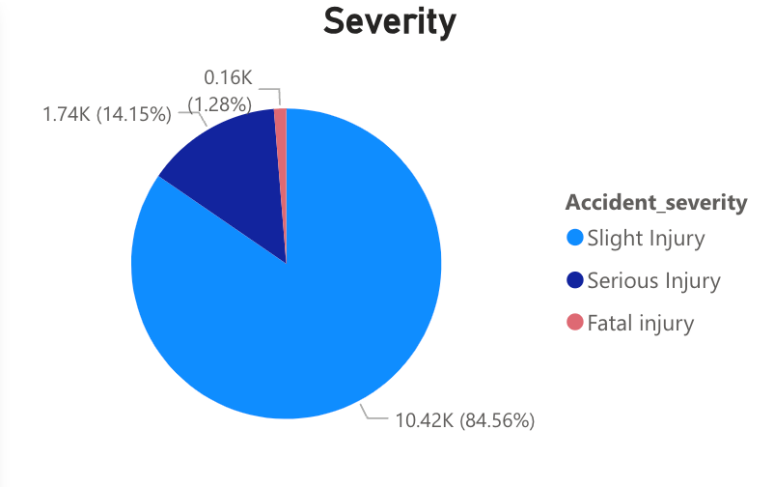


- **Insight:** The peak accident times are between 15:00 and 18:00 hours, with a significant rise starting around 6:00 AM and a peak at 5:00 PM.

- **Implication:** These peak hours coincide with rush hours, suggesting a need for enhanced traffic management and enforcement during these times. Traffic congestion during these hours increases the likelihood of accidents. Implementing traffic flow improvements, optimizing signal timings, and deploying traffic officers during these

peak hours could help mitigate this issue. Additionally, encouraging flexible working hours or promoting remote work could reduce congestion and accident rates.

3. **Accident Severity Breakdown (Pie Chart):**



- **Insight:** The majority of accidents (84.56%) resulted in slight injuries, while serious injuries and fatal accidents accounted for 14.15% and 1.28%, respectively.

- **Implication:** While most accidents result in minor injuries, the presence of serious and fatal injuries highlights the need for ongoing improvements in road safety measures and emergency response capabilities. The data indicates that while the majority of accidents are minor, the occurrence of severe and fatal injuries still presents a significant risk. Strengthening road safety infrastructure, such as guardrails, better signage, and pedestrian crossings, can help prevent severe accidents. Additionally, improving the response time and capabilities of emergency services can save lives and reduce the severity of injuries.

4. **Accident Distribution by Area (Treemap):**

- **Insight:** Office areas and residential areas are the most common locations for accidents, followed by church areas and industrial areas.

- **Implication:** This distribution suggests that high-traffic areas such as workplaces and residential zones require more focused road safety initiatives. The high incidence of accidents in office and residential areas could be due to a combination of high traffic volumes and potentially inadequate road infrastructure. Measures such as better road design, improved lighting, and the implementation of traffic calming measures like speed bumps and pedestrian crossings could enhance safety in these areas. Public awareness campaigns focusing on road safety in these zones can also be effective.

Interactivity and Filters

1. **Severity Filter:**

    - Allows users to filter data based on the severity of the accidents, providing tailored insights for different types of incidents.

    - **Usage:** Select specific severity levels (e.g., slight injury, serious injury, fatal injury) to see how metrics change for each category. This can help in understanding the distribution and impact of different severity levels across various parameters.

2. **Day of Week Slicer:**

    - Provides the ability to filter accident data by specific days of the week.

    - **Usage:** Analyze trends and patterns for individual days to identify high-risk periods and implement targeted interventions. This can help in planning and scheduling road safety campaigns and enforcement activities more effectively.

3. **Hour Slicer:**

    - Enables filtering of accident data by specific hours of the day.

    - **Usage:** Focus on particular time periods to understand hourly variations and plan traffic management strategies accordingly. Identifying peak hours for accidents can help in deploying traffic officers and adjusting traffic signals to improve flow and reduce accidents.

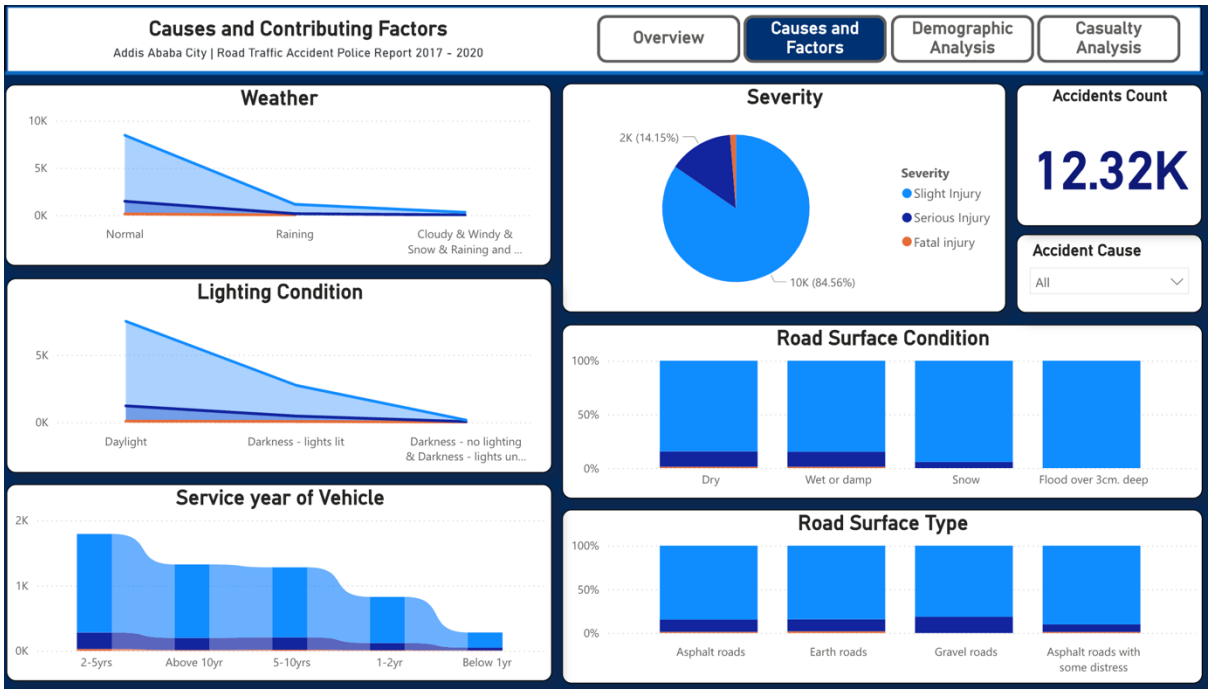
4. **Area Slicer:**

    - Allows filtering by specific areas where accidents occurred.

    - **Usage:** Drill down into accident data for specific locations to identify localized issues and prioritize resource allocation. This can be particularly useful for urban planners and traffic management authorities to focus their efforts on high-risk areas.

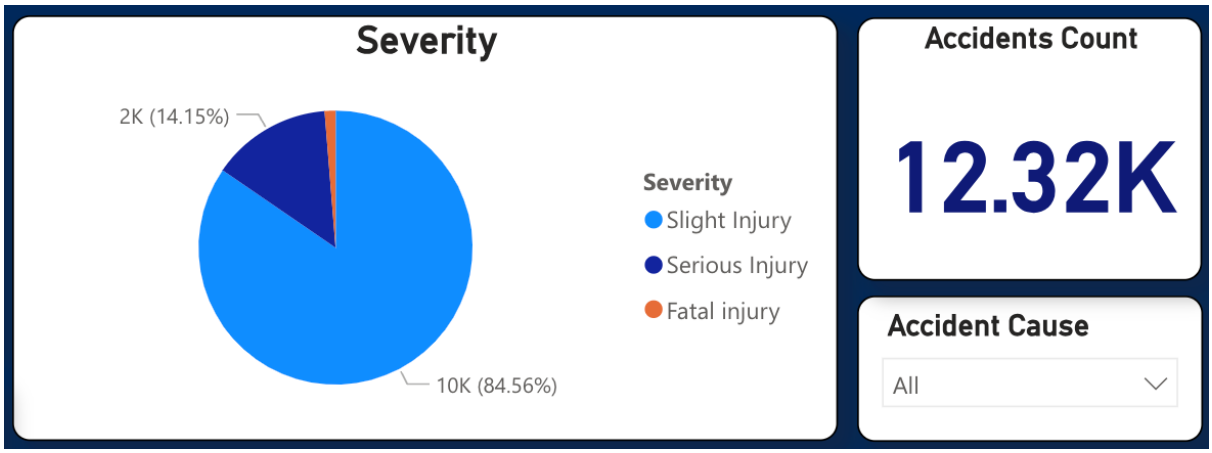
Dashboard 1 provides a comprehensive overview of road traffic accidents in Addis Ababa City, highlighting key metrics and trends across different dimensions such as time, location, and severity. The visualizations effectively convey critical insights that can inform targeted interventions and policy decisions to enhance road safety.

IV.2. Dashboard 2: Causes and Contributing Factors



Summary of Key Metrics

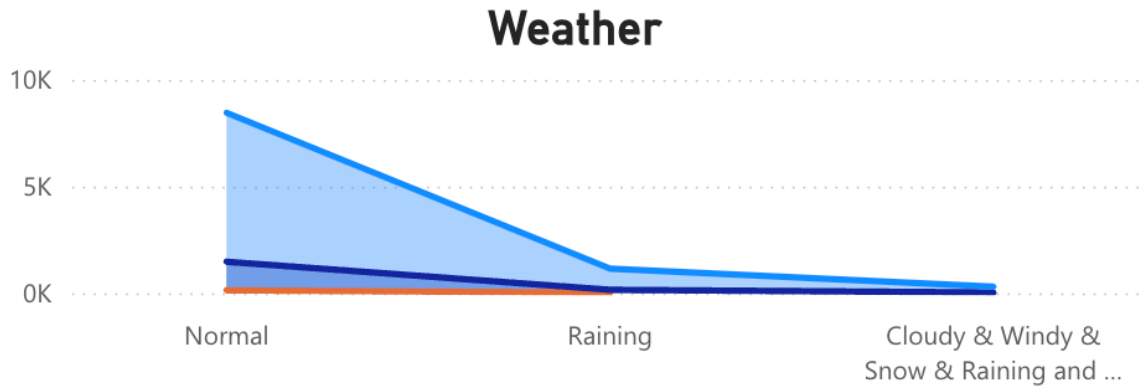
- **Accidents Count:** 12.32K
- **Severity Distribution:**
    - Slight Injury: 84.56%
    - Serious Injury: 14.15%
    - Fatal Injury: 1.28%



These metrics provide an immediate overview of the total accidents and their severity distribution.

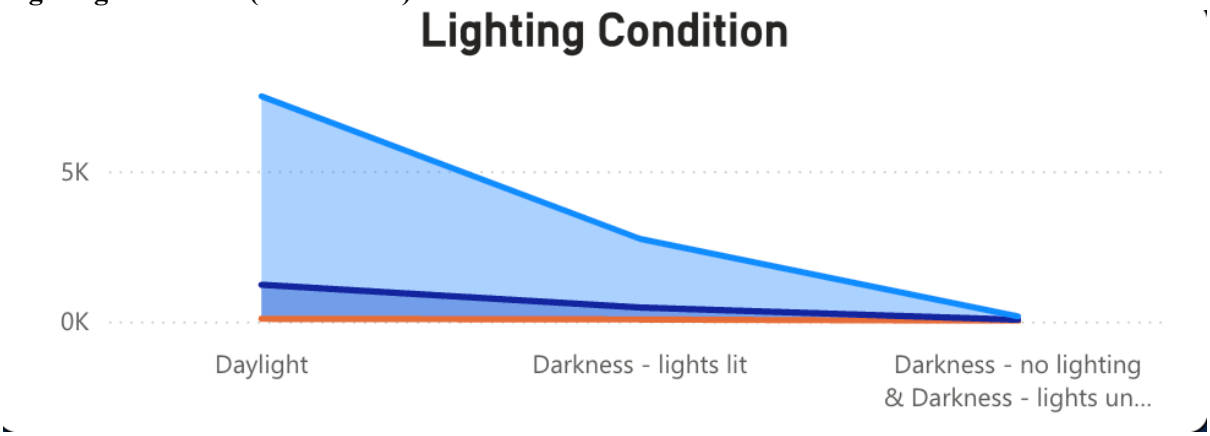
Visual Analysis

1. **Weather Conditions (Area Chart):**



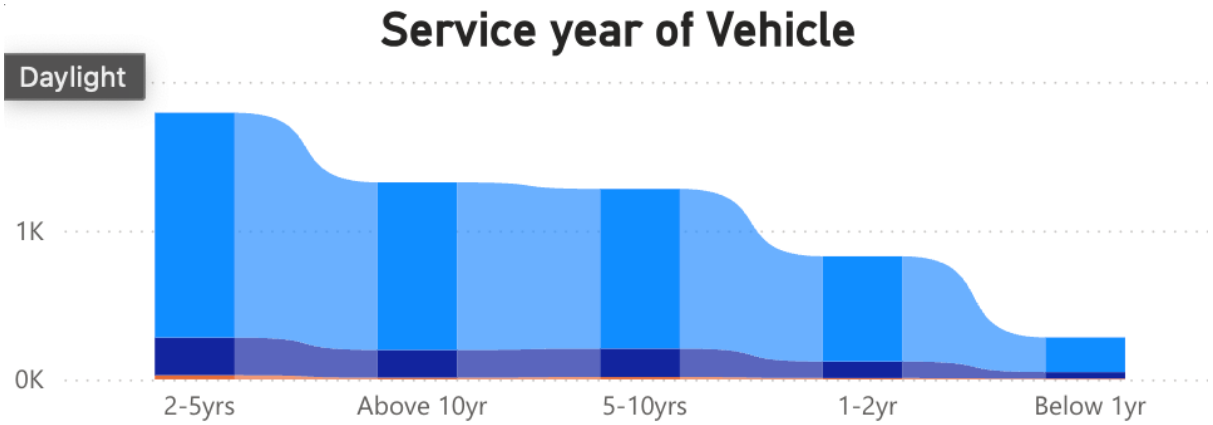
   - **Insight:** The majority of accidents occur under normal weather conditions, followed by raining, and a negligible number occur under cloudy & windy, snowy, or other adverse conditions.
   - **Implication:** Normal weather conditions having the highest accident rate suggests that factors other than weather play a significant role in accident occurrences, such as driver behavior, road conditions, and traffic volume. There should be a focus on improving driving habits and road conditions regardless of weather.

2. **Lighting Condition (Area Chart):**



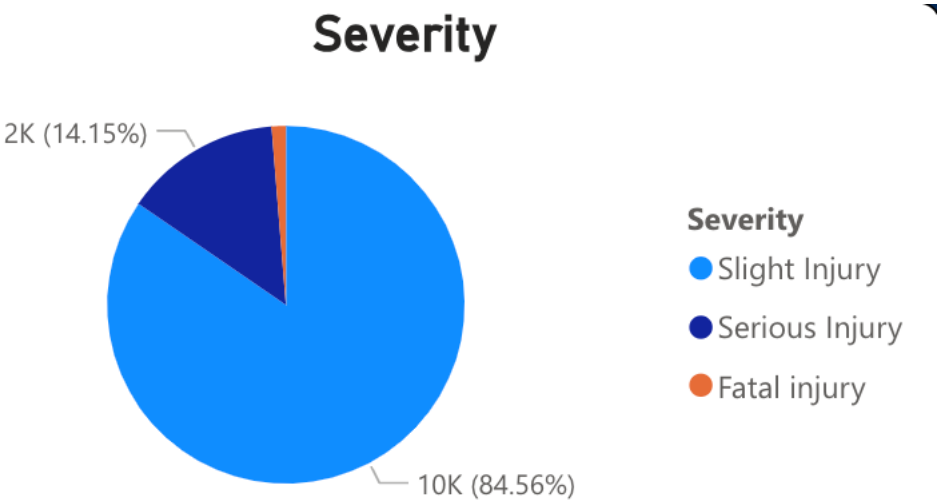
   - **Insight:** Most accidents occur during daylight, with a significant drop in accidents during darkness with lights lit and an even lower number during complete darkness.
   - **Implication:** This could be due to higher traffic volumes during the day. Ensuring good lighting and visibility during nighttime can help reduce accidents. Additionally, driver vigilance and road safety measures during the day need to be enhanced.

3. **Service Year of Vehicle (Area Chart):**



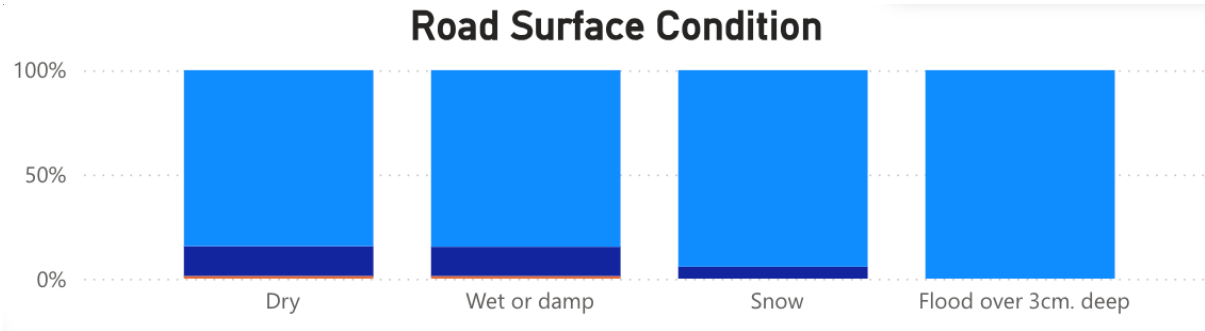
- **Insight:** Vehicles aged between 2-5 years are involved in the most accidents, followed by vehicles above 10 years, and the least accidents involve vehicles below 1 year.
- **Implication:** This suggests that mid-aged vehicles might not be maintained as well as newer ones. Regular maintenance checks and stricter vehicle inspection policies could help reduce accidents involving mid-aged and older vehicles.

4. **Severity (Pie Chart):**



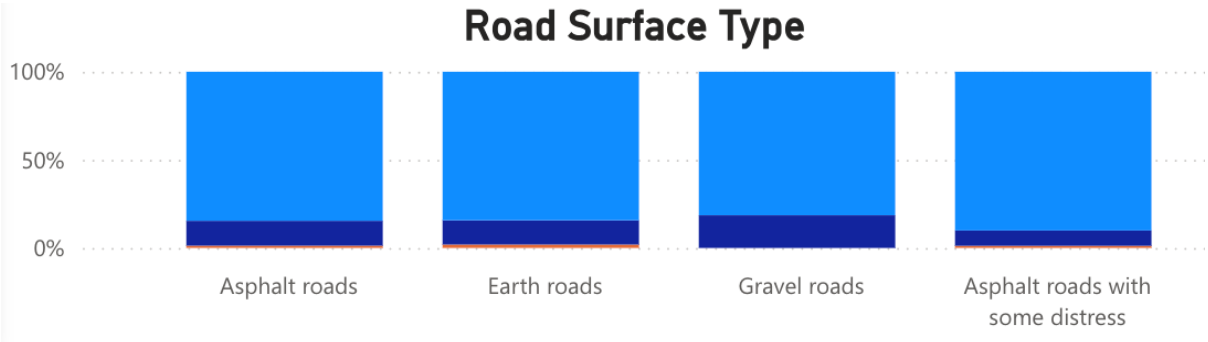
- **Insight:** Slight injuries dominate the severity of accidents (84.56%), with serious injuries (14.15%) and fatal injuries (1.28%) being less common.
- **Implication:** Although the majority of accidents result in minor injuries, the occurrence of serious and fatal injuries still presents a significant concern. Emphasizing the importance of safety features in vehicles and rapid emergency response can help mitigate these severe outcomes.

5. **Road Surface Condition (100% Stacked Bar Chart):**



- **Insight:** Dry road surfaces are where most accidents occur, followed by wet or damp conditions, snow, and then flooding over 3cm deep.
- **Implication:** Dry conditions resulting in the highest number of accidents again point to factors other than weather influencing accidents. Enhanced road safety measures, even during dry conditions, are essential. Improving drainage and road maintenance during adverse conditions can also help.

6. **Road Surface Type (100% Stacked Bar Chart):**



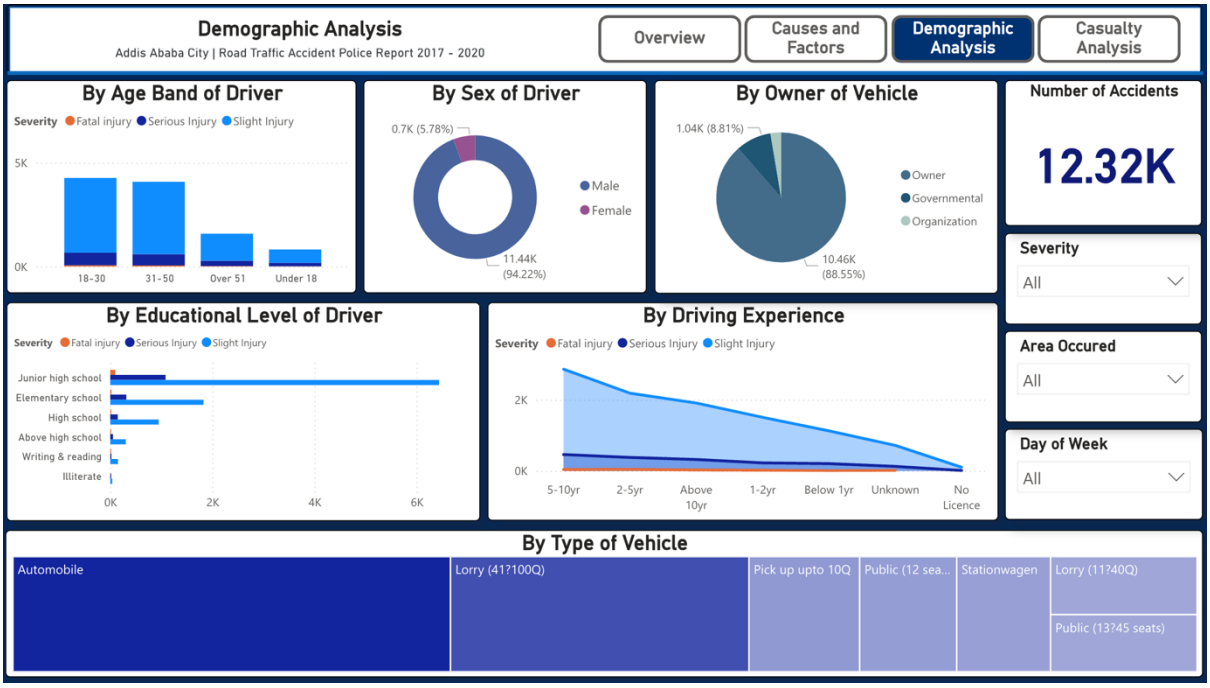
- **Insight:** Asphalt roads see the highest accident frequency, followed by gravel roads, earth roads, and asphalt roads with some distress.
- **Implication:** The high number of accidents on asphalt roads may be due to higher traffic volumes on these roads. Ensuring regular maintenance and quality checks on asphalt roads can reduce accident rates. Focused interventions on less maintained road types like earth and gravel roads are also needed to ensure overall road safety.

Interactivity and Filters

1. **Accident Cause Filter:**
   - Allows users to filter data based on specific causes of accidents.
   - **Usage:** Select specific causes (e.g., driver error, vehicle defect, environmental factors) to see how metrics change for each cause. This helps in understanding the impact of various contributing factors and planning targeted interventions.
2. **Severity Filter:**
   - Provides the ability to filter accident data by the severity of injuries.
   - **Usage:** Analyze trends and patterns for different severity levels to prioritize road safety measures and resource allocation effectively.

Dashboard 2 provides a comprehensive analysis of the causes and contributing factors to road traffic accidents in Addis Ababa City. The visualizations effectively highlight the impact of weather, lighting, vehicle age, road surface conditions, and road types on accident occurrences and their severity.

IV.3. Dashboard 3: Demographic Analysis



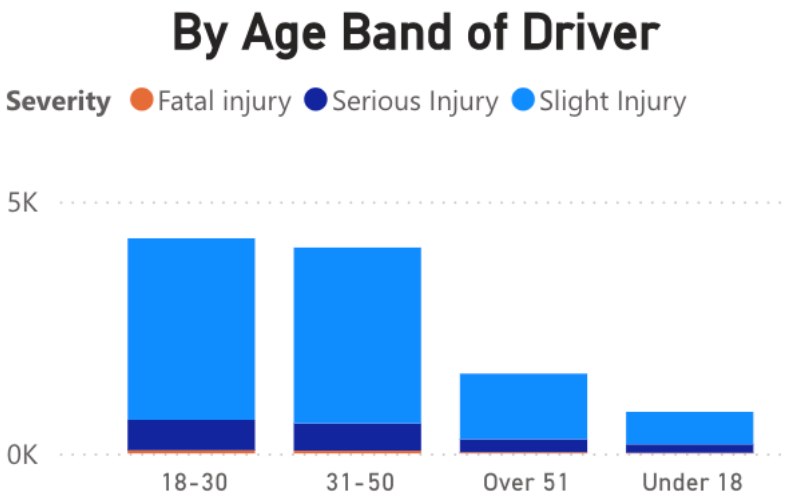
Summary of Key Metrics

- **Total Number of Accidents:** 12.32K
- **Severity Distribution:**
    - Slight Injury: 84.56%
    - Serious Injury: 14.15%
    - Fatal Injury: 1.28%

These metrics provide an immediate overview of the total accidents and their severity distribution, indicating the overall impact of road traffic incidents on public health and safety.

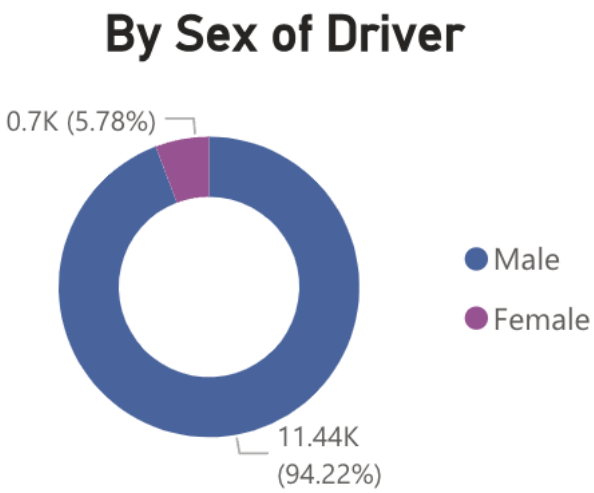
Visual Analysis

1. **By Age Band of Driver (Stacked Column Chart):**



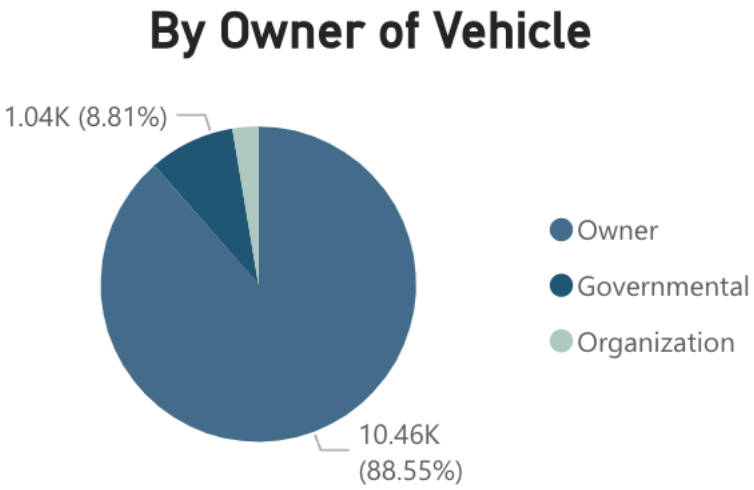
- **Insight:** The majority of accidents involve drivers aged 18-30 and 31-50. Drivers over 51 and under 18 are involved in fewer accidents.
- **Implication:** The high number of accidents among young and middle-aged drivers suggests that these age groups may benefit from targeted educational campaigns focused on safe driving practices. Addressing risk behaviors specific to these age groups, such as speeding and distracted driving, could reduce accident rates. Additionally, implementing graduated licensing programs for young drivers and continuous education for middle-aged drivers might help in reducing accident occurrences.

2. **By Sex of Driver (Donut Chart):**



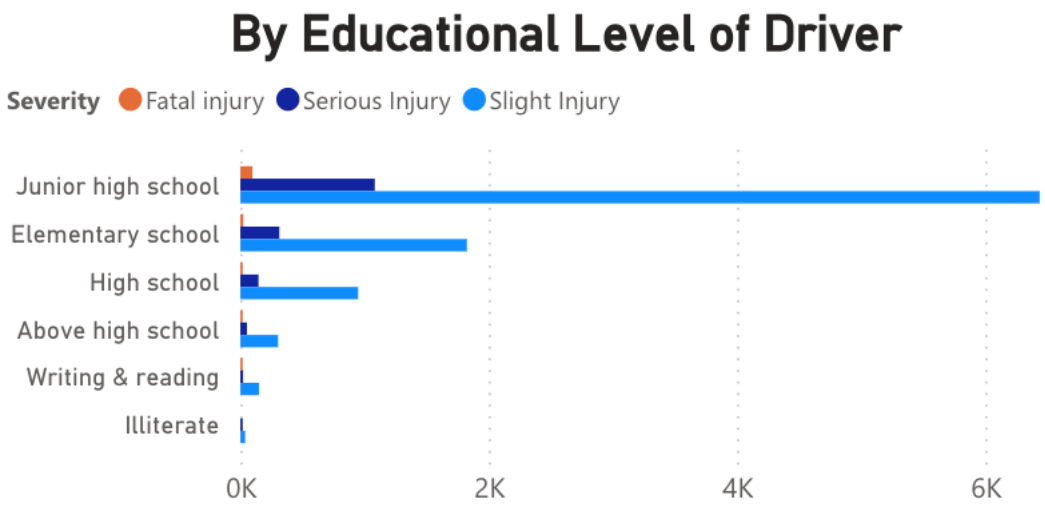
- **Insight:** Males are involved in 94.22% of accidents, while females account for 5.78%.
- **Implication:** The significant disparity between male and female drivers involved in accidents suggests that road safety programs should include gender-specific approaches. This could involve addressing risk-taking behaviors more common among male drivers and promoting safe driving habits across both genders. Campaigns targeting male drivers should focus on reducing aggressive driving and encouraging adherence to traffic laws.

3. **By Owner of Vehicle (Pie Chart):**



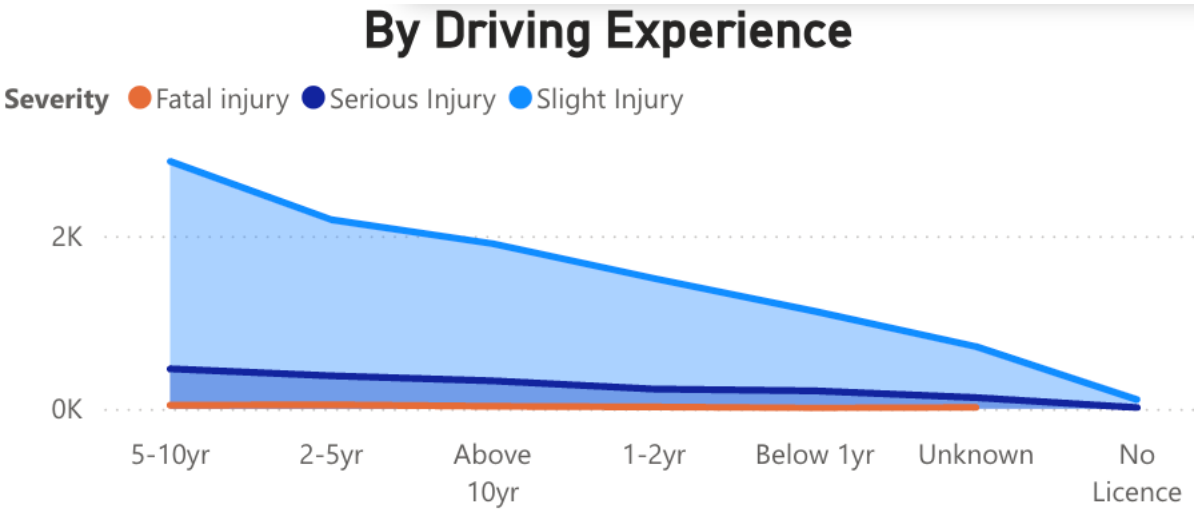
- **Insight:** Privately owned vehicles are involved in 88.55% of accidents, followed by governmental (8.81%) and organizational vehicles (2.64%).
- **Implication:** The predominance of private vehicles in accidents indicates a need for enhanced vehicle safety inspections and owner education programs. It also suggests that government and organizational fleets may benefit from stricter maintenance protocols and driver training programs. Encouraging regular maintenance checks and promoting the use of modern safety features in private vehicles can help reduce accident rates.

4. **By Educational Level of Driver (Clustered Bar Chart):**



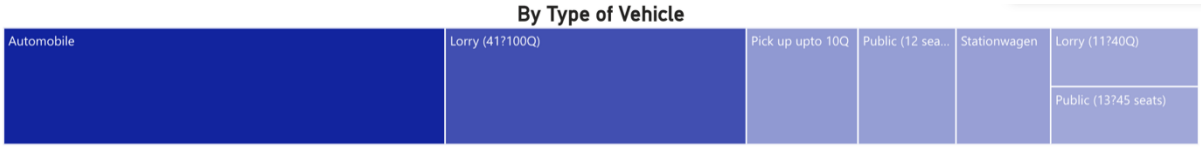
- **Insight:** Drivers with junior high school education are involved in the most accidents, followed by those with elementary and high school education. Those with higher education levels are involved in fewer accidents.
- **Implication:** The data suggests that educational level may influence driving behavior and accident rates. Targeted educational campaigns that focus on road safety could be integrated into school curriculums at various levels to instill safe driving practices from a young age. Programs to enhance road safety awareness and defensive driving skills should be promoted, especially among those with lower educational attainment.

5. **By Driving Experience (Area Chart):**



- **Insight:** Drivers with 5-10 years of experience are involved in the most accidents, followed by those with 2-5 years of experience. The number of accidents decreases with more and less experience.
- **Implication:** This pattern indicates that drivers in their mid-career stages might become overconfident or complacent, leading to higher accident rates. Emphasizing continuous driver education and periodic refresher courses could help mitigate this issue. Providing incentives for experienced drivers to participate in advanced driving courses and ensuring regular assessments can maintain high safety standards.

6. **By Type of Vehicle (Treemap):**



- **Insight:** Automobiles are the most frequently involved in accidents, followed by lorries, pick-up trucks, public vehicles, station wagons, and other types.
- **Implication:** The high involvement of automobiles suggests a need for stringent safety standards and inspections for personal vehicles. Additionally, focused interventions for commercial vehicles like lorries and pick-up trucks could include advanced driver training and stricter regulatory compliance. Promoting the use of safety technologies and implementing policies that encourage safer vehicle designs can reduce accident involvement.

Interactivity and Filters

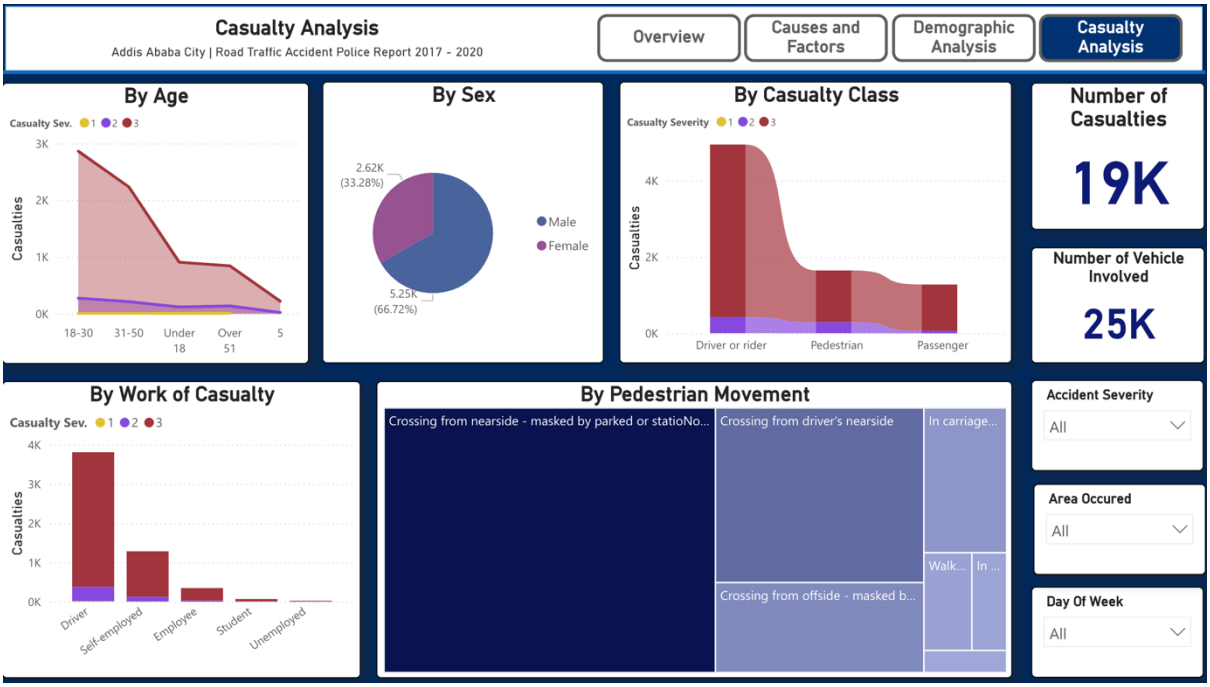
1. **Severity Filter:**
   - Allows users to filter data based on the severity of the accidents, providing tailored insights for different types of incidents.
   - **Usage:** Select specific severity levels (e.g., slight injury, serious injury, fatal injury) to see how metrics change for each category. This helps in understanding the distribution and impact of different severity levels across various parameters.
2. **Area Filter:**

- Provides the ability to filter accident data by specific areas where the accidents occurred.
- **Usage:** Analyze trends and patterns for different areas to identify high-risk locations and implement targeted interventions. Understanding area-specific accident trends can help in deploying resources effectively and planning infrastructure improvements.

3. **Day of Week Filter:**
   - Enables filtering of accident data by specific days of the week.
   - **Usage:** Focus on particular days to understand daily variations and plan road safety measures accordingly. Identifying high-risk days can help in deploying traffic officers and enhancing public awareness campaigns.

Dashboard 3 provides a comprehensive demographic analysis of road traffic accidents in Addis Ababa City. The visualizations effectively highlight the impact of driver age, sex, educational level, driving experience, vehicle ownership, and vehicle type on accident occurrences and their severity.

IV.4. Dashboard 4: Casualty Analysis



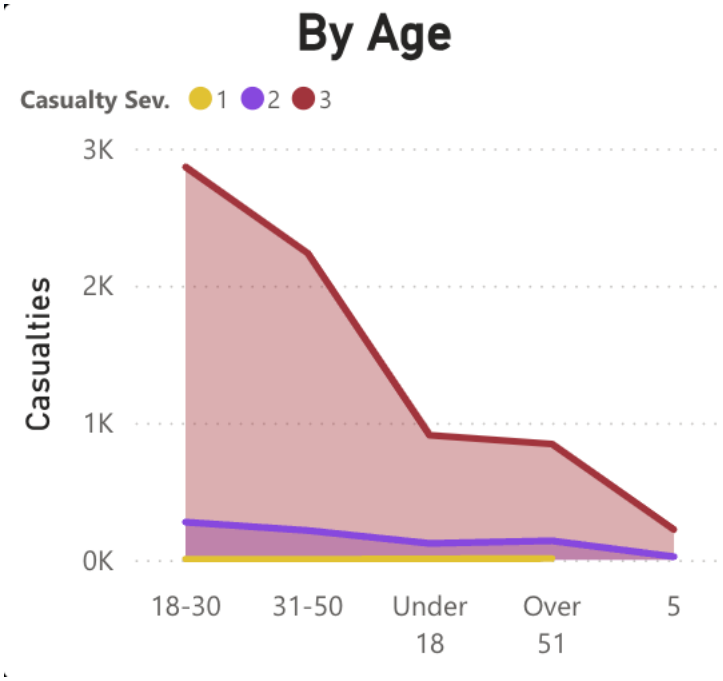
Summary of Key Metrics

- **Total Number of Casualties:** 19K
- **Number of Vehicles Involved:** 25K

These metrics provide an immediate overview of the total number of casualties and the vehicles involved in the accidents, indicating the overall impact on public health and safety.

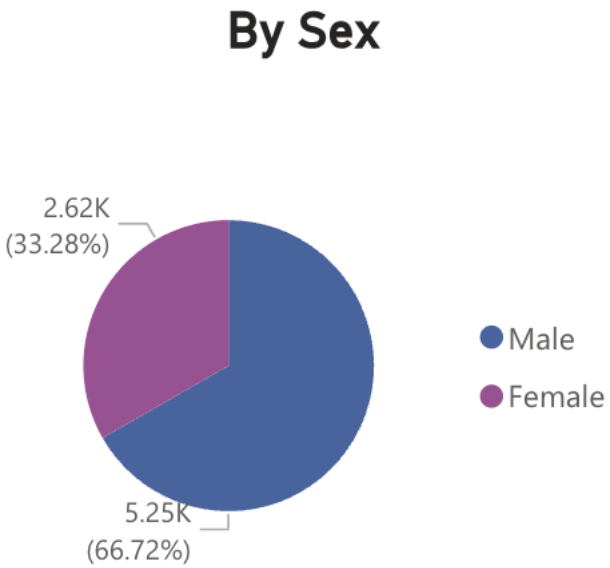
Visual Analysis

1. **By Age of Casualty (Stacked Area Chart)**



- **Insight:** The majority of casualties are aged 18-30, followed by those aged 31-50. There are fewer casualties among those under 18 and over 51.
- **Implication:** The high number of young and middle-aged casualties indicates that these age groups are at higher risk. Targeted interventions, such as educational programs focusing on road safety for young adults and workplace safety for middle-aged individuals, could help reduce these numbers. Additionally, promoting safe practices among younger and middle-aged pedestrians can also be beneficial.

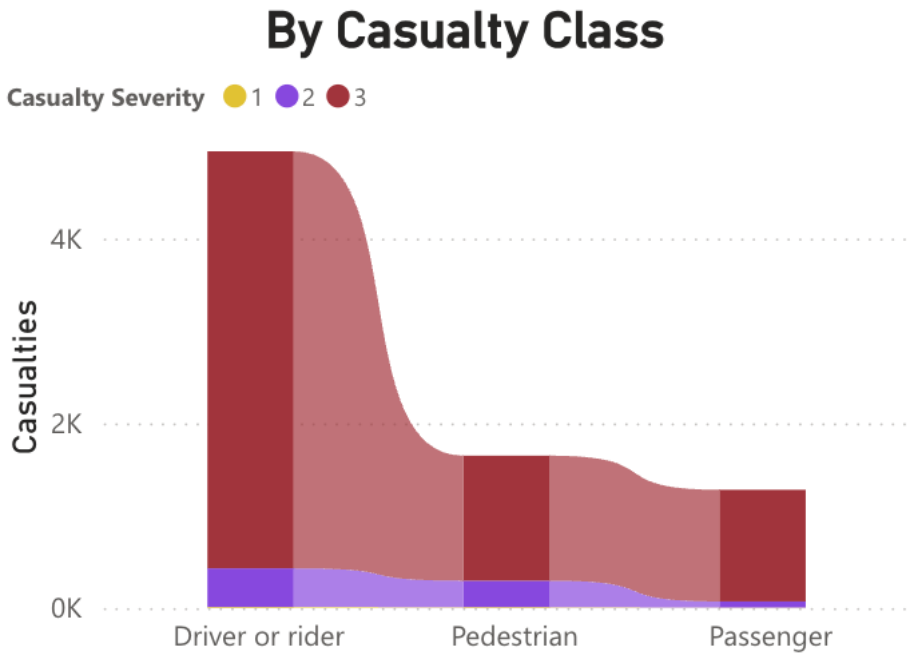
2. **By Sex of Casualty (Pie Chart):**



- **Insight:** Males account for
- 66.72% of casualties, while females make up 33.28%.

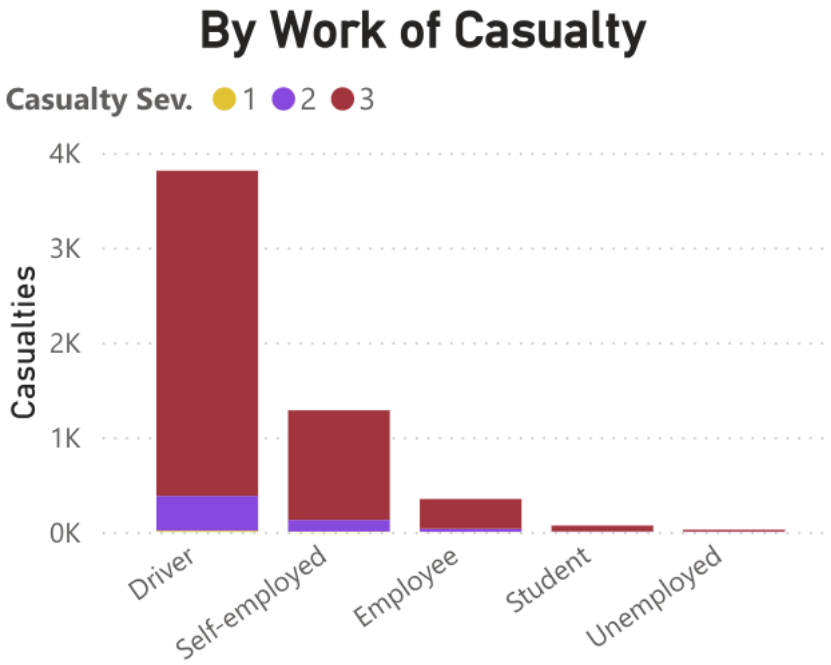
- **Implication:** The higher proportion of male casualties suggests that road safety programs should include gender-specific approaches. Addressing risk-taking behaviors more common among males and promoting safe practices for all genders can help reduce the casualty rate. Gender-specific educational campaigns and interventions can be developed to address these disparities.

3. **By Casualty Class (Ribbon Chart):**



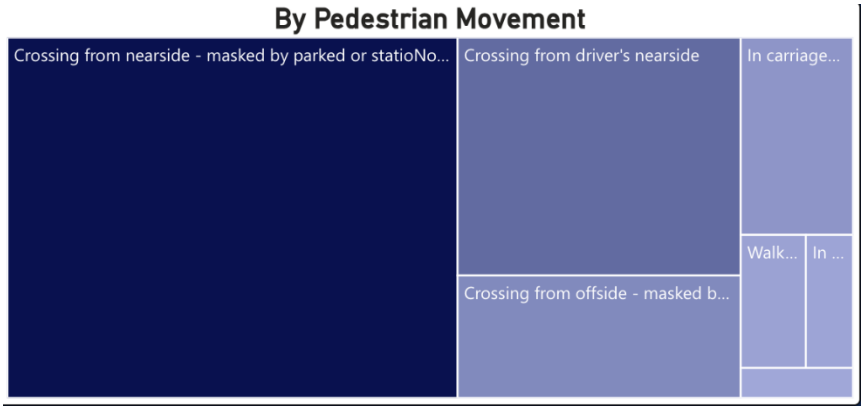
- **Insight:** Drivers or riders constitute the largest class of casualties, followed by pedestrians and passengers.
- **Implication:** The high number of driver or rider casualties indicates a need for targeted safety programs focusing on this group. Enhancing driver education, promoting the use of safety gear, and improving vehicle safety features can help reduce the number of casualties in this class. For pedestrians and passengers, improving road infrastructure, such as pedestrian crossings and passenger safety measures, is crucial.

4. **By Work of Casualty (Stacked Column Chart):**



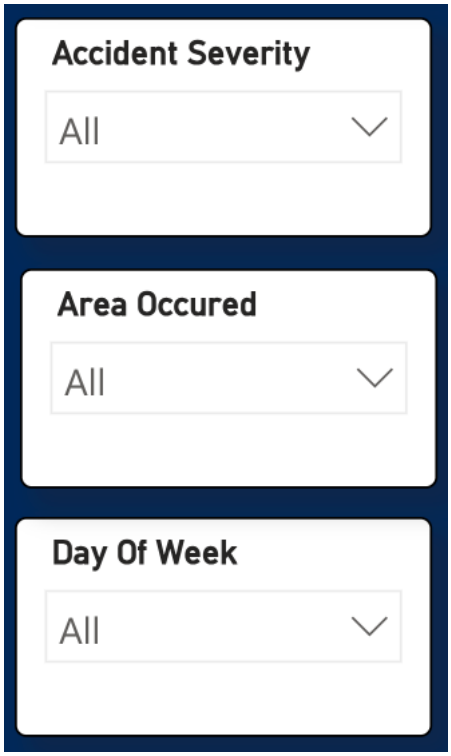
- **Insight:** Most casualties are drivers, followed by self-employed individuals, employees, students, and the unemployed.
- **Implication:** The high number of driver casualties underscores the need for continuous driver education and training programs. Tailored interventions for self-employed individuals and employees, such as workplace safety training and flexible working hours to avoid peak traffic times, can help reduce casualty numbers. Educational institutions can also play a role in promoting road safety among students.

5. **By Pedestrian Movement (Treemap):**



- **Insight:** The highest number of pedestrian casualties occur while crossing from the nearside, masked by parked or stationary vehicles, followed by crossing from the driver's nearside and in carriageways.
- **Implication:** Improving pedestrian safety measures, such as clear pedestrian crossings, better signage, and removing visual obstructions near crossing points, can help reduce the number of pedestrian casualties. Educating pedestrians about safe crossing practices and enhancing driver awareness regarding pedestrian presence can also contribute to safer road environments.

Interactivity and Filters



1. **Accident Severity Filter:**
    - Allows users to filter data based on the severity of the casualties, providing tailored insights for different types of incidents.
    - **Usage:** Select specific severity levels (e.g., slight injury, serious injury, fatal injury) to see how metrics change for each category. This helps in understanding the distribution and impact of different severity levels across various parameters.
2. **Area Filter:**
    - Provides the ability to filter casualty data by specific areas where the accidents occurred.
    - **Usage:** Analyze trends and patterns for different areas to identify high-risk locations and implement targeted interventions. Understanding area-specific casualty trends can help in deploying resources effectively and planning infrastructure improvements.
3. **Day of Week Filter:**
    - Enables filtering of casualty data by specific days of the week.
    - **Usage:** Focus on particular days to understand daily variations and plan road safety measures accordingly. Identifying high-risk days can help in deploying traffic officers and enhancing public awareness campaigns.

Dashboard 4 provides a comprehensive analysis of casualties resulting from road traffic accidents in Addis Ababa City. The visualizations effectively highlight the impact of age, sex, casualty class, work of casualty, and pedestrian movement on casualty occurrences and their severity.

V. CONCLUSION

This data visualization project has successfully transformed the raw data on road traffic accidents in Addis Ababa into an interactive dashboard that empowers stakeholders with actionable insights. By adhering to principles of user-friendliness, clear visual hierarchy, and a focus on actionable insights, the dashboard provides a comprehensive view of the city's road safety landscape.

Through the dashboard's four distinct sections, we have unveiled a multi-faceted understanding of road traffic accidents in Addis Ababa:

1. **Overview:** A snapshot of the scale and severity of accidents, highlighting trends over time and spatial distributions.
2. **Causes and Contributing Factors:** A deep dive into the primary causes, including environmental conditions, vehicle factors, and driver demographics.
3. **Demographic Analysis:** An exploration of the demographics of individuals involved in accidents, particularly drivers, shedding light on potential risk factors.
4. **Casualty Analysis:** An examination of casualty demographics and injury severity, emphasizing the human impact of these accidents.

While this project represents a significant step forward in harnessing data for road safety improvements, it is not without limitations. The dataset, originating from manual police records, may contain inherent biases or inconsistencies. Additionally, the analysis is retrospective, focusing on past accidents, and may not fully capture emerging trends or the impact of recent interventions.

Moving forward, there is a wealth of potential for further research and dashboard enhancement. This could include:

- **Incorporating real-time data:** Integrating live traffic data and accident reports to provide up-to-the-minute insights and enable rapid response.
- **Predictive modeling:** Leveraging machine learning techniques to forecast accident hotspots and identify high-risk scenarios.
- **Expanding data sources:** Incorporating data from hospitals, insurance companies, and other relevant sources to enrich the analysis.

In conclusion, this data visualization project serves as a foundation for evidence-based decision-making in road safety initiatives in Addis Ababa. By empowering stakeholders with accessible and actionable insights, we aspire to contribute to a future where road traffic accidents are significantly reduced, and the city's streets become safer for all.