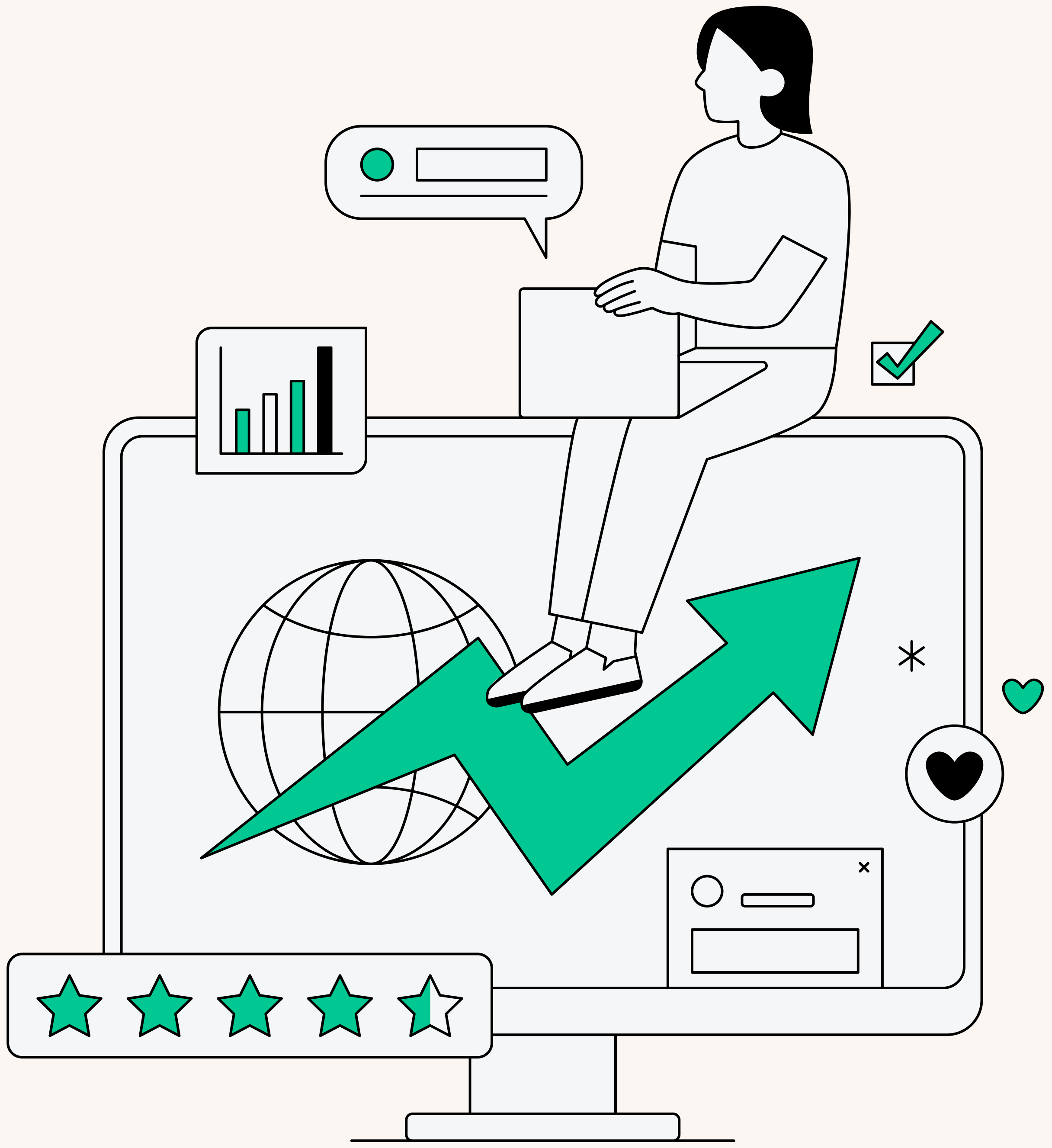
Aviation Risk Analysis Project

Presented by Alfred Ricky Otieno

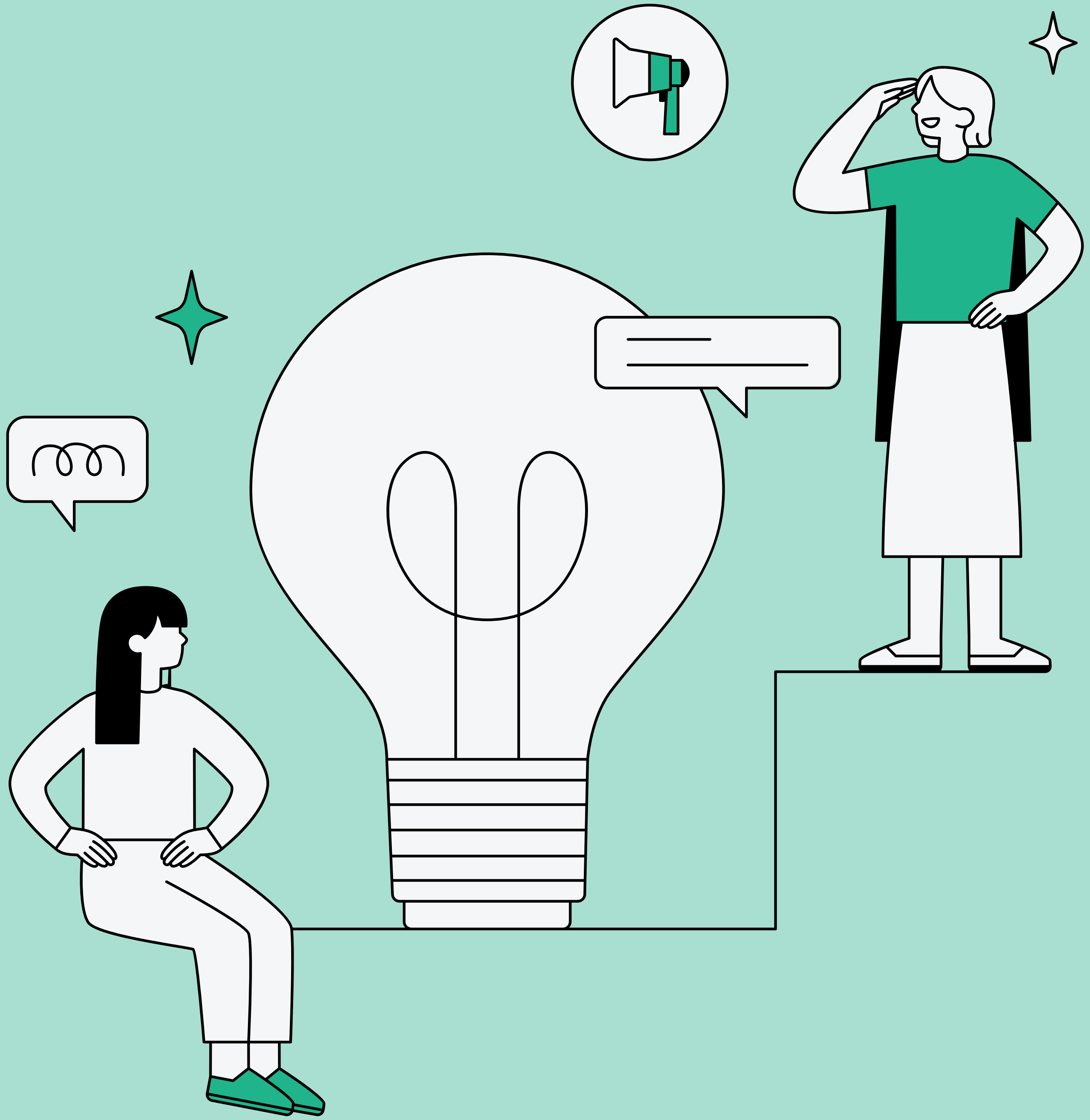
Date: 07th September 2024



Project Overview

This project analyzes aviation incidents with the goal of identifying key risk factors, including aircraft types, flight phases, and weather conditions, to recommend safety improvements for the aviation industry.

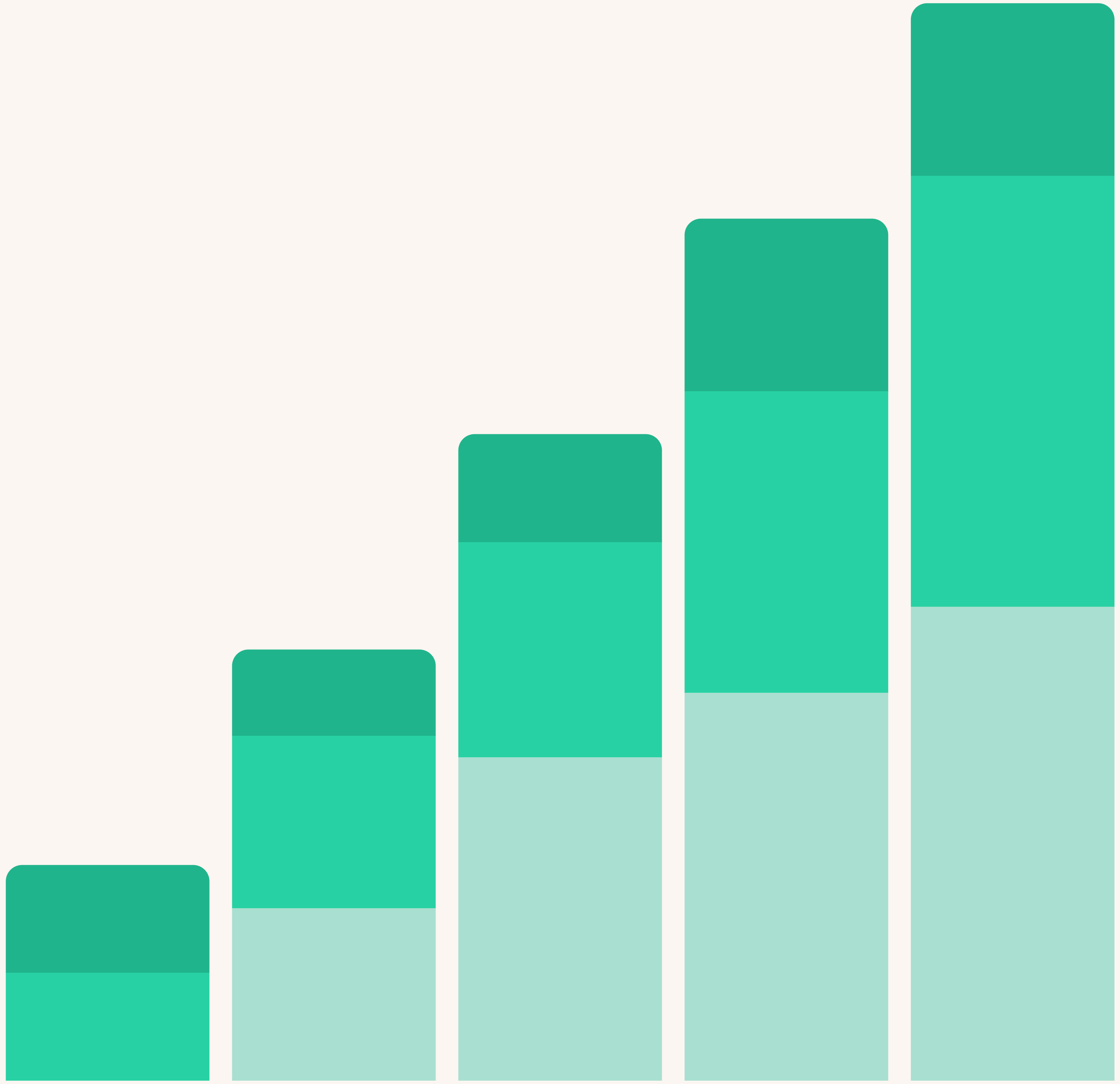
The project follows the Cross Industry Standard Procedure for Data Mining (CRISP-DM) methodology to ensure a systematic and data-driven approach.



Business Understanding

- Business Context: Our company is looking to diversify its portfolio by entering the aviation industry. Specifically, the company is interested in purchasing and operating airplanes for both commercial and private enterprises. However, the company lacks expertise in aviation and is concerned about the potential risks associated with aircraft. The management needs a comprehensive understanding of these risks to make informed decisions about which aircraft to purchase and operate.

- Problem Statement: We need to identify low-risk aircraft types, understand the trends and patterns in aviation incidents, and evaluate the impact of different factors such as weather conditions, flight phases, and aircraft age on incident rates.



Objectives

01.

Objective 1: Identify Low-Risk Aircraft Types:

- Analyze historical incident data to determine which aircraft models have the lowest incident rates.

02.

Objective 2: Analyze Incident Trends Over Time:

- Conduct a time series analysis to track the frequency of incidents over the years and identify patterns.

03.

Objective 3: Assess the Impact of Flight Phases on Incidents:

- Evaluate the risk associated with each flight phase (e.g., takeoff, landing) by analyzing incident severity.

Objectives

04.

Objective 4: Investigate the Role of Weather Conditions:

- Analyze the correlation between weather conditions (IMC, VMC) and the likelihood and severity of incidents.

Our goal is to identify patterns in aviation incidents to improve safety by understanding which aircraft types are at higher risk and how external factors like weather and flight phases contribute to incident severity

Data Understanding

Our dataset contains 10,000+ records of aviation incidents with the following key variables:

- Make and Model (aircraft type).
- Event.Date (date of the incident).
- Total.Fatal.Injuries, Total.Serious.Injuries, Total.Minor.Injuries (severity of incidents).
- Weather.Condition (IMC, VMC, etc.).

Some challenges with the data include:

- Missing values in Weather.Condition and some injury-related fields.
- Inconsistent naming conventions for Make (e.g., 'CESSNA' vs 'Cessna').
- Outliers in injury counts for some incidents.

Data Preparation and Cleaning

01.

Standardizing aircraft Make names: Merging variations like 'Cessna' and 'CESSNA' into a single entry using Tableau calculated fields.

02.

Handling missing data: Replacing NULL values in injury-related fields with 0 to ensure accurate aggregations.

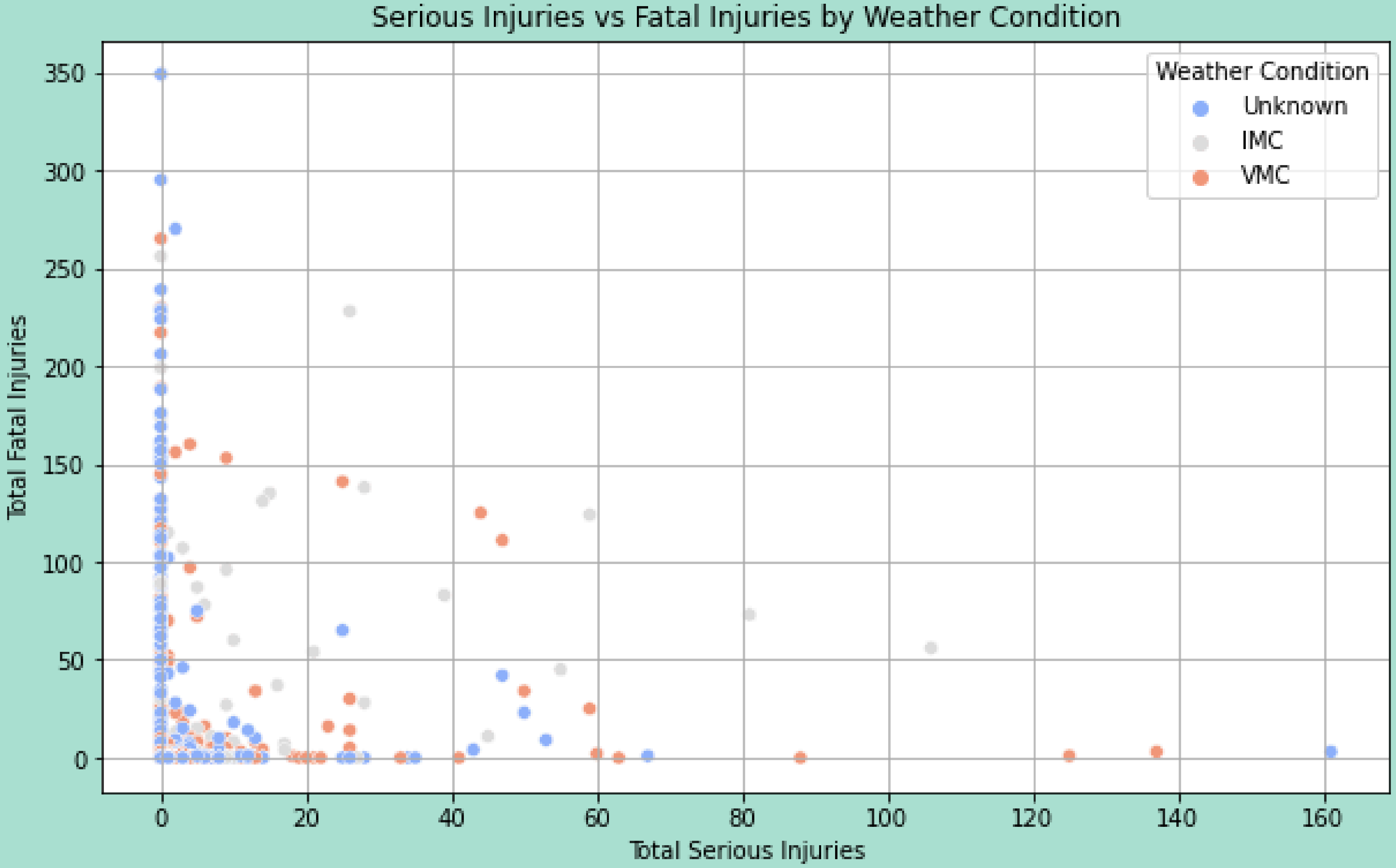
03.

Dealing with outliers: For example, capping extreme values of Total.Fatal.Injuries to avoid skewing the analysis.

Exploratory Data Analysis (EDA)

Trends: Our exploratory analysis revealed that:

- Incidents have decreased in frequency over the last two decades.
- Aircraft models like PA-28-140 show consistently lower fatalities, while others, like Cessna 172M, have a wider range of outcomes.



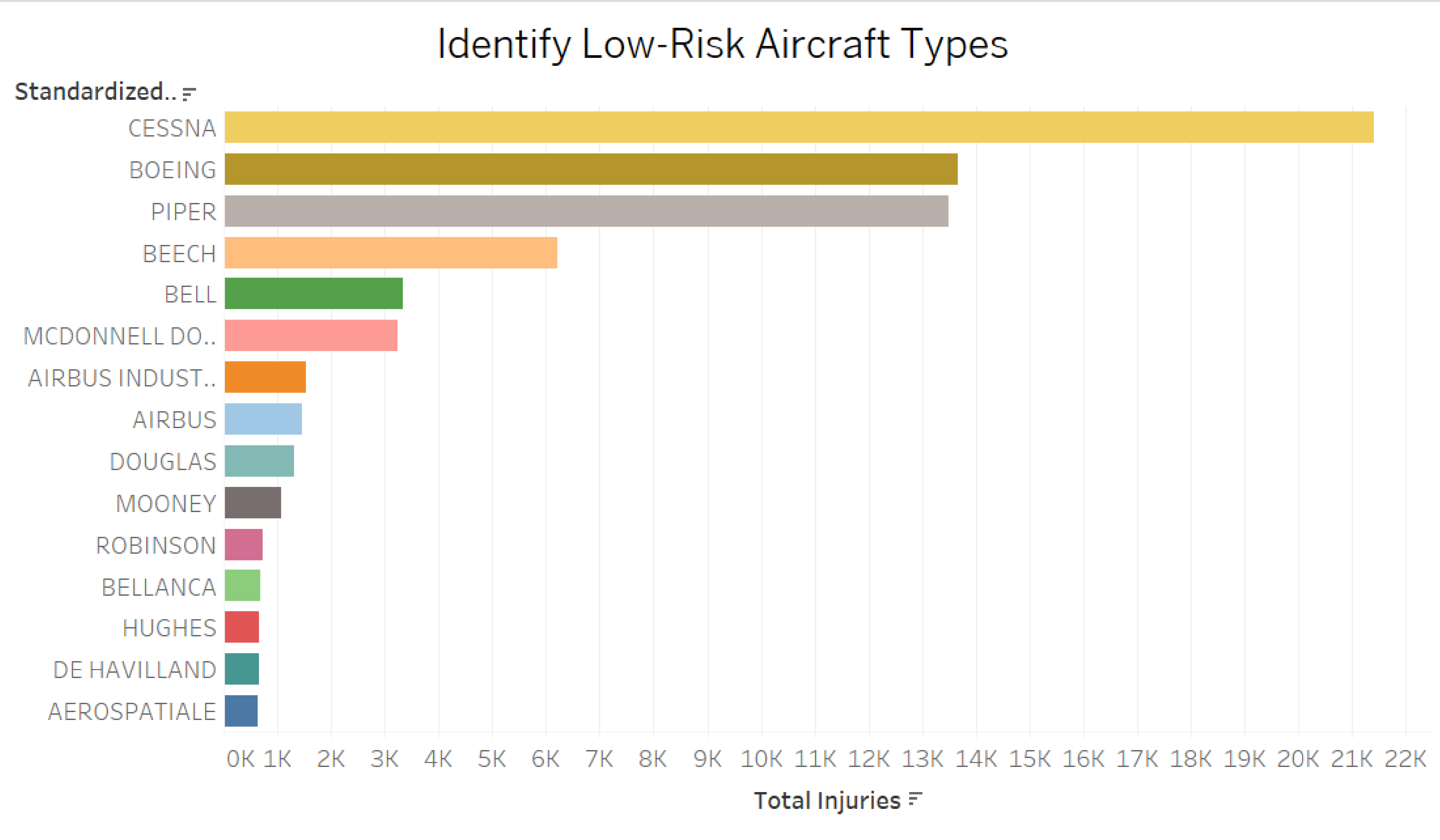
Key Insights:

- Weather conditions seem to play a role, with IMC incidents tending to be more severe.

Key Analysis 1 – Low-Risk Aircraft Types

The analysis of total fatal and serious injuries across aircraft models revealed that:

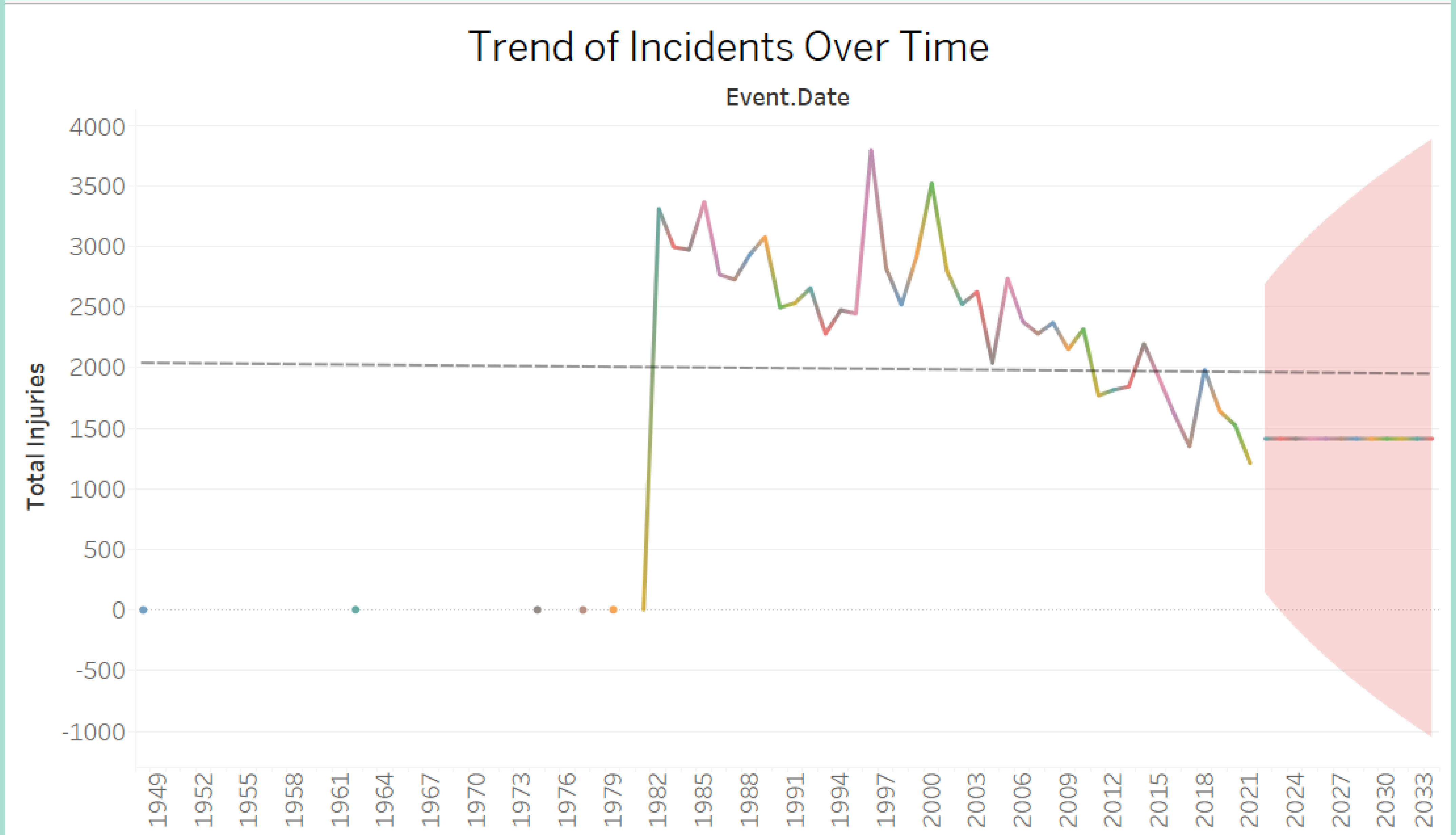
- Aerospatiale consistently ranks as one of the safest models with fewer fatalities.
- On the other hand, models like Cessna 172M have higher incident rates, making them higher risk.



Key Insights:

- 1. CESSNA has the highest number of incidents, suggesting it might be widely used or more prone to incidents compared to other aircraft types.
- 2. PIPER and BEECH also have a high number of incidents, indicating they are commonly involved in incidents.
- 3. Aircraft types like MOONEY and AEROSPATIALE have relatively lower incident counts, indicating they may be used less frequently or are safer.

Key Analysis 2- Incident Trends Over Time

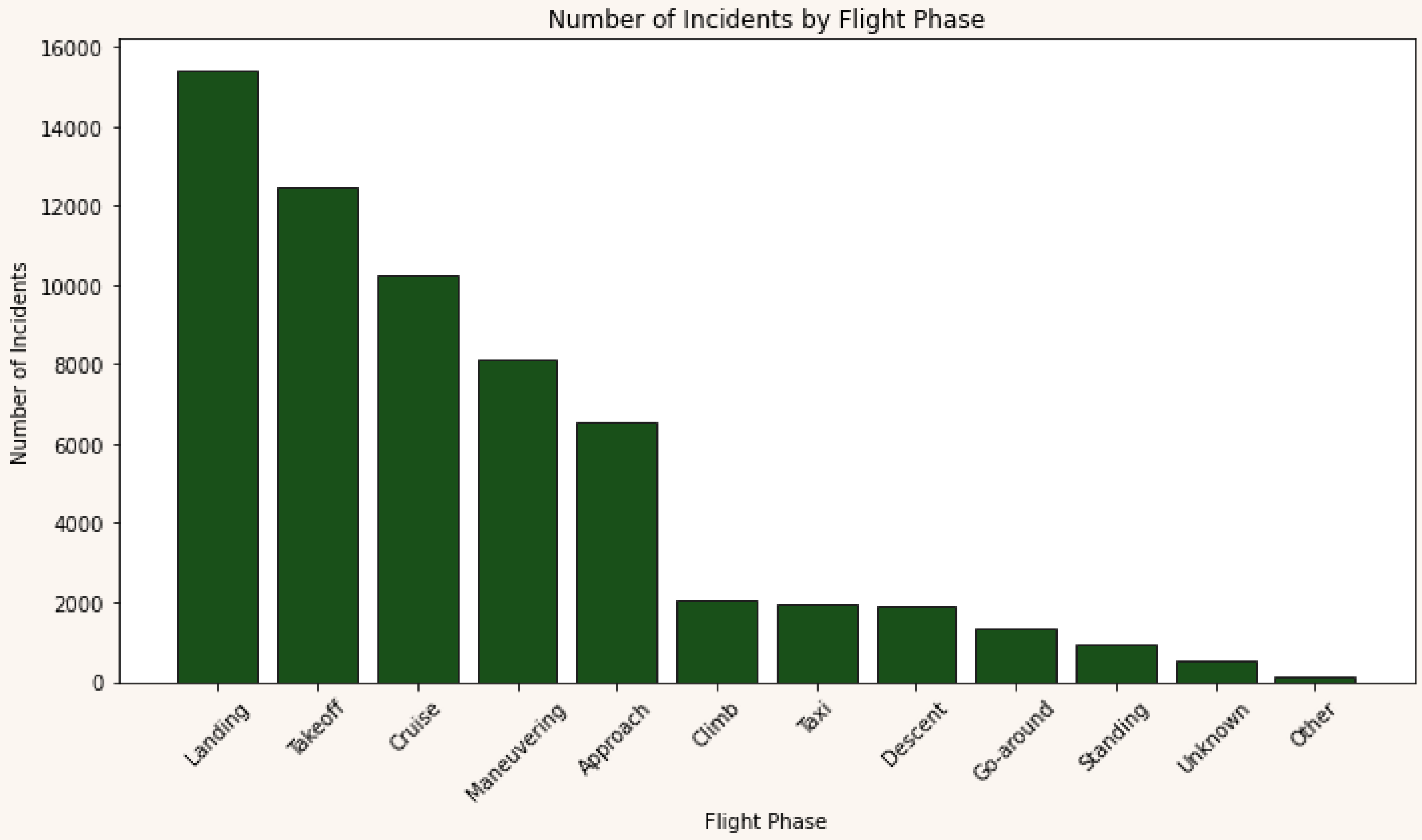


- Pre-1982: No incidents recorded, likely due to missing data.
- Mid-1980s Peak: Highest number of incidents, possibly due to increased aviation activity or reporting.
- Late 1980s to Early 2000s Decline: Gradual reduction in incidents, suggesting improved safety and regulations.
- Post-2000 Stabilization: Consistent incident numbers, indicating a mature and controlled aviation environment.

Key Insights

By plotting incidents over time, we observed a notable decline in incident frequency after the early 2000s. However, incident severity (fatalities) has fluctuated year to year.

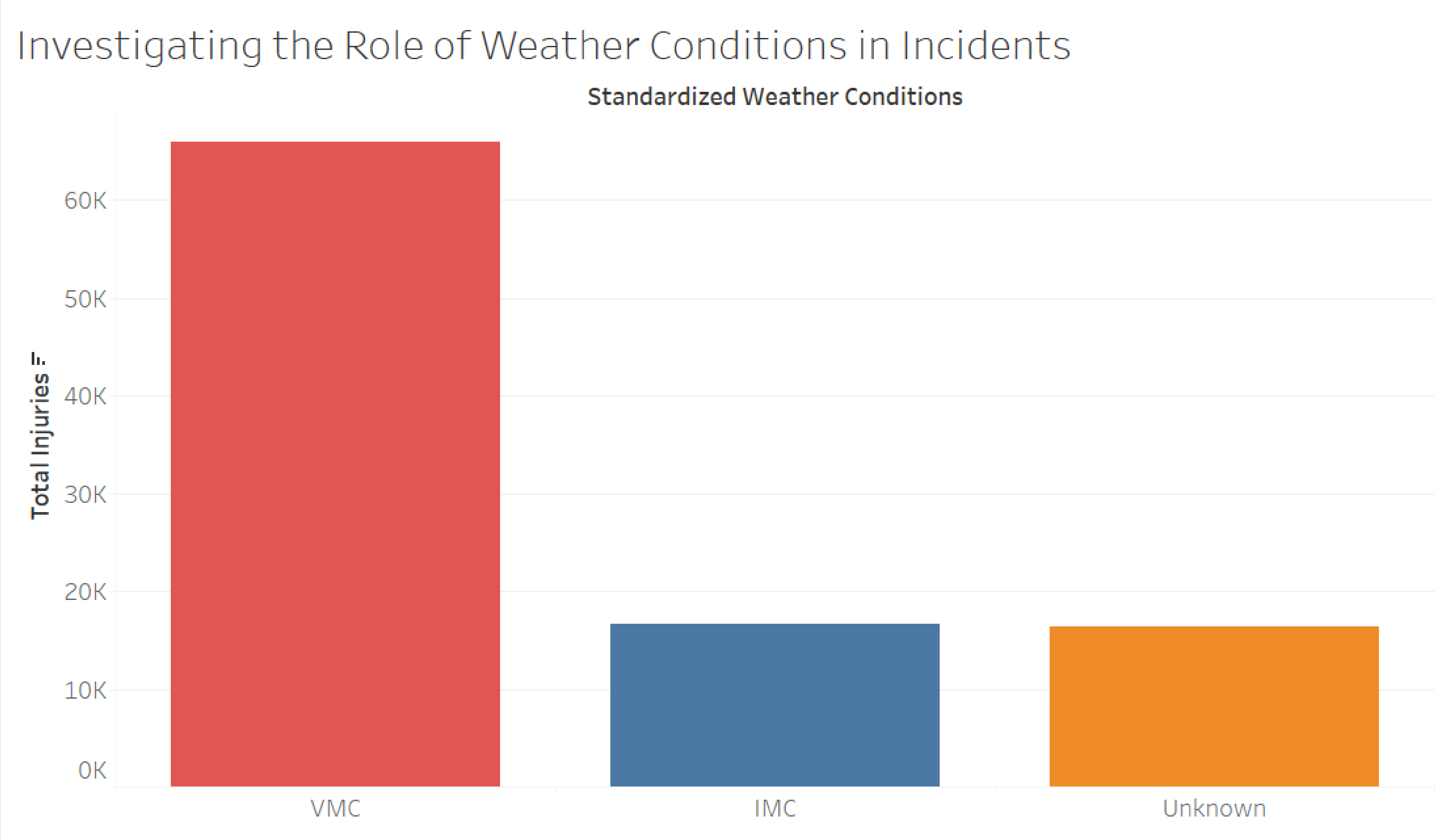
Key Analysis 3 – Impact of Flight Phases on Incidents



Observations:

1. LANDING: This phase has the highest number of incidents, indicating that landing is the most critical phase with the most reported incidents.
2. TAKEOFF: The second-highest number of incidents occurs during takeoff, suggesting this phase also poses significant risks.
3. CRUISE: This phase shows a considerable number of incidents, making it the third-highest, which indicates that despite being generally safer, cruise still experiences notable risks.
4. APPROACH: A significant number of incidents occur during approach, highlighting that this preparatory phase for landing is also risky.
5. MANEUVERING: While not as high as the other phases, maneuvering still shows a notable number of incidents, pointing to risks during in-flight maneuvers.

Key Analysis 4 – Role of Weather Conditions



Observations:

1. VMC (Visual Meteorological Conditions): The highest number of incidents, indicating most flights occur in these conditions or unexpected challenges arise even in clear weather.
2. IMC (Instrument Meteorological Conditions): Fewer incidents than VMC, suggesting careful handling of adverse weather, but still notable.
3. UNK (Unknown): Few incidents, likely due to incomplete or unreported weather data.

Business Recommendations

Prioritize Low-Risk Aircraft Models for Commercial Operations

Aircraft models like PA-28-140 have shown consistently lower incident severity based on historical data. These aircraft should be prioritized for commercial use.

Why?: The PA-28-140 exhibited fewer total injuries and fatalities compared to other models. By selecting safer models, you lower the operational risk and enhance overall safety.

Increase Safety Protocols During Takeoff and Landing Phases

Enhance Safety During Critical Flight Phases

Strengthen safety protocols during takeoff and landing, which account for the highest number of serious incidents and fatalities.

Why?: These phases of flight are the most critical, with a higher likelihood of severe incidents. Strengthening safety measures during these stages can significantly reduce the risk of fatalities and serious injuries.

Business Recommendations

Improve Training for Pilots Operating in IMC

Incidents that occur under IMC (poor weather and visibility) conditions tend to be more severe in terms of both fatalities and serious injuries. Pilots should undergo additional, focused training on instrument flying and operating in adverse weather to reduce risk under these challenging conditions

Limitations and Future Work

Key limitations in the dataset include:

- Missing data for certain variables, especially Weather.Condition.
- No information about aircraft age or maintenance history, which could be crucial factors in risk analysis."

Future Work: Incorporating aircraft maintenance records and weather forecast data could enable the development of predictive models for incident severity.

Conclusion

Our analysis identified the key factors that impact aviation safety, including aircraft type, flight phase, and weather conditions. By implementing targeted safety improvements, we can significantly reduce the risk of fatal incidents in the aviation industry.

Presented by Alfred Ricky Otieno

Thank you very much!

Date: 07th September 2024