Minich Analytics

Aviation Accidents Analysis

Agenda

- Project Overview
- Business Question
- Data
- Data Cleaning & Feature Engineering
- Data Analysis
- Conclusion
- Recommendation

Words talk numbers scream

Tom Ellsworth- Biz Doc

Back to Agenda Page

Project Overview: Aviation Risk Analysis

- **Company Context:**
  - Diversification strategy to expand into the aviation industry.
  - Aims to purchase and operate airplanes for commercial and private enterprises.
- **Project Purpose:**
  - To assess the risks associated with different aircraft make and models.
  - Provide actionable insights to guide safe and cost-effective purchasing decisions.
- **Outcome:**
  - Support the new aviation division with data-driven recommendations for aircraft acquisition.

Business Problem & Objectives

- **Business Problem:**
  - The company is entering the aviation industry but lacks knowledge about aircraft risks.
  - Identify low-risk aircraft for the company’s commercial and private operations.
- **Key Business Questions:**
  - Which aircraft make and models have the lowest accident risks?
  - How have accident risks changed over time for specific aircraft models?
  - What operational factors impact accident risks for different aircraft models?

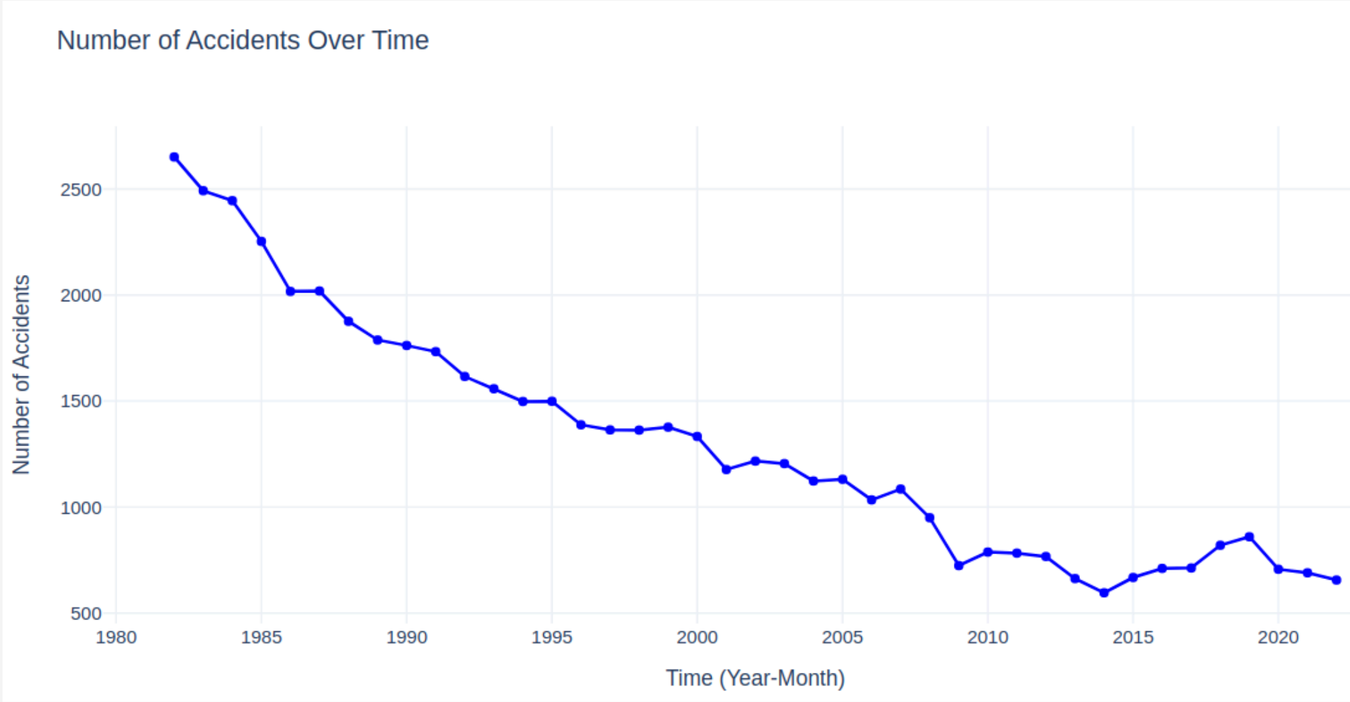
Data Overview

- **Dataset Source:**
  - Data retrieved from aviation safety databases and incident reports.
  - Includes information on aircraft accidents, injuries, damage, and operational conditions.
- **Key Features of the Dataset:**
  - **Event Details:** Date, location, and type of investigation.
  - **Aircraft Characteristics:** Make, model, damage severity, number of engines, and amateur build status.
  - **Injury Data:** Fatal, serious, minor injuries, and total people involved.
  - **Operational Conditions:** Weather conditions and phase of flight.

Data Analysis and Findings

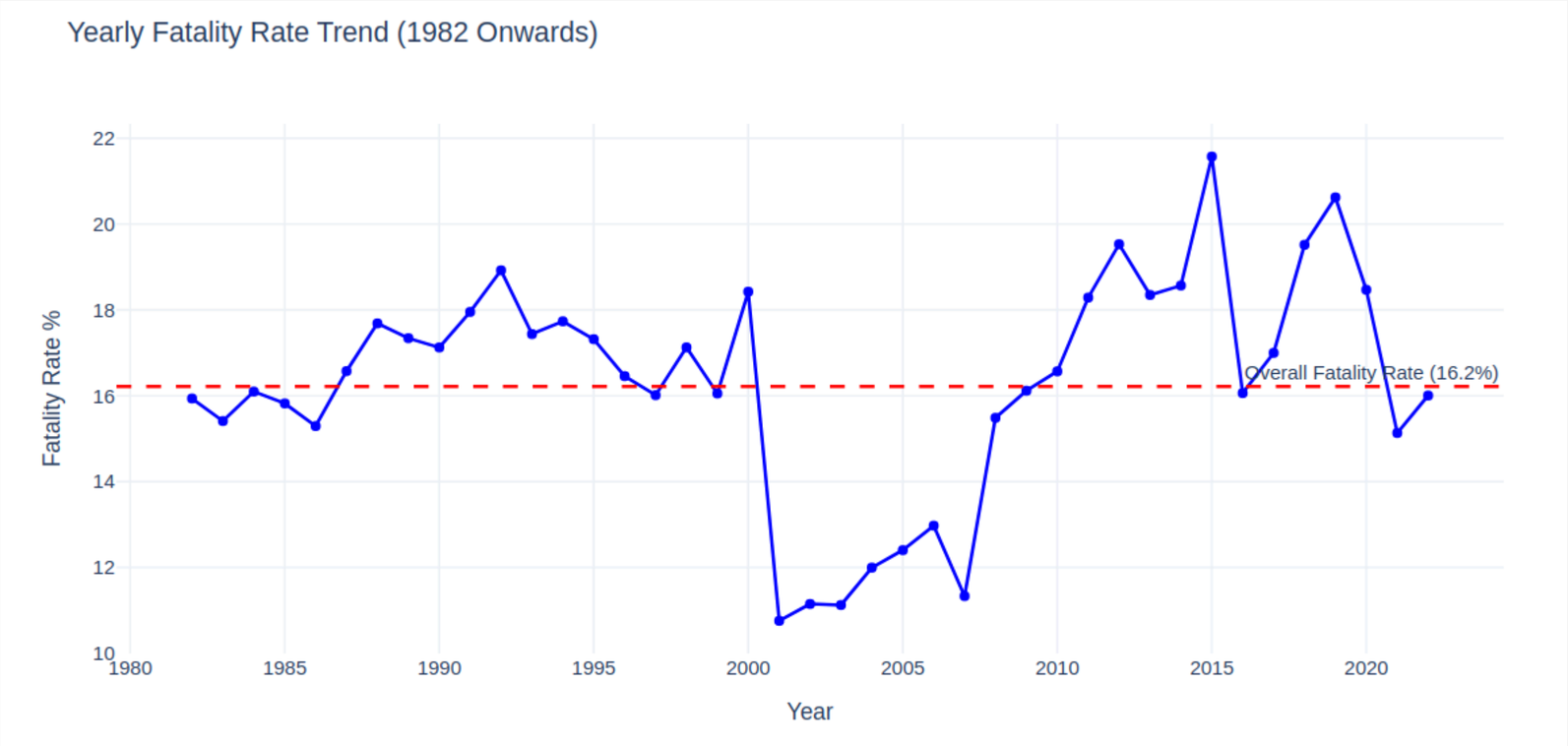
Trends in Number of Accidents Over Time

- **Key Findings:**
  - The decrease in aviation accidents since the 1980s reflects advancements in aviation safety measures
  - Trend appears to stabilize after 2010, with minor fluctuations around 2020.
  - The steep decline in the early years suggests major safety transformations during the 1980s and 1990s, likely due to safety practices and stricter industry regulations.



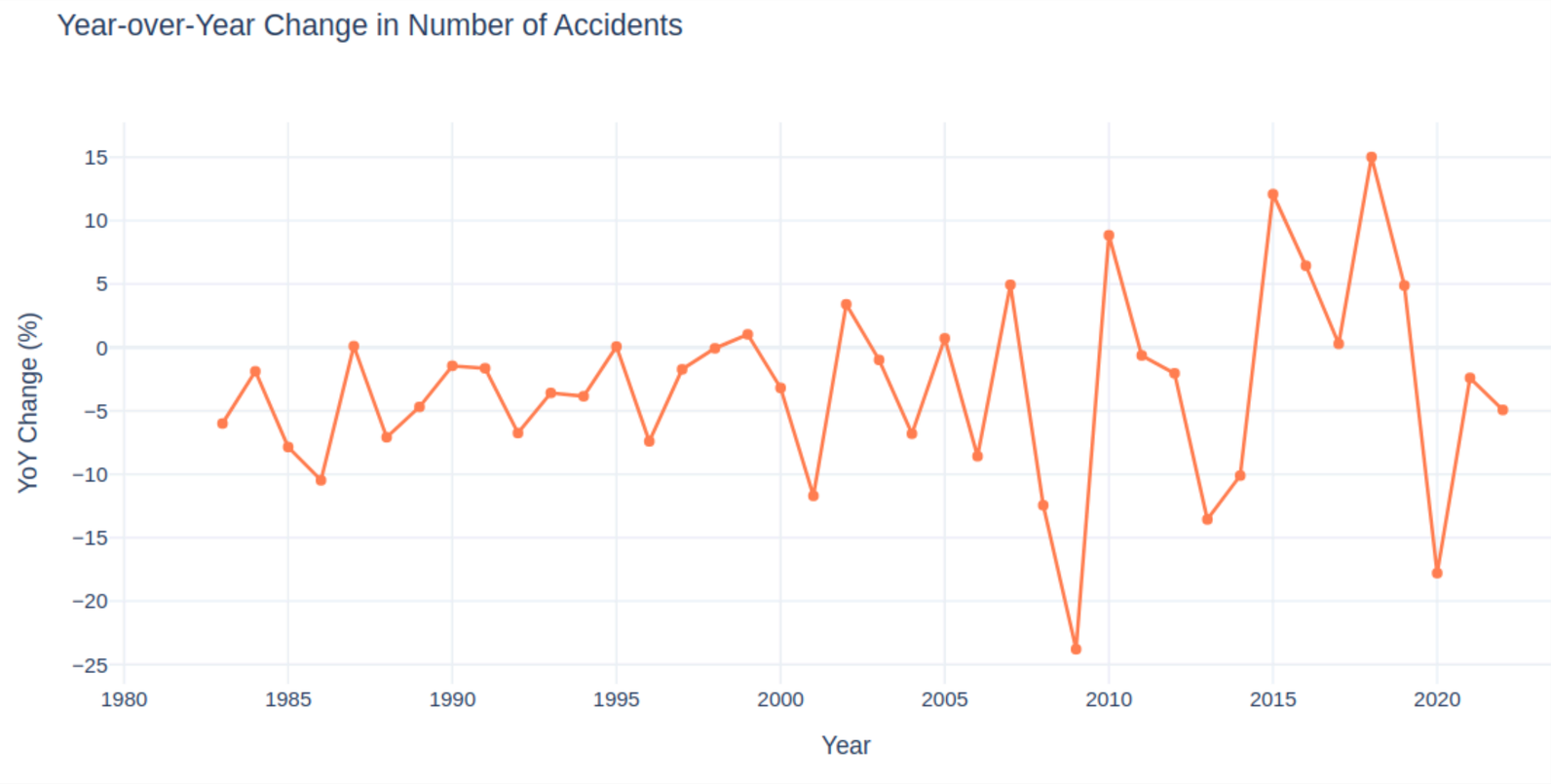
Yearly Fatality Rates

- **Key Findings:**
  - Rates oscillate around the 16.2% average.
  - Notable declines in early 2000s reflect improved safety protocols, emergency responses, or aircraft design.
  - Spikes Post-2010 suggest involvement of larger aircraft or higher casualty events.



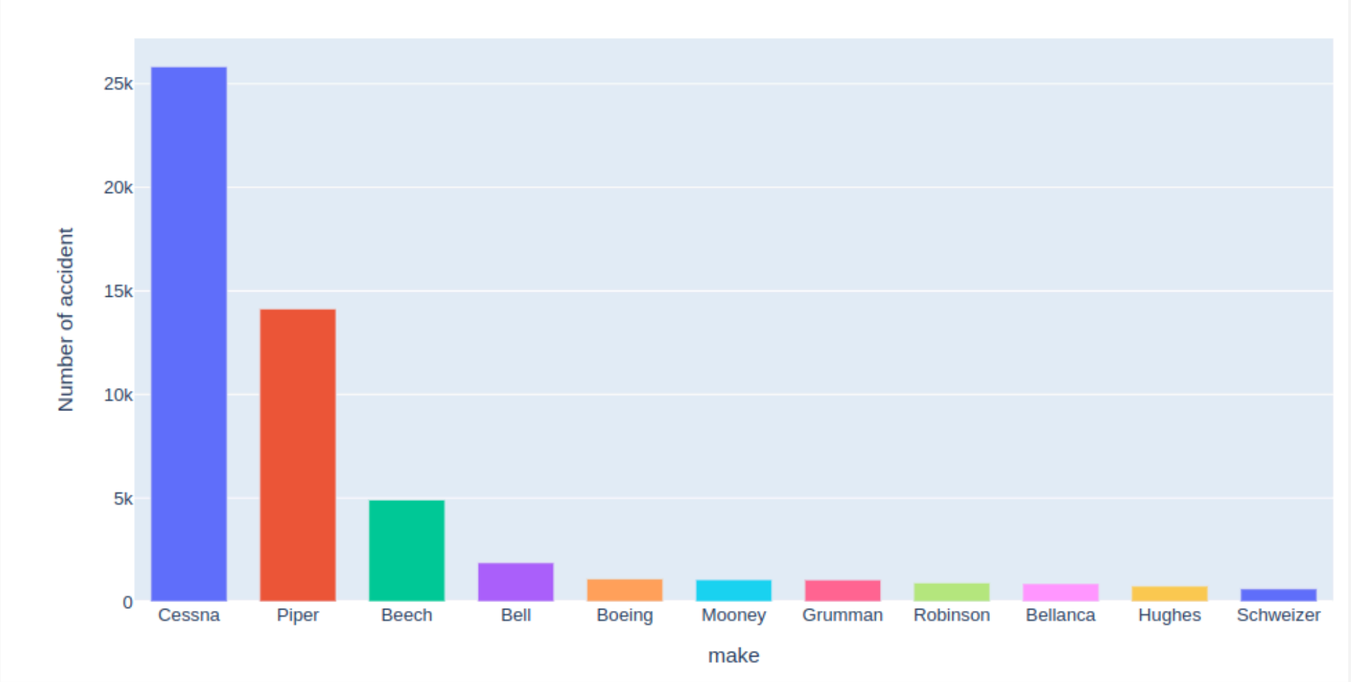
Year over year analysis

- **Key Findings:**
  - Highly Variable YoY Changes reflect external or temporary factors.
  - No Consistent YoY Increase Patterns reinforcing the overall downward trend in accident rates.
  - More Pronounced Volatility Post-2010 suggesting short-term factors influencing accident trends despite the decline.



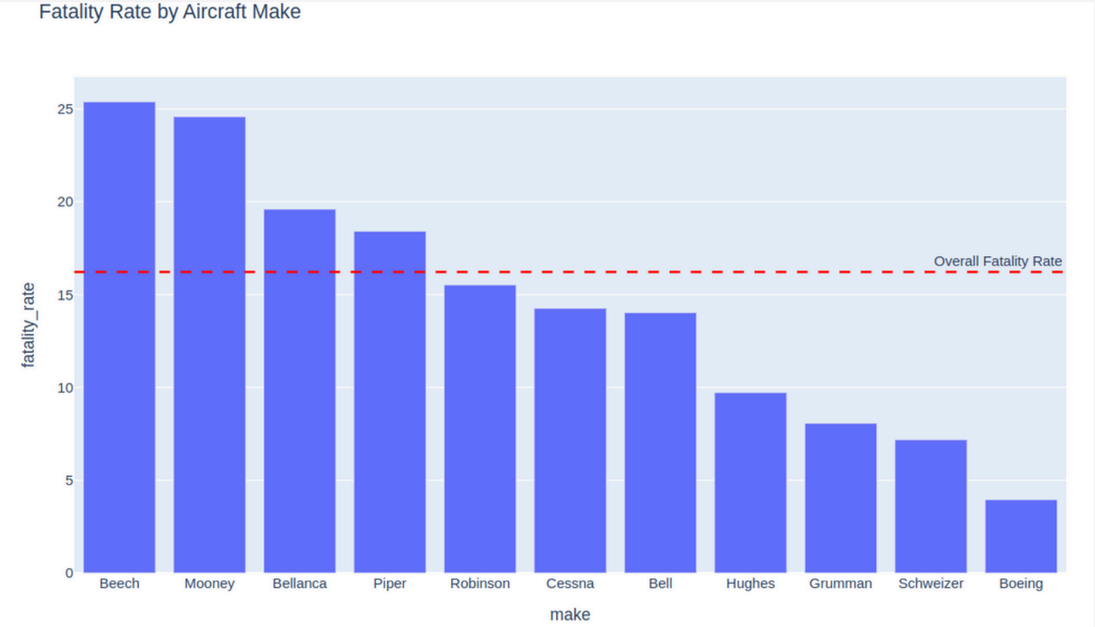
Aircraft with most Accidents

- Cessna leads with over 25,000 accidents, significantly higher than other manufacturers.
- Piper and Beech rank second and third, but with far fewer incidents.
- Aircraft makes like Bell, Boeing, and Mooney have fewer than 5,000 accidents, indicating concentrated risk in a few manufacturers.



Fatality Rate by Amateur-Built Aircraft

- **Key Findings:**
  - Beech and Mooney aircraft have fatality rates above 20%, exceeding the overall average of 16%.
  - Boeing has the lowest fatality rate, significantly below the average. Hughes, Grumman, and Schweizer fatality rates are also substantially lower that mean rate.
  - Bellanca and Piper aircraft show fatality rates just above the mean.
  - Cessna, Robinson and Bell are closer to or below the benchmark.

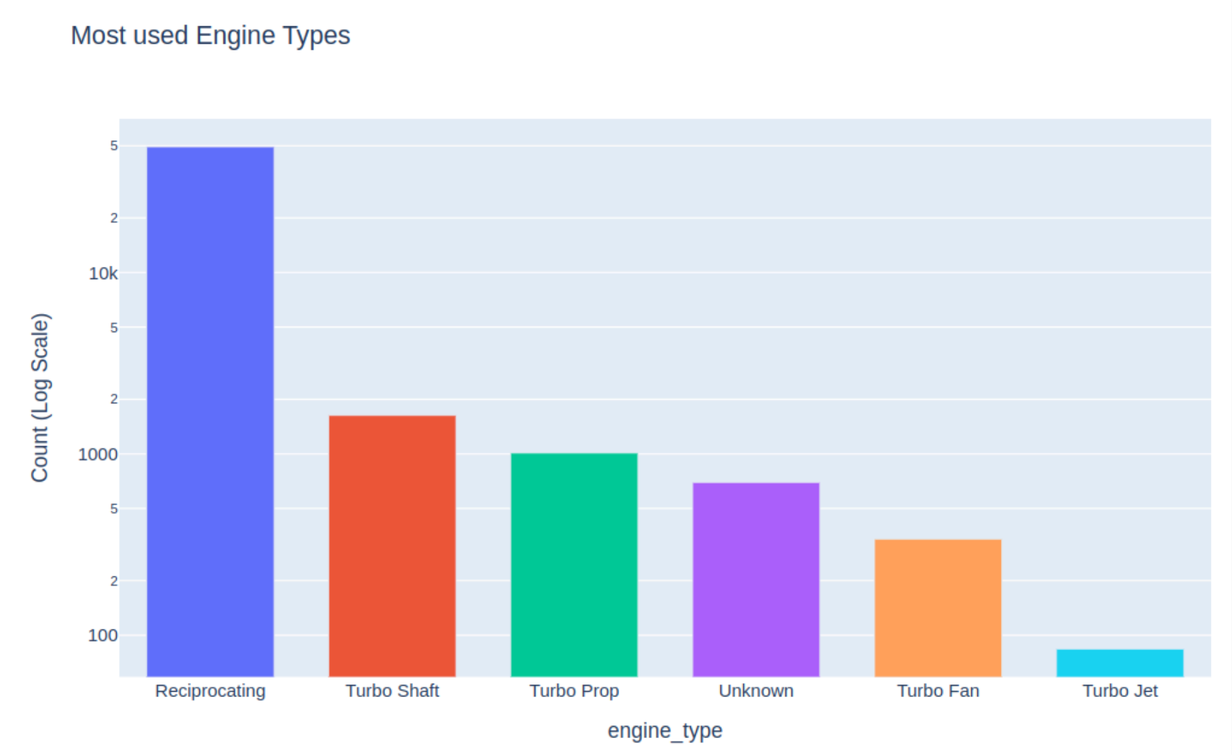


Comparison with Most Used Aircraft Make

- **Key Findings:**
  - Despite being the most accident-prone make, Cessna maintains fatality rates close to the average (16%).
  - Boeing, though less frequent in accidents, demonstrates exceptional safety with the lowest fatality rate.
  - Mooney and Bellanca, while not as commonly involved in accidents, exhibits one of the highest fatality rates..

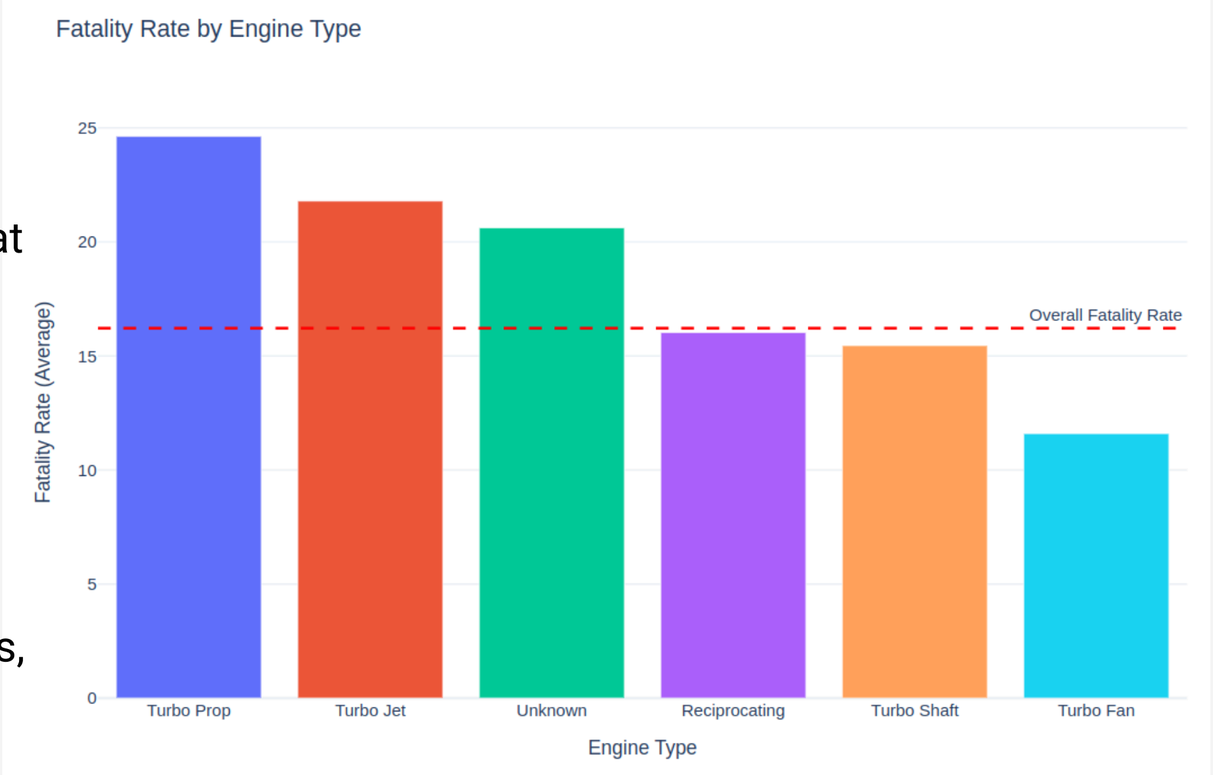
Most Used Type of Engines

- Reciprocating engines dominate, with over 14,000 occurrences, common in propeller-driven aircraft.
- Turbo Shaft engines are the second most common, used predominantly in helicopters, with around 1,800 occurrences.
- Other engine types like Turbo Fan and Turbo Jet have significantly fewer occurrences, under 500.



Fatality Rate by Engine Type

- Turbo Prop engines have the highest fatality rate, exceeding the overall average.
- Turbo Jet engines also exhibit a high fatality rate, though less severe than Turbo Props.
- Unknown engine types rank third, highlighting reporting gaps that need addressing.
- Reciprocating engines are closer to the overall average fatality rate, suggesting moderate safety performance.
- Turbo Shaft and Turbo Fan engines have the lowest fatality rates, reflecting improved safety technologies.

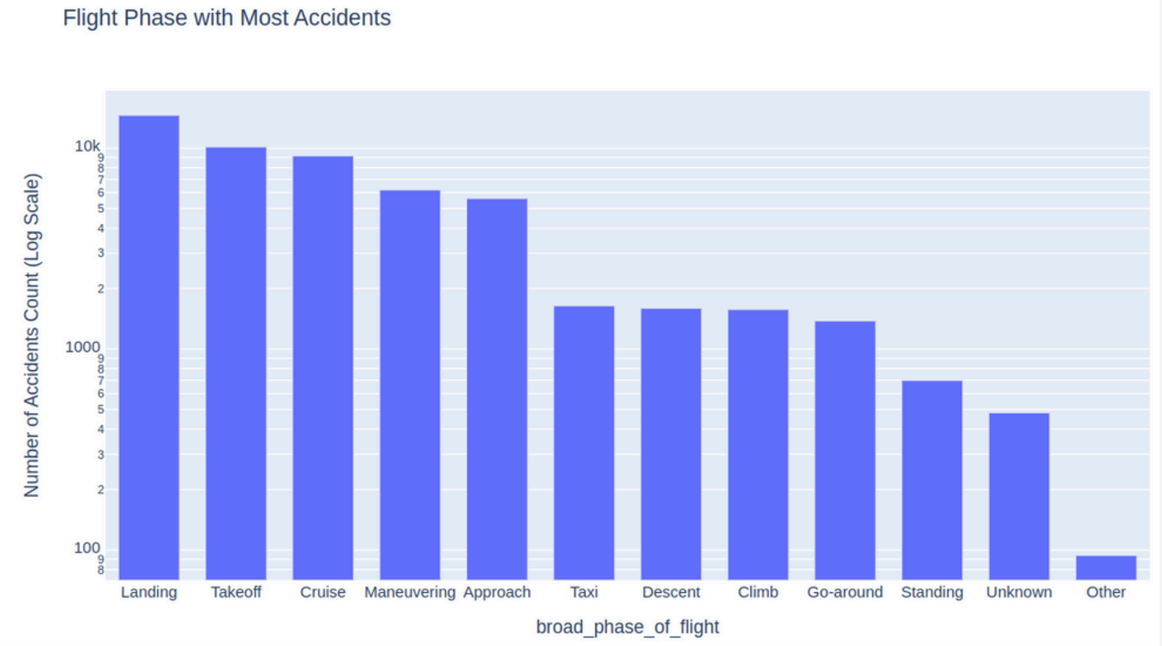


Comparison with Most Used Engine Types

- Reciprocating engines, despite being the most commonly used, maintain a moderate fatality rate, underscoring their relative reliability.
- Turbo Prop engines, though less prevalent, have a disproportionately higher fatality rate, posing significant risks.
- Turbo Fan and Turbo Shaft engines, while less used, demonstrate superior safety performance, suggesting potential for safer operations with modern engines.
- The discrepancy between usage and safety highlights the importance of balancing operational costs with safety outcomes when selecting engine types.

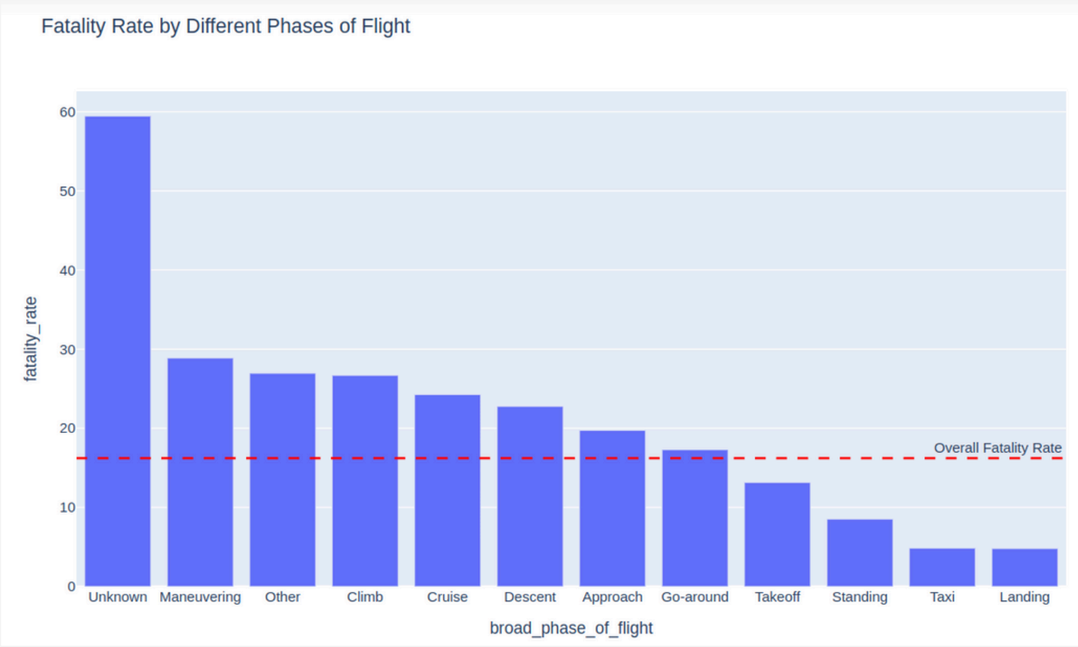
Phases of Flight with Most Accidents

- Landing phase accounts for the highest number of accidents, indicating this is the riskiest flight phase.
- Takeoff and Cruise phases follow, with operational challenges during these critical stages.
- Maneuvering and Approach phases are also notable but lower in comparison, while phases like Taxi and Climb have the least incidents.



Phase of Flight vs Fatality Rate

- The "Unknown" phase has the highest fatality rate, significantly exceeding the mean rate of 16%, emphasizing gaps in reporting or understanding.
- Fatality rates are also high during maneuvering, climb, cruise, descent, and approach, reflecting the critical nature of these phases requiring precise control.
- Lowest fatality rates are observed during go-around, takeoff, standing, taxi, and landing, suggesting these phases are safer despite some operational challenges.

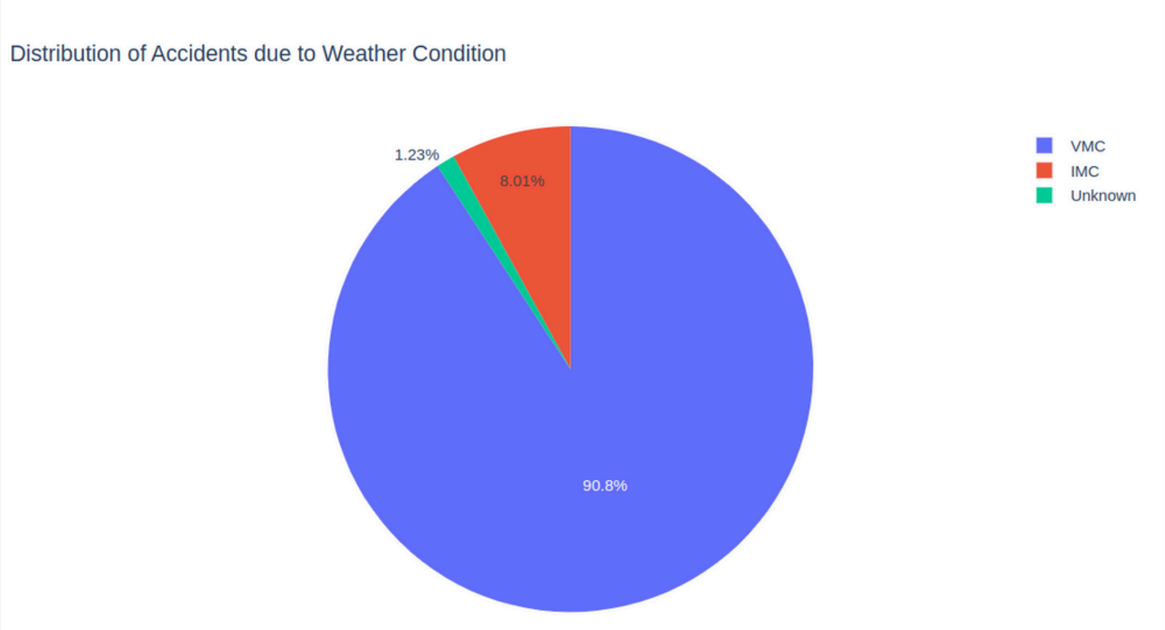


Phase of Flight and Fatality Rate by Phases Key Comparisons

- **Key Findings:**
  - High accident counts in landing and takeoff phases don’t necessarily correlate with high fatality rates, highlighting the distinction between frequency and severity.
  - Phases like maneuvering and approach appear high-risk in both metrics (accidents and fatalities), requiring focused interventions.
  - Low fatality rates during landing suggest advancements in safety measures during this phase, despite its high accident count.

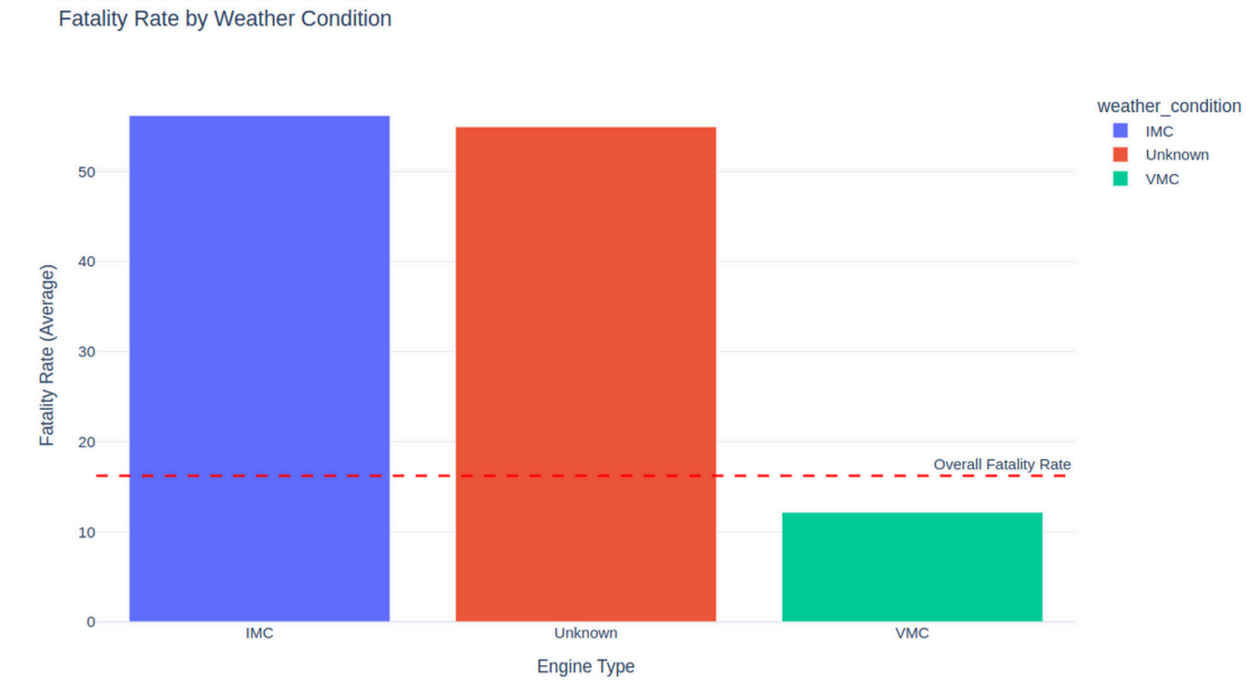
Weather Conditions with Most Accidents

- About 90.8% of accidents occur under Visual Meteorological Conditions (VMC), indicating weather is often not the primary cause.
- Only 8.01% occur in Instrument Meteorological Conditions (IMC), reflecting relatively fewer weather-related accidents.
- Minimal data is labeled as Unknown, ensuring strong data completeness for weather-related analysis..



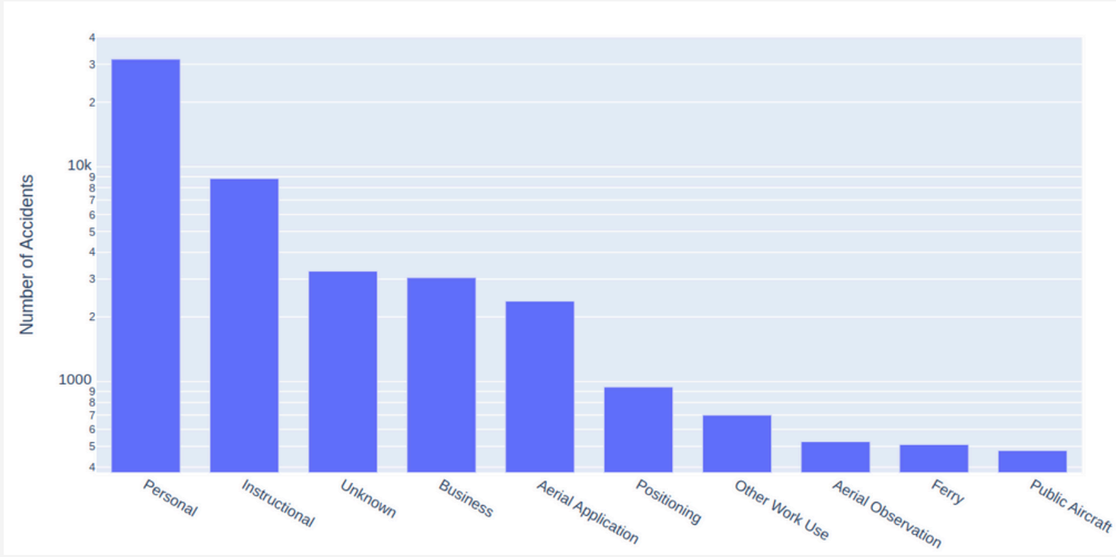
Fatality Rate by Weather Condition

- Unknown weather conditions have the high fatality rate, far exceeding the overall average, indicating critical reporting gaps.
- Instrument Meteorological Conditions (IMC) show a relatively high fatality rate, highlighting the risks of poor visibility or severe weather.
- Visual Meteorological Conditions (VMC) have a lower fatality rate, closer to the overall average, reaffirming the safety of favorable weather conditions.



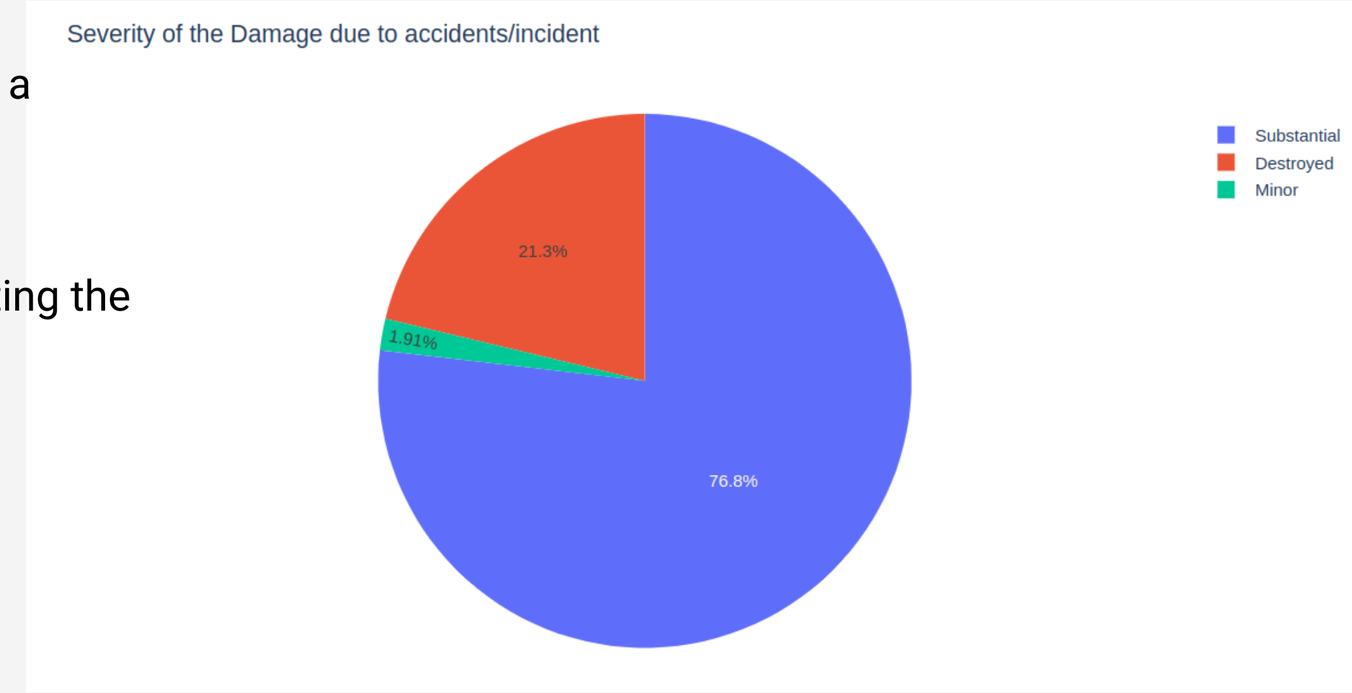
Flight Use Purpose and Number of Accidents

- Personal flights lead with over 14,000 accidents, reflecting higher risks in private or recreational operations.
- Instructional flights (e.g., student pilots) rank second, with around 8,500 accidents, showing significant safety challenges in training.
- Unknown purpose flights (4,000 accidents) highlight gaps in data clarity, while other purposes like Business and Aerial Application show lower but notable risks.



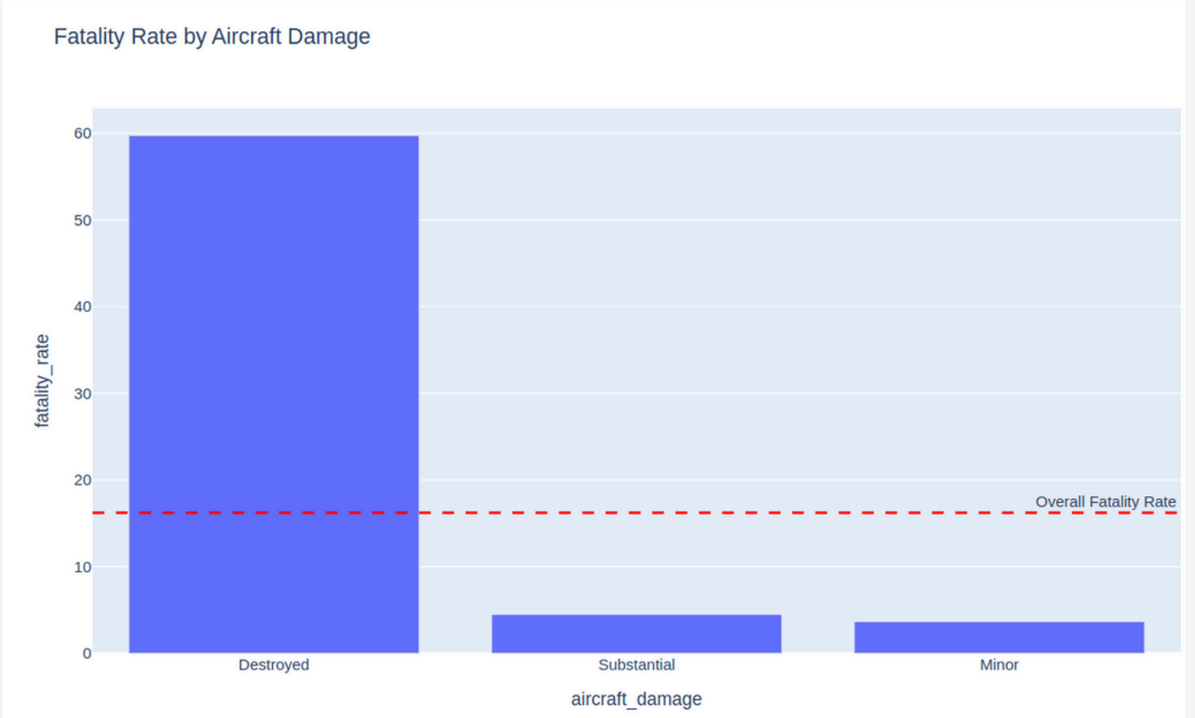
Aircraft Damage Severity Due to Accidents

- Substantial damage accounts for 76.8% of accidents, indicating significant structural or functional harm in most incidents.
- Destroyed aircraft represent 21.3% of accidents, showing a notable number of total losses.
- Only 1.91% of accidents result in minor damage, highlighting the rarity of limited or repairable harm..



Fatality Rate by Severity of Aircraft Damage

- "Destroyed" aircraft incidents have the highest fatality rate, well above the average of 16%, indicating catastrophic consequences for safety in such events.
- "Substantial damage" incidents show a moderate fatality rate, highlighting that while not as severe as destroyed aircraft, these cases still carry significant risks.
- "Minor damage" incidents have the lowest fatality rate, but fatalities can still occur.

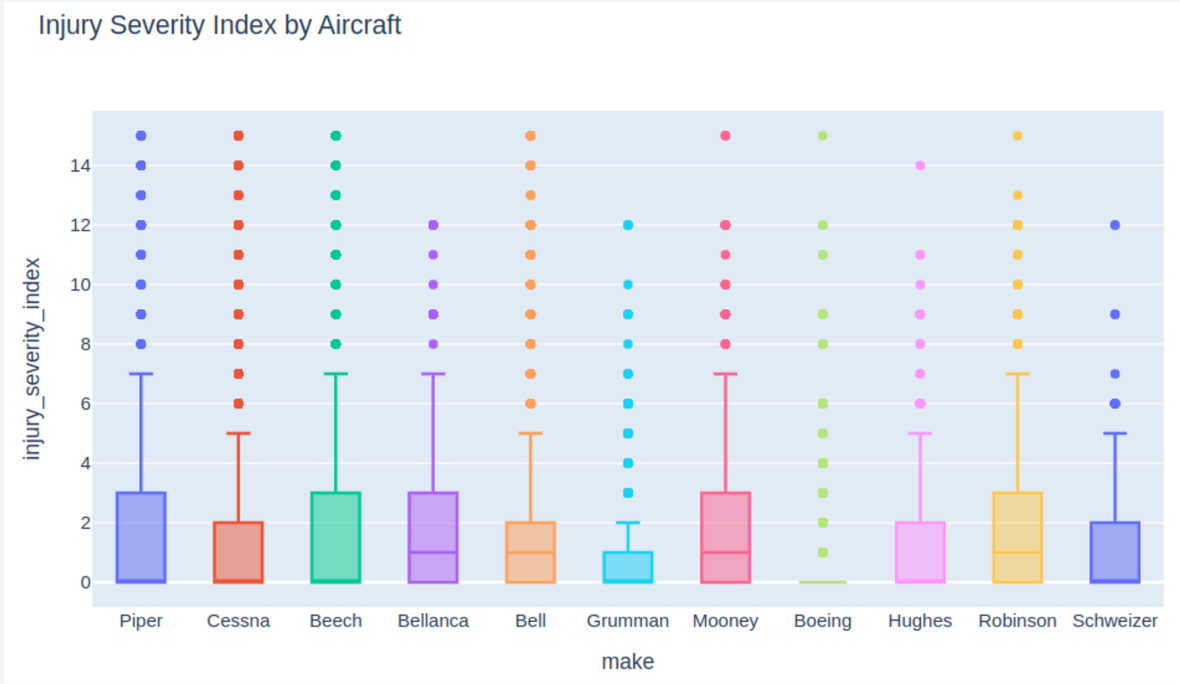


Comparison between Aircraft Damage Severity Analysis

- **Key Findings:**
  - The "Destroyed" category ranks highest for both fatality rates and frequency of severe damage, confirming its critical safety impact.
  - Substantial damage appears prominently in both analyses, underscoring its dual significance in accident outcomes and fatality risks.
  - While minor damage is frequent, its low fatality rate contrasts with its occurrence, making it less critical for survival-focused safety interventions.
  - Safety measures and designs should prioritize mitigating total destruction risks, as this poses the gravest survival challenge.

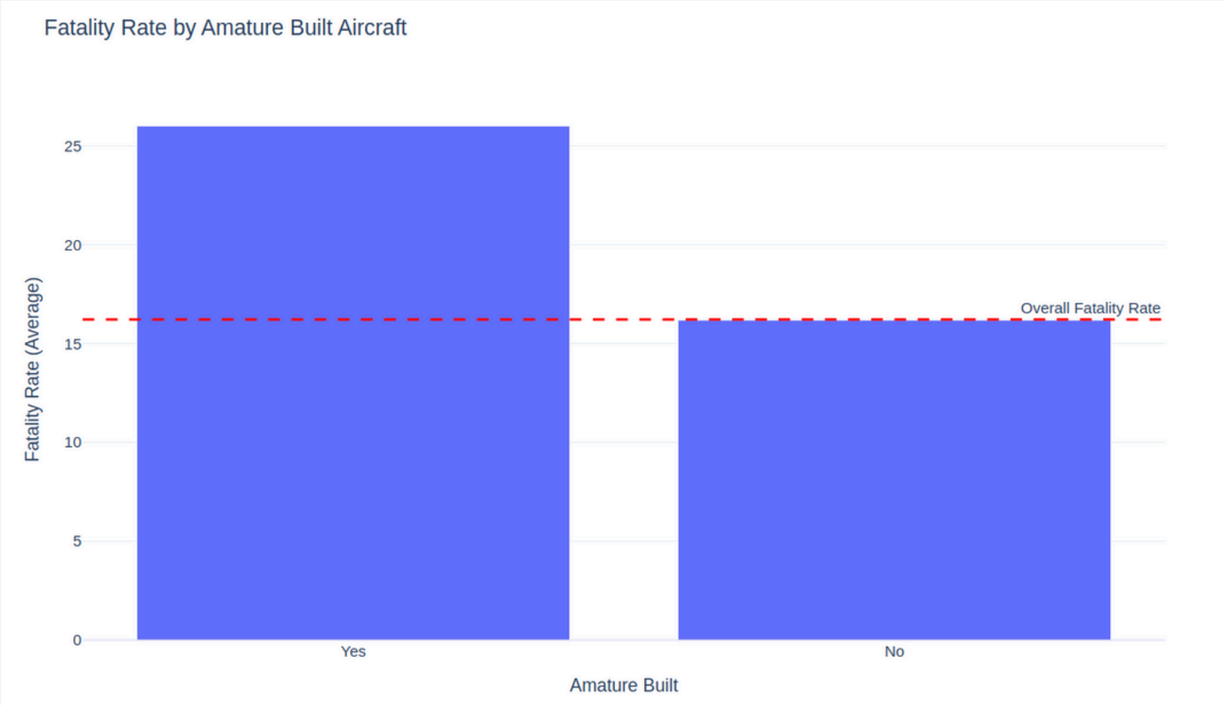
Injury Severity Index by Aircraft Make

- Aircraft like Piper, Beech, Bellanca, and Cessna show similar severity ranges, with a maximum extending around 14.
- Robinson and Mooney have high median injury severity, indicating frequent severe injuries.
- Boeing has one of the lowest medians, suggesting lower typical injury severity.
- Outliers are present for all makes, highlighting occasional extreme severity cases.



Fatality Rate by Amateur-Built Aircraft

- **Key Findings:**
  - Amateur-built aircraft classified as "Yes" exhibit a fatality rate significantly above the mean of 16%, indicating higher risks associated with these planes.
  - There is a huge disparity in fatality rates between amateur-built and professionally manufactured aircraft.



Conclusion

- While Cessna models account for the highest number of accidents, their fatality rates remain relatively low compared to other makes like Beech and Mooney.
- Aircraft that suffer substantial or complete damage result in notably higher fatality rates.
- Aircraft such as Boeing have consistently lower fatality rates, suggesting they may offer a safer choice
- Reciprocating engines dominate accident counts, due to their widespread use in general aviation, while turbine-powered aircraft tend to exhibit fewer accidents.
- The number of aviation accidents has significantly declined since the 1980s, driven by advancements in safety technologies and regulations.
- The decline has plateaued after 2010, with year-over-year variations influenced by external factors. The stabilization suggests diminishing returns from existing safety measures or emerging challenges that require new approaches.

Conclusion

- The majority of accidents occur during the landing phase, but the maneuvering and climb phases show higher fatality rates, highlighting them as critical areas for operational safety improvement.
- Amateur-built aircraft pose significantly higher risks due to less stringent manufacturing and maintenance standards, warranting caution in their use.
- Accidents under Visual Meteorological Conditions (VMC) dominate, indicating non-weather-related causes as a primary area for intervention.

Business Recommendations

- **Prioritize Safe Aircraft Models for Purchase**
  - Invest in aircraft models like Boeing, which exhibit lower fatality rates and better safety performance, even in accidents.
  - Avoid amateur-built aircraft due to their significantly higher fatality rates and lack of robust safety standards.
- **Focus on Safety Improvements for High-Risk Phases**
  - Enhance training and operational procedures for critical phases like maneuvering, climb, and cruise, which show higher-than-average fatality rates.
  - Implement additional safety measures for landing operations, as they account for the highest number of accidents.
- **Leverage Insights to Mitigate Seasonal and Environmental Risks**
  - Plan operational activities with increased safety vigilance during summer months when accidents peak.
  - Focus on addressing non-weather-related issues, as the majority of accidents occur under favorable visual meteorological conditions.

THANK YOU

CONNECT WITH US.

WESTERN ONZERE

+254 71-216-0286

onzerewestern@gmail.com

https://www.linkedin.com/in/western-onzere-ml/

https://www.youtube.com/@MinichAnalytics/featured