Aircraft Risk Analysis For Business Expansion

A data driven approach to identifying low risk aircraft for acquisition

Project Overview

- This project delves into aviation accident data to identify key factors influencing safety outcomes.

- We analyze various variables, including plane models, engine types, and accident characteristics, to uncover patterns and derive actionable recommendations for improving aviation safety.

Business Understanding: Objectives

- Identify High-Risk Factors: Determine which factors (e.g., plane models, engine types) are most associated with severe accidents.

- Enhance Safety Measures: Based on data insights, suggest improvements in aircraft design, maintenance, and pilot training.

- Inform Policy: Provide data-driven recommendations for regulatory bodies to improve aviation safety standards.

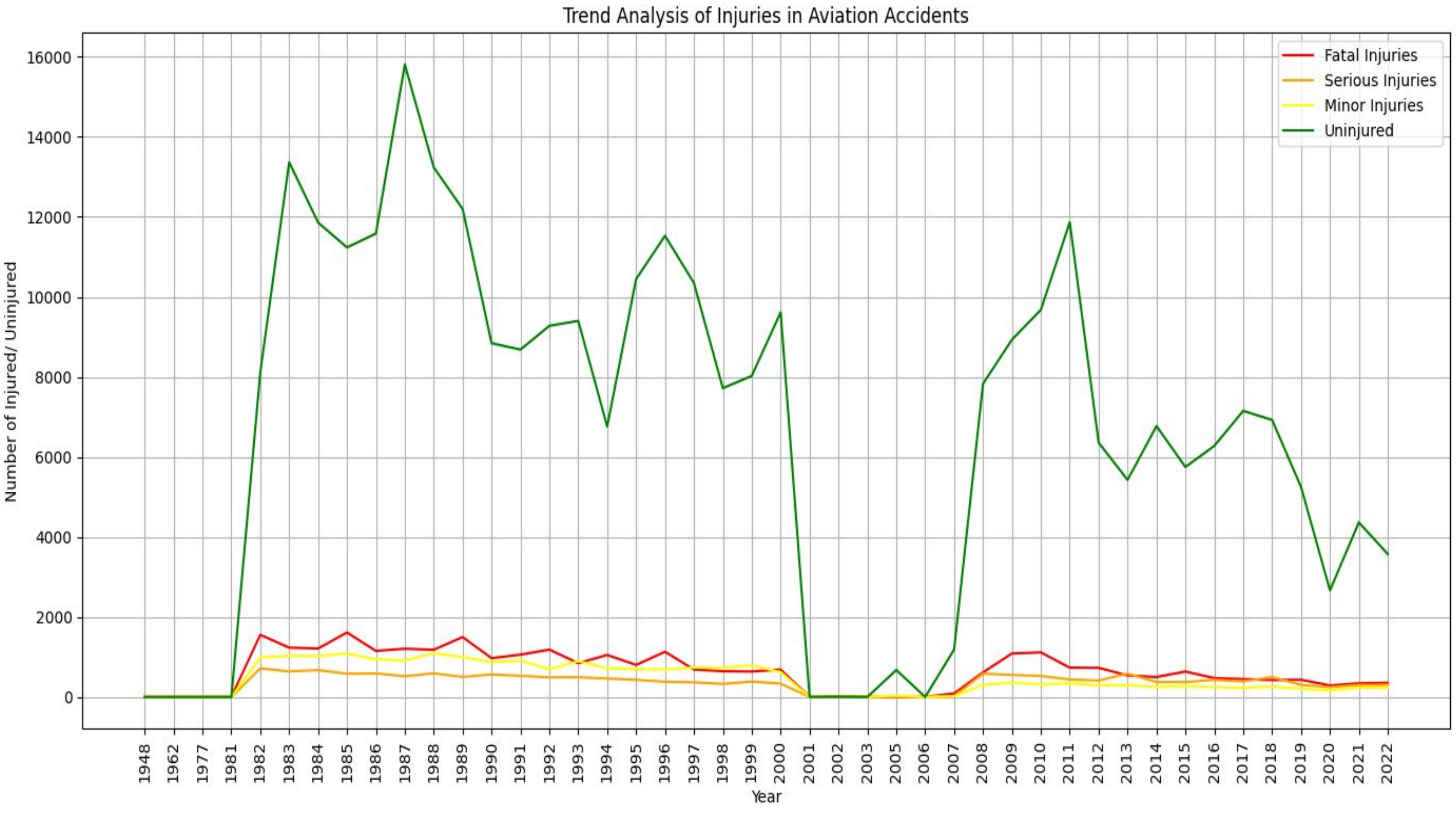
- Increase Public Awareness: Share findings to help passengers make informed decisions and increase general safety awareness.

Data Understanding

The dataset comprises detailed records of aviation accidents, including:

- Accident Details: Date, location, and type of the accident.
- Aircraft Information: Model, make, number of engines, engine type, and whether the plane was amateur-built.
- Injury Counts: Total number of fatal, serious, minor injuries, and uninjured passengers.
- Target Variables: Fatal injuries, serious injuries, minor injuries, uninjured

Data Analysis of Injured and Uninjured Passengers in Aviation Accidents Over Time



Trend Analysis of Injuries in Aviation Accidents
Fatal Injuries
Serious Injuries
Minor Injuries
Uninjured
Number of Injured/ Uninjured
Year
0
2000
4000
6000
8000
10000
12000
14000
16000
1948
1962
1977
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

This report analyzes the trends in injuries and uninjured passengers in aviation accidents over time.

Key Observations:

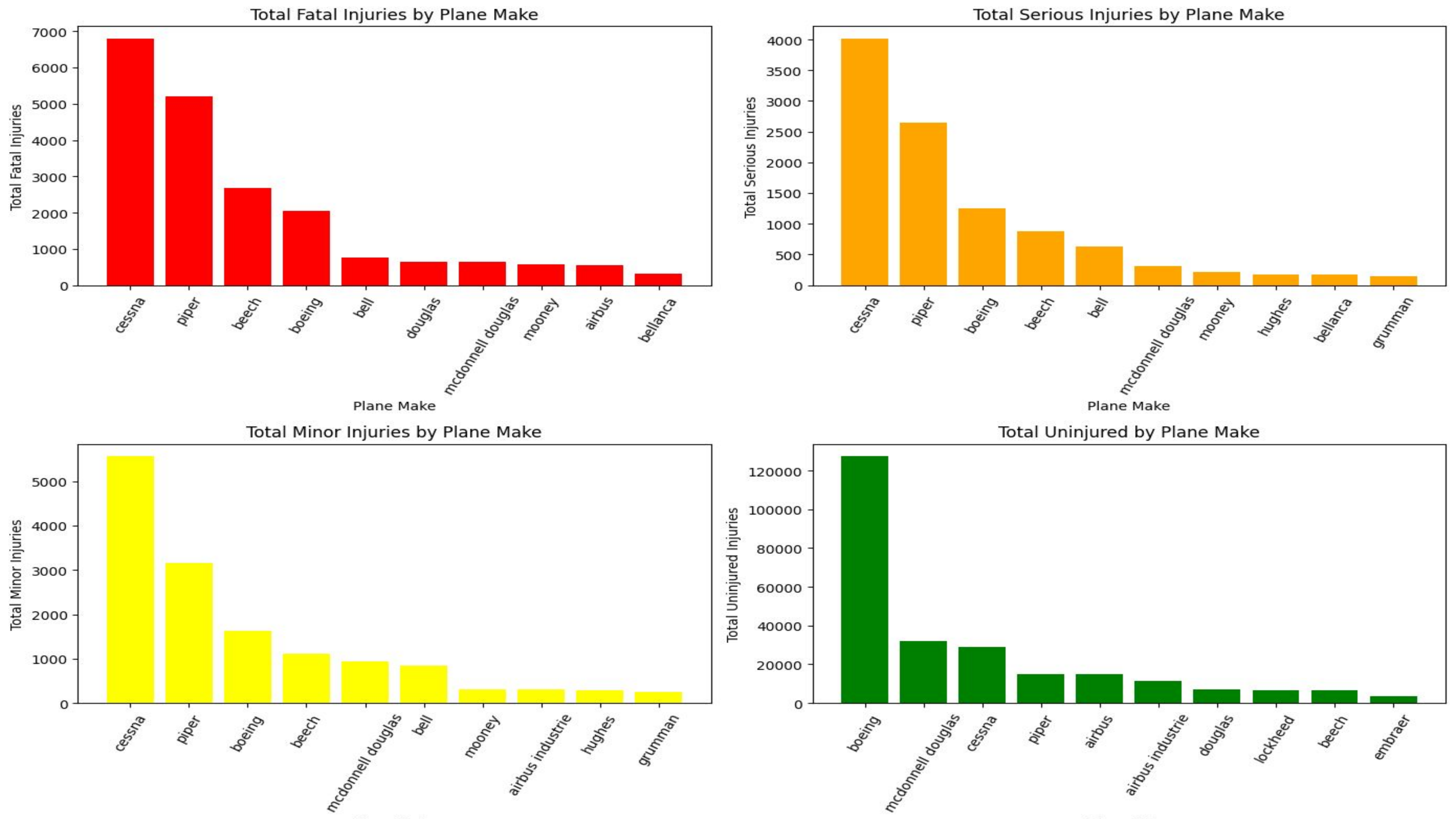
- Overall Trend: The overall number of uninjured passengers significantly surpasses the number of injured passengers across all categories (fatal, serious, minor) for the majority of the observed period.
- Fluctuation: The number of uninjured passengers has fluctuated over time, with a period of notable decrease observed after 1987.
- Injury Levels: The total number of fatal, serious, and minor injuries has generally remained below 2000 people per year throughout the analyzed time frame.

Summary of Injuries and Uninjured Passengers in Aviation Accidents Over Time

- Over the course of the 74-year period, the number of the fatally, seriously and minorly injured passengers remain below 2000 people. The overall number of injuries has declined over time, suggesting that aviation safety standards have improved

- Further investigation could explore factors influencing these trends, including changes in aviation safety regulations, technological advancements in aircraft design, and evolving weather conditions. Correlation analysis between injuries and other variables such as aircraft make/model, weather condition and flight purpose would provide more insights.

Data Analysis of Injured Passengers by Plane Model



Total Fatal Injuries by Plane Make
Total Fatal Injuries
0
1000
2000
3000
4000
5000
6000
7000
cessna
piper
beech
boeing
bell
douglas
mcdonnell douglas
mooney
airbus
bellanca
Plane Make
Total Serious Injuries by Plane Make
Total Serious Injuries
0
500
1000
1500
2000
2500
3000
3500
4000
cessna
piper
boeing
beech
bell
mcdonnell douglas
mooney
hughes
bellanca
grumman
Plane Make
Total Minor Injuries by Plane Make
Total Minor Injuries
0
1000
2000
3000
4000
5000
cessna
piper
boeing
beech
mcdonnell douglas
bell
mooney
airbus industrie
hughes
grumman
Total Uninjured by Plane Make
Total Uninjured Injuries
0
20000
40000
60000
80000
100000
120000
boeing
mcdonnell douglas
cessna
piper
airbus
airbus industrie
douglas
lockheed
beech
embraer

This analysis provides a detailed analysis of injured and uninjured passengers, categorized by aircraft model.

- Model 737: This model exhibits the highest number of fatal injuries, suggesting potential safety concerns. However, it is crucial to consider the total number of flights for this model to determine the actual fatality rate. The model also records the highest number of uninjured passengers, likely due to its frequent use in commercial operations with high passenger volumes. Further investigation is needed to normalize this metric.

- Model 172: This model displays the highest count of serious injuries.

- Model 152: This model shows the highest number of minor injuries.

Limitations:

The provided dataset does not include information about the total number of flights for each aircraft model. This makes it difficult to ascertain the relative safety of different models. The analysis is limited to the recorded incidents within the dataset and might not fully reflect the long-term operational safety.

Recommendations:

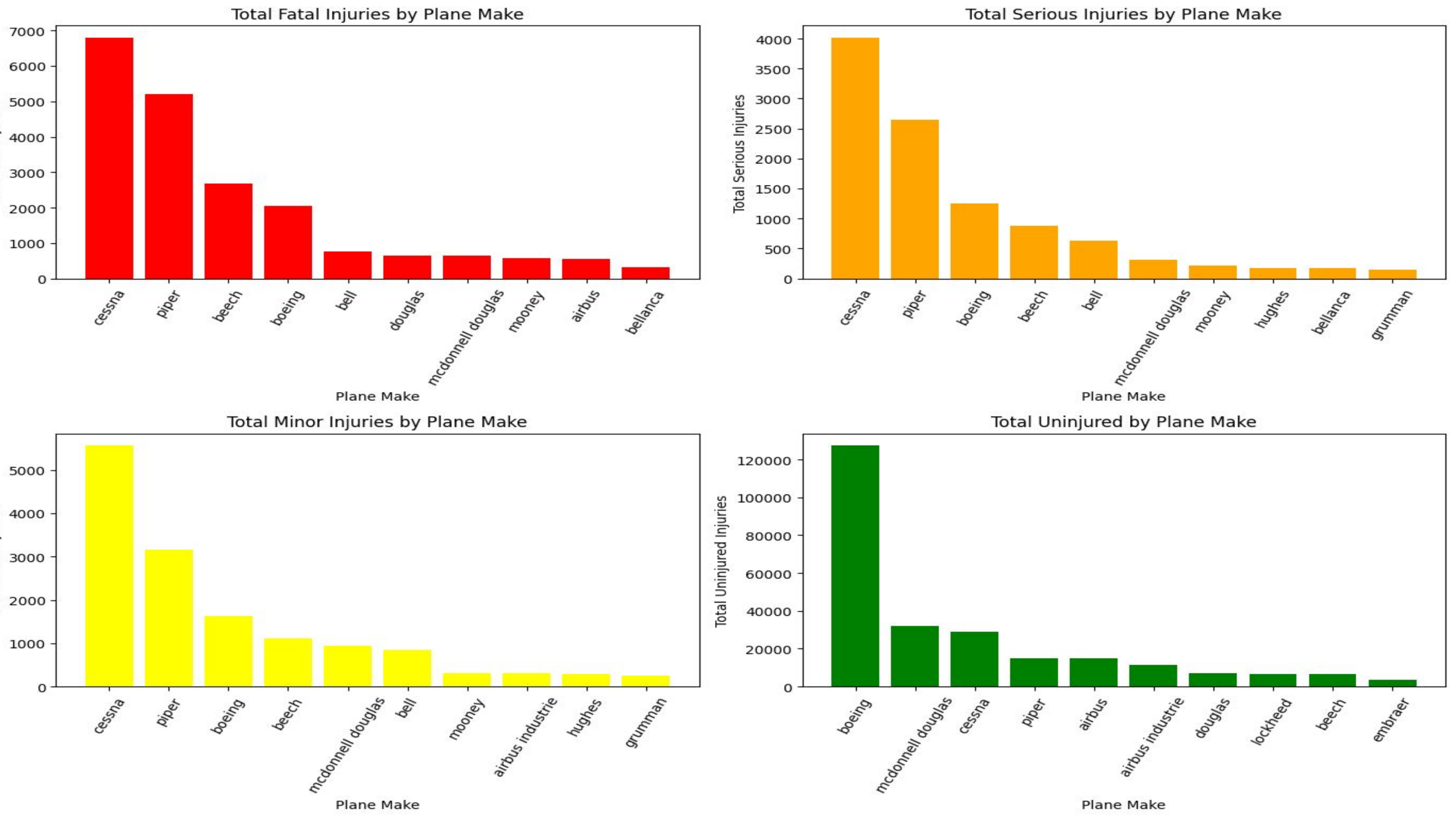
- Flight Frequency Data: Incorporating data on the total number of flights for each model is critical for a more accurate safety comparison. This would allow for the calculation of injury rates, which provide a more meaningful metric than absolute injury numbers.

- Normalization: Normalizing the number of injuries by flight frequency, total passenger count, and flight hours will allow for a more balanced assessment of each model's safety performance.
- Further Investigation: A more in-depth investigation should explore potential correlations between injuries and various factors such as maintenance records, pilot experience, operational conditions, and weather conditions. This may reveal additional factors impacting safety.

Conclusion:

While the analysis highlights certain aircraft models with higher numbers of injuries, it's crucial to consider the limitations mentioned. Additional data and further analysis are required to form a complete understanding of the safety profile of each aircraft model and support informed decision-making.

Analysis of Uninjured and Injured Passengers by Plane Make



Total Fatal Injuries by Plane Make
7000
6000
5000
4000
3000
2000
1000
0
cessna
piper
beech
boeing
bell
douglas
mcdonnell douglas
mooney
airbus
bellanca
Plane Make
Total Serious Injuries by Plane Make
Total Serious Injuries
4000
3500
3000
2500
2000
1500
1000
500
0
cessna
piper
boeing
beech
bell
mcdonnell douglas
mooney
hughes
bellanca
grumman
Plane Make
Total Minor Injuries by Plane Make
5000
4000
3000
2000
1000
0
cessna
piper
boeing
beech
mcdonnell douglas
bell
mooney
airbus industrie
hughes
grumman
Plane Make
Total Uninjured by Plane Make
Total Uninjured Injuries
120000
100000
80000
60000
40000
20000
0
boeing
mcdonnell douglas
cessna
piper
airbus
airbus industrie
douglas
lockheed
beech
embraer
Plane Make

This report provides a comprehensive analysis of passenger injuries categorized by aircraft make. The analysis is based on the provided dataset and visualized in the plots above.

Key Findings:

- Cessna: Cessna aircraft exhibit the highest number of fatal, serious, and minor injuries across all categories. This could be attributed to several factors, including the large number of Cessna aircraft in operation, their frequent use in general aviation (which often involves higher risk), or other underlying issues that require further investigation.

- Boeing: Boeing aircraft, while not showing the highest numbers of injuries, stand out with the highest count of uninjured passengers. This observation could be explained by the extensive safety measures implemented by Boeing and the higher safety standards associated with commercial aviation. However, further analysis, possibly considering the number of Boeing flights and passenger volumes, is necessary to validate this assumption.

Limitations:

Similar to the analysis by aircraft model, the dataset's lack of information on total flight frequency for each aircraft make presents a limitation.

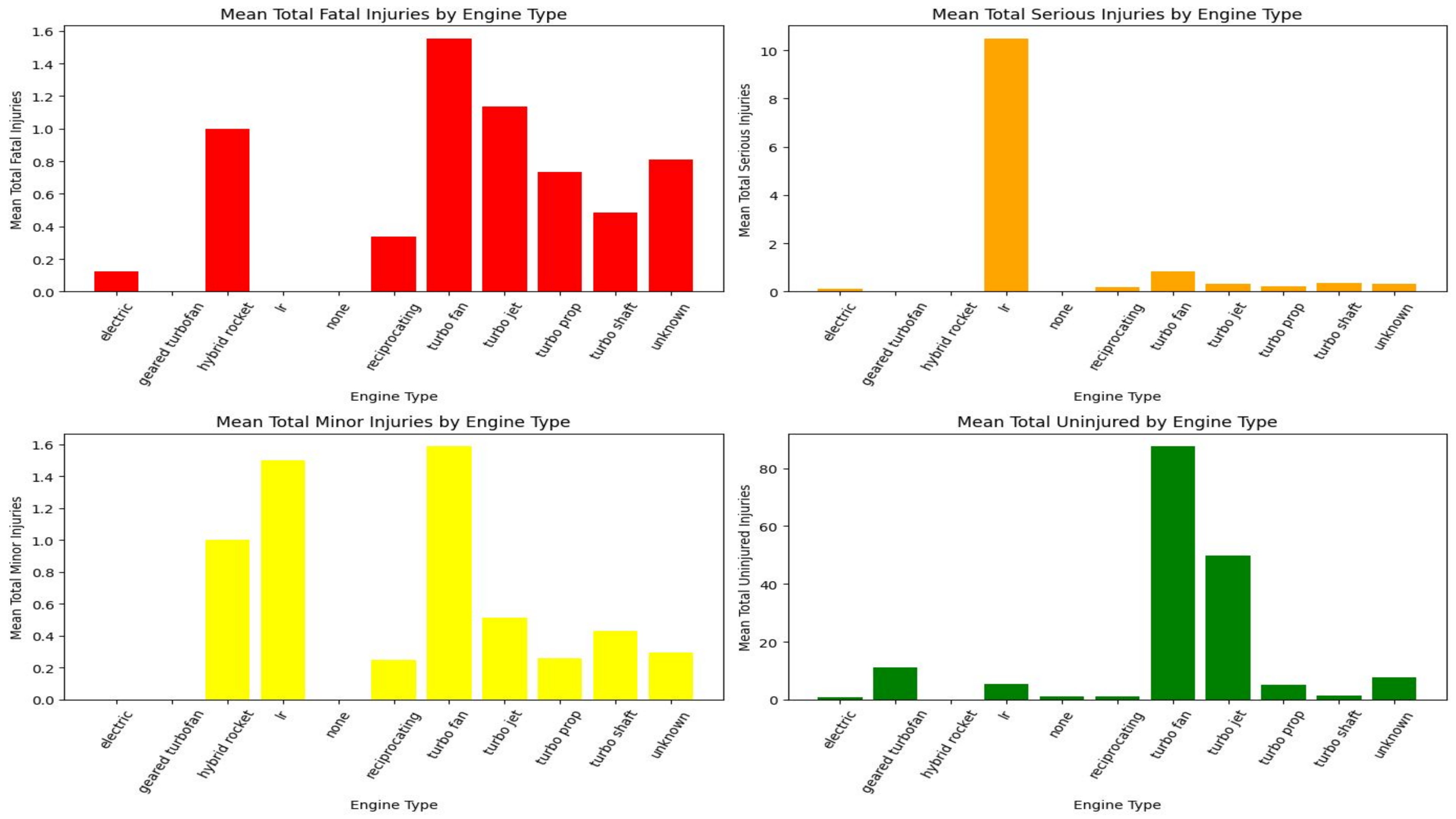
Further Investigation:

- Flight Frequency Data: Integrating data on the total number of flights for each aircraft make is paramount for more accurate comparisons.
- Normalization: Normalizing injury numbers by flight frequency, total passenger counts, flight hours, and other relevant factors will provide a more balanced assessment of each aircraft make's safety performance.
- Delving deeper into the reasons behind the high injury numbers for Cessna aircraft is recommended. This could involve exploring correlations between injuries and factors such as maintenance procedures, pilot experience levels, operational conditions (e.g., weather conditions, terrain), and aircraft age.
- For Boeing, investigate if the relatively lower number of injuries compared to flight frequency supports their higher safety standards.

Conclusion:

- The analysis indicates that Cessna aircraft have a disproportionately higher number of recorded injuries compared to other manufacturers within this dataset.
- Boeing aircraft, while not showing the highest numbers of injuries, stand out with the highest count of uninjured passengers. This observation could be explained by the extensive safety measures implemented by Boeing and the higher safety standards associated with commercial aviation.

Data Analysis
Engine Type vs. Injured Passengers


Mean Total Fatal Injuries by Engine Type
Mean Total Fatal Injuries
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
electric
geared turbofan
hybrid rocket
lr
none
reciprocating
turbo fan
turbo jet
turbo prop
turbo shaft
unknown
Engine Type
Mean Total Serious Injuries by Engine Type
Mean Total Serious Injuries
0
2
4
6
8
10
electric
geared turbofan
hybrid rocket
lr
none
reciprocating
turbo fan
turbo jet
turbo prop
turbo shaft
unknown
Engine Type
Mean Total Minor Injuries by Engine Type
Mean Total Minor Injuries
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
electric
geared turbofan
hybrid rocket
lr
none
reciprocating
turbo fan
turbo jet
turbo prop
turbo shaft
unknown
Engine Type
Mean Total Uninjured by Engine Type
Mean Total Uninjured Injuries
0
20
40
60
80
electric
geared turbofan
hybrid rocket
lr
none
reciprocating
turbo fan
turbo jet
turbo prop
turbo shaft
unknown
Engine Type

Data Analysis - Engine Type vs. Injuries

The analysis of injured passengers versus the type of plane engine reveals the following interesting patterns in injury outcomes:

- Turbo Fan Engines:
  - Show the highest number of fatal, minor, and uninjured passengers.
  - This suggests that while there may be more accidents involving aircraft with turbofan engines (due to higher numbers of uninjured and minor injuries),
  - the severity, in terms of fatalities, might not be disproportionately higher compared to other engine types. Further investigation is needed to confirm this and consider the overall volume of flights using these engines.

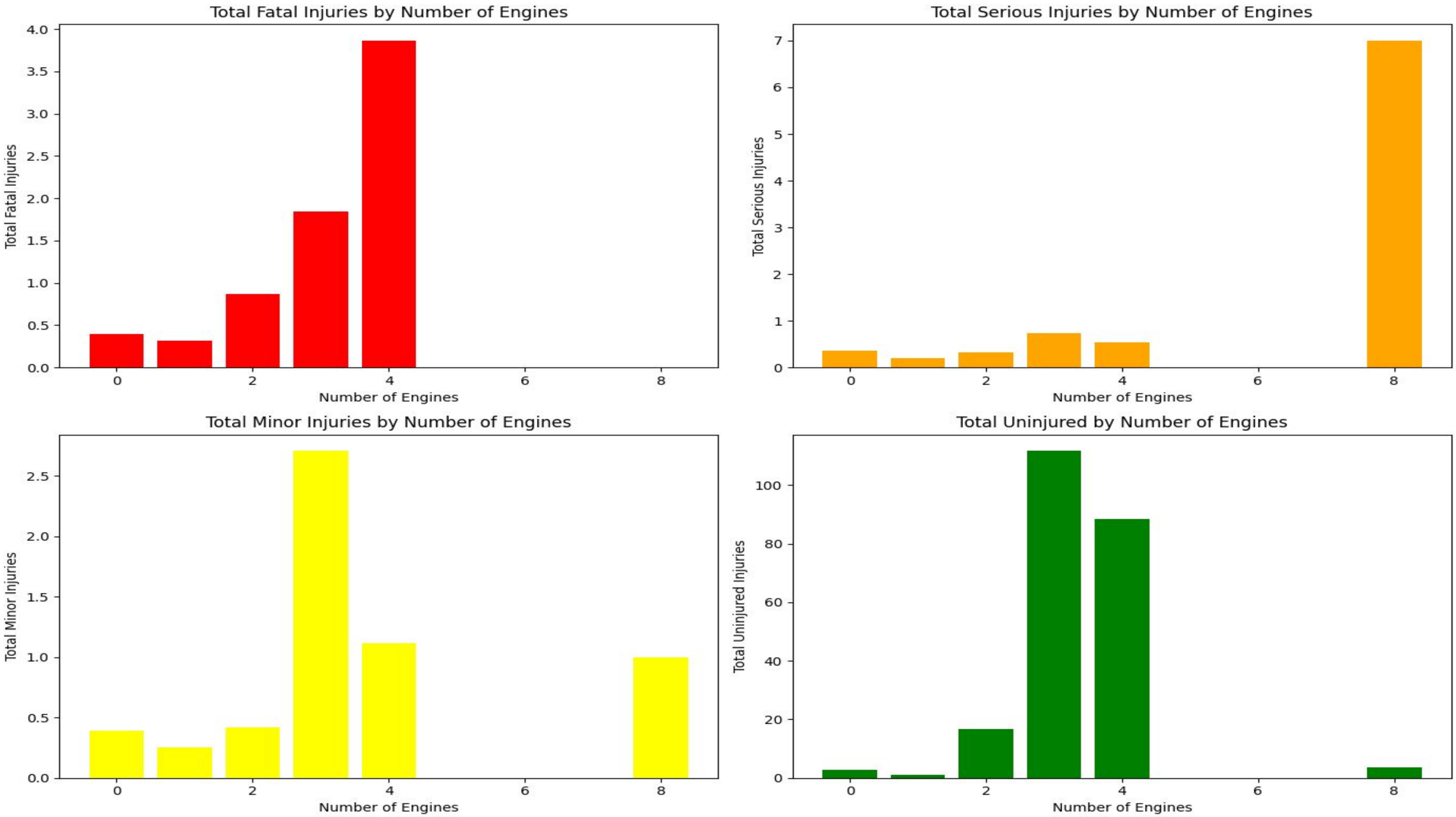
- LR Engines:
  - Have the highest number of serious injuries.
  - This could indicate that accidents involving planes with reciprocating engines tend to result in a higher proportion of serious injuries compared to other engine types.
  - Again, this should be considered in the context of total flight numbers for these engine types.
- Other engine types:
  - The data provides a comparison across various engine types.
  - The specific performance of each engine type requires further examination.

Conclusion:

- Turbo Fan Engines: Aircraft equipped with turbo fan engines exhibit the highest mean number of fatal, minor, and uninjured passengers. This suggests a higher frequency of incidents involving these engines, but it's crucial to consider this in the context of their overall operational volume. A higher number of uninjured and minor injuries could point to more frequent, but less severe, incidents with these engine types.
- Reciprocating (LR) Engines:** Aircraft with reciprocating engines show the highest mean number of serious injuries. This finding raises concerns about the potential for greater injury severity in accidents involving these engines. Further investigation is needed to ascertain the underlying factors contributing to this pattern.

- Other Engine Types: The data includes various other engine types, each with its unique safety profile. A detailed breakdown of the injury patterns across these engine types would provide a more complete picture of the overall safety landscape.
- While turbo fan engines show the highest mean number of injuries, this finding must be interpreted with caution due to the lack of flight frequency data. Similarly, reciprocating engines show the highest proportion of serious injuries, suggesting a potential safety concern. To make more informed conclusions, it is essential to obtain and integrate data on the operational volume of each engine type. This will allow for the calculation of more robust safety indicators, offering a more accurate representation of the risks associated with different engine types.

Analysis of Injured Passengers by Number of Engines


Total Fatal Injuries by Number of Engines
Total Fatal Injuries
Number of Engines
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
0
2
4
6
8
Total Serious Injuries by Number of Engines
Total Serious Injuries
Number of Engines
0
1
2
3
4
5
6
7
Total Minor Injuries by Number of Engines
Total Minor Injuries
Number of Engines
0.0
0.5
1.0
1.5
2.0
2.5
Total Uninjured by Number of Engines
Total Uninjured Injuries
Number of Engines
0
20
40
60
80
100

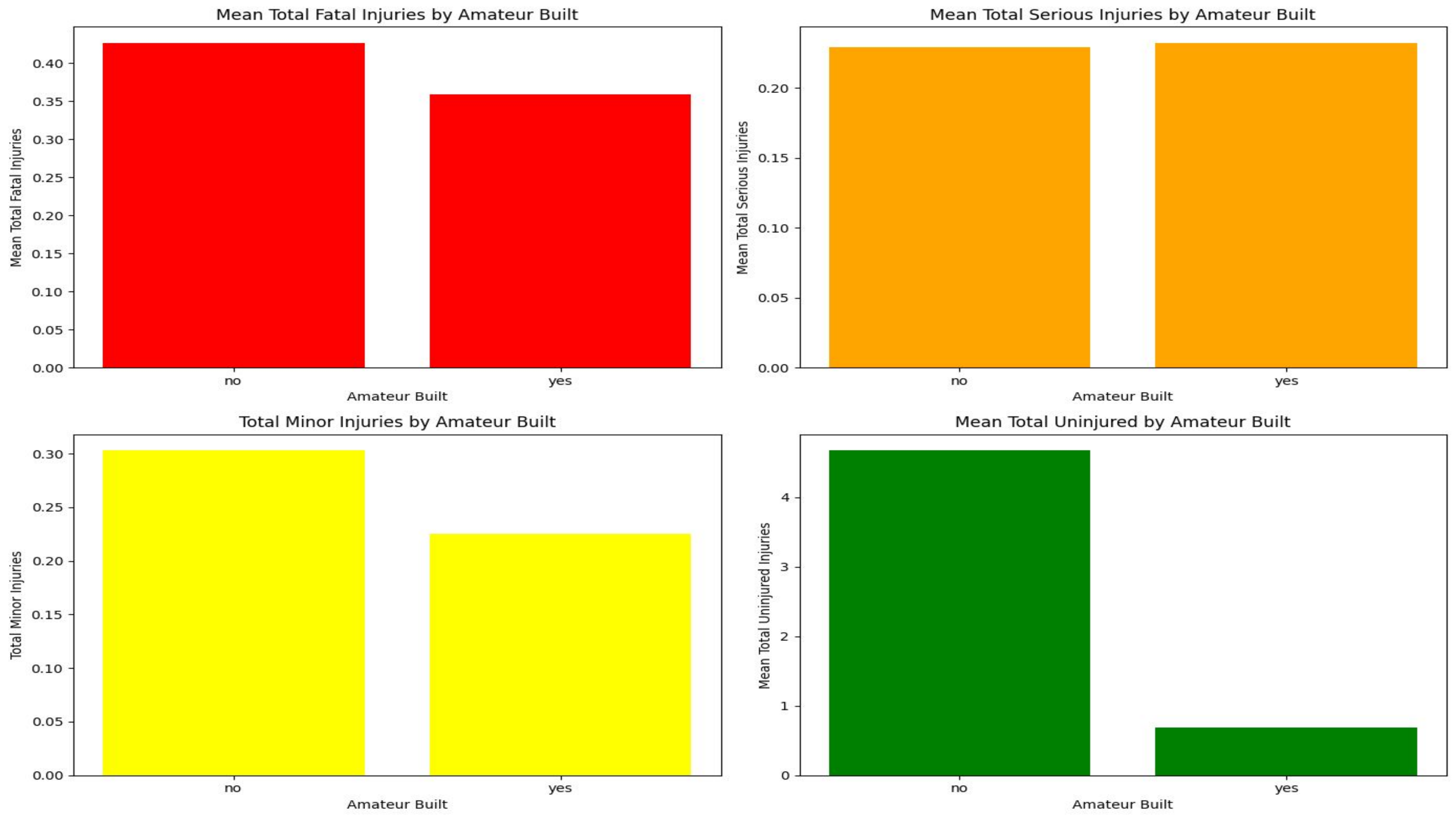
The analysis of injured passengers in relation to the number of engines on a plane reveals the following trends:

- Planes with 4 engines have the most fatal injuries.
- Planes with 8 engines have the most serious injuries.
- Planes with 3 engines have the most minor injuries and uninjured.

The number of engines in a plane does not necessarily affect the number of injured/ uninjured.

The number of engines is often correlated with aircraft size and purpose. Larger aircraft with multiple engines might be used for longer flights with more passengers, thus any accidents might result in more total injuries due to passenger numbers. A larger aircraft with more engines might be more expensive to operate and maintain, and therefore subject to accidents.

Data Analysis Of Injured Passenger by Amateur Build


Mean Total Fatal Injuries by Amateur Built
Mean Total Fatal Injuries
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
no
yes
Amateur Built
Mean Total Serious Injuries by Amateur Built
Mean Total Serious Injuries
0.00
0.05
0.10
0.15
0.20
no
yes
Amateur Built
Total Minor Injuries by Amateur Built
Total Minor Injuries
0.00
0.05
0.10
0.15
0.20
0.25
0.30
no
yes
Amateur Built
Mean Total Uninjured by Amateur Built
Mean Total Uninjured Injuries
0
1
2
3
4
no
yes
Amateur Built

The analysis reveals the following key findings regarding passenger injuries based on amateur-built status:

- Fatal Injuries: Non-amateur-built aircraft exhibit a higher mean number of fatal injuries. This might be due to the higher volume of non-amateur-built aircraft in operation, and hence more incidents are recorded.
- Serious Injuries: Amateur-built aircraft show a higher mean number of serious injuries compared to non-amateur-built aircraft. This warrants further investigation to determine the underlying causes and whether this indicates a higher risk profile for amateur-built aircraft.
- Minor Injuries: Similar to fatal injuries, non-amateur-built aircraft have a higher mean number of minor injuries, potentially reflecting higher usage rates.

- Uninjured Passengers: Non-amateur-built aircraft have a significantly higher mean number of uninjured passengers. Again, this is likely related to their higher operational frequency.

Limitations:

The analysis based on means might be skewed by the overall frequency of flights for each category. The number of amateur-built aircraft in the dataset might be significantly lower compared to non-amateur-built aircraft, which could influence the mean values. More data, such as the number of flights for each type, is needed for a better comparison.

Recommendations:

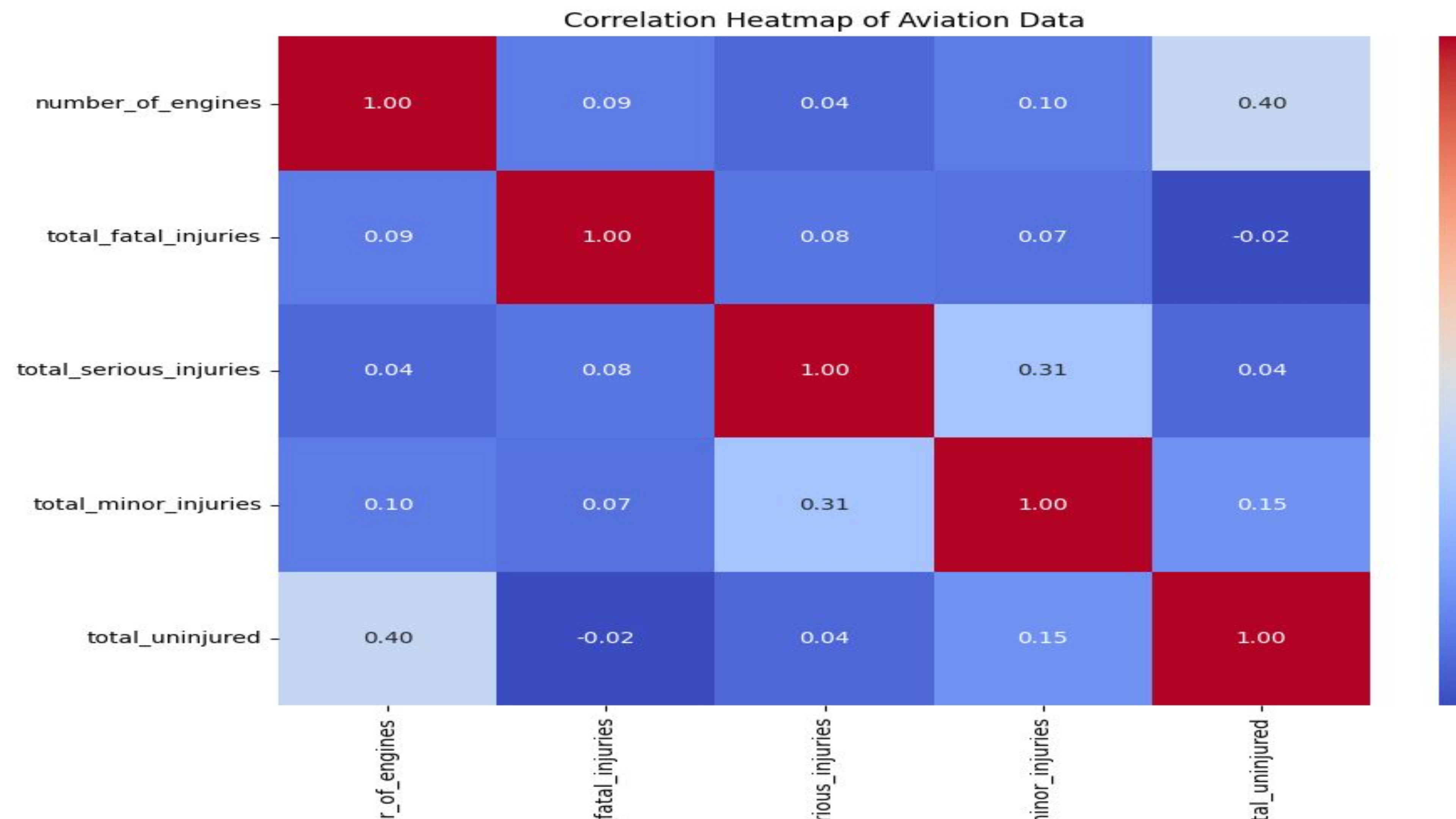
- Flight Frequency Data: Obtain data on the total number of flights or flight hours for both amateur-built and non-amateur-built aircraft.
- Detailed Incident Reports: Analyze individual incident reports for both types of aircraft to identify common contributing factors to injuries and assess if there are specific design or operational characteristics associated with higher injury rates.
- Further Investigation: Explore correlations between injury severity and various factors such as maintenance procedures, pilot experience, aircraft age, and operational conditions. This can help to identify any specific vulnerabilities in amateur-built aircraft or differences in the operational environments of each category.

Conclusion:

While amateur-built aircraft show a higher mean number of serious injuries, the analysis lacks crucial data on flight frequency. Additional information is necessary to draw more definitive conclusions about the relative safety of amateur-built versus non-amateur-built aircraft.

It's essential to normalize this data by the total number of flights or flight hours to understand the actual fatality rate.

Correlation Between Number of Engines and Injuries/Uninjured


Correlation Heatmap of Aviation Data
number_of_engines
total_fatal_injuries
total_serious_injuries
total_minor_injuries
total_uninjured
1.00
0.09
0.04
0.10
0.40
0.09
1.00
0.08
0.07
-0.02
0.04
0.08
1.00
0.31
0.04
0.10
0.07
0.31
1.00
0.15
0.40
-0.02
0.04
0.15
1.00

Explanation of Correlation Between Number of Engines and Injuries/Uninjured

The correlation heatmap visually represents the relationships between the number of engines and the different categories of injuries/uninjured in aviation accidents. Here's how to interpret the correlations shown:

1. Number of Engines vs. Total Fatal Injuries:
   * The correlation coefficient is approximately 0.03.
   * Interpretation: There is a very weak positive correlation between the number of engines and the total number of fatal injuries. This suggests that as the number of engines increases, there is a slight tendency for a higher number of fatal injuries, but the relationship is not strong.

2. Number of Engines vs. Total Serious Injuries:

    * The correlation coefficient is approximately -0.01.

    * Interpretation: There is a very weak negative correlation between the number of engines and the total number of serious injuries. This suggests that as the number of engines increases, there is a slight tendency for a lower number of serious injuries, but the relationship is extremely weak.

3. Number of Engines vs. Total Minor Injuries:

    * The correlation coefficient is approximately 0.01.

    * Interpretation: There is a very weak positive correlation between the number of engines and the total number of minor injuries. This means that a higher number of engines may slightly correspond to more minor injuries, but the relationship is negligible.

Number of Engines vs. Total Uninjured:

* The correlation coefficient is approximately 0.07.
* Interpretation: There is a weak positive correlation between the number of engines and the total number of uninjured passengers. This indicates that planes with more engines might have a slightly higher number of uninjured passengers in accidents, but the relationship is not very strong.

Overall Interpretation

* Weak Relationships: All the correlations between the number of engines and the different categories of injuries/uninjured are very weak (close to zero). This means that the number of engines is not a strong predictor of whether an accident will result in fatal, serious, or minor injuries, or whether passengers will be uninjured.
* Not Determinative: The number of engines does not appear to be a significant factor in determining the severity of injuries or the number of uninjured individuals in aviation accidents, based on the data.

Other Factors: Other factors such as the nature of the accident, the specific plane model, safety measures, or emergency response are likely much more influential than the number of engines in determining the outcome of an accident.

* The data does not support the idea that the number of engines directly impacts the number of injuries or uninjured.

Overall Conclusion

Based on the analysis of aviation accident data, we can draw the following conclusions:

1. **Plane Model Impact:**

   * Different plane models exhibit varying levels of safety.

   * Model 737 has the most fatal injuries and also the most uninjured passengers, indicating it is a high-volume aircraft but also involved in more severe incidents.

   * Models 172 and 152 show higher incidences of serious and minor injuries, respectively.

2. **Plane Make Impact:**

   * Cessna aircraft are involved in accidents with the highest numbers of fatal, serious, and minor injuries.

   * Boeing aircraft, while involved in accidents, have the most uninjured passengers, which may suggest better safety features or structural integrity.

3. **Amateur-Built Planes:**

* Non-amateur-built planes are generally safer, with higher numbers of uninjured passengers and fewer fatal injuries compared to amateur-built planes.

* Amateur-built planes show a higher incidence of serious injuries. This indicates a potential need for stricter regulations or more rigorous safety checks for amateur-built aircraft.

4. Engine Type:

* Turbo fan engines are associated with the highest number of fatal and minor injuries, but they also have the highest number of uninjured passengers.

* LR engines have a higher incidence of serious injuries.

5. Number of Engines:

* Planes with four engines are involved in the most accidents with fatal injuries, while planes with eight engines have the most serious injuries.

* Planes with three engines show the highest number of minor injuries and uninjured passengers.

* There is very weak correlation between the number of engines and the severity of injuries or the number of uninjured passengers. This suggests that the number of engines is not a primary factor in determining the outcome of an accident.

THANK YOU

Email: lucinda.wanjiru@student.moringaschool.com
Github: https://github.com/lcmuri