AVIATION_PROJECT

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STUDENT PACE: FULL TIME-REMOTE

SCHEDULED PROJECT REVIEW DATE/TIME:

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BLOG POST URL:

BUSINESS UNDERSTANDING

Introduction: Business Problem:

The company is expanding in to new industries to diversify its portfolio. Specifically, they are interested in purchasing and operating airplanes for commercial and private enterprises, but do not know anything about the potential risks of aircraft.

GOAL

To Determine Which Aircraft Are The Lowest Risk For The Company To Start This New Business Endeavor. To Translate Findings Into Actionable Insights That The Head Of The New Aviation Division Can Use To Help Decide Which Aircraft To Purchase.

Abbreviations.

1. VMC (Visual Meteorological Conditions)
 -Weather conditions that allow pilots to fly primarily by visual reference to the ground and horizon.

2. IMC (Instrument Meteorological Conditions)
 - Weather conditions requiring pilots to rely on aircraft instruments for navigation and control due to poor visibility or cloud obstruction.

3. UNK(Unknown)
 - Weather conditions were not reported, recorded, or available for the incident.

DATA VISUALIZATION

Objectives

- 1. Check if there's a correlation between the number of injuries and specific weather conditions?
- 2. How do the number of accidents/injuries vary by country?
- 3. What is the total number of accidents recorded over a specific period?

Data Visualization

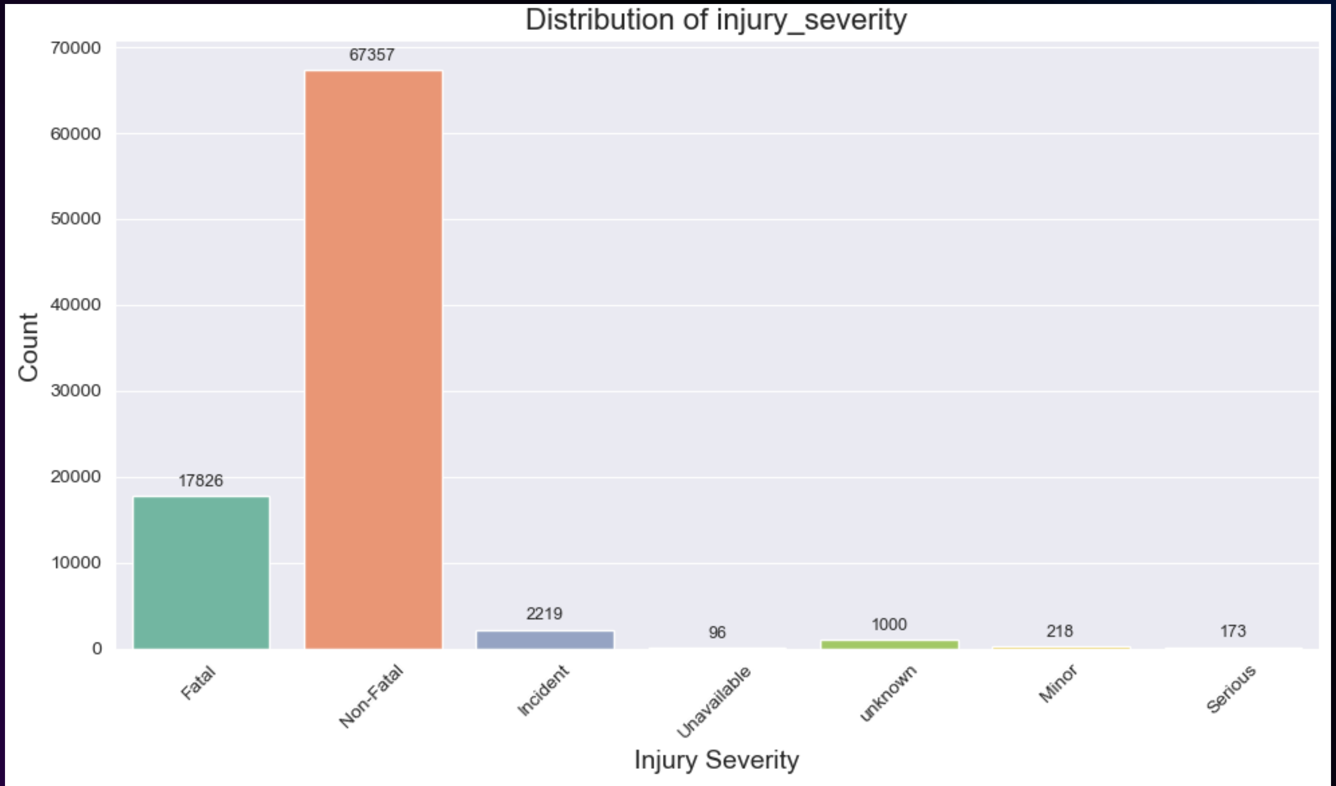
- 4. Do certain types of flights/make of aircraft contribute in a higher incidence of injuries?
- 5. Is there a relationship between the extent of aircraft damage and the type of engine involved in an accident?
- 6. How do different weather conditions influence the extent of aircraft damage during an incident?
- 7. Analyze how make, weather, and flight phase together influence accident rates.

UNIVARIATE ANALYSIS

It checks distribution for individual features in the dataset

1.INJURY SEVERITY

A distribution showing the number of injury severity in different planes



OBSERVATION

So this shows that 'non fatal' injuries are the most common, followed by 'fatal' Injuries.

Other categories like 'minor',' serious',' unavailable' are less common.

Conclusion Conclusion

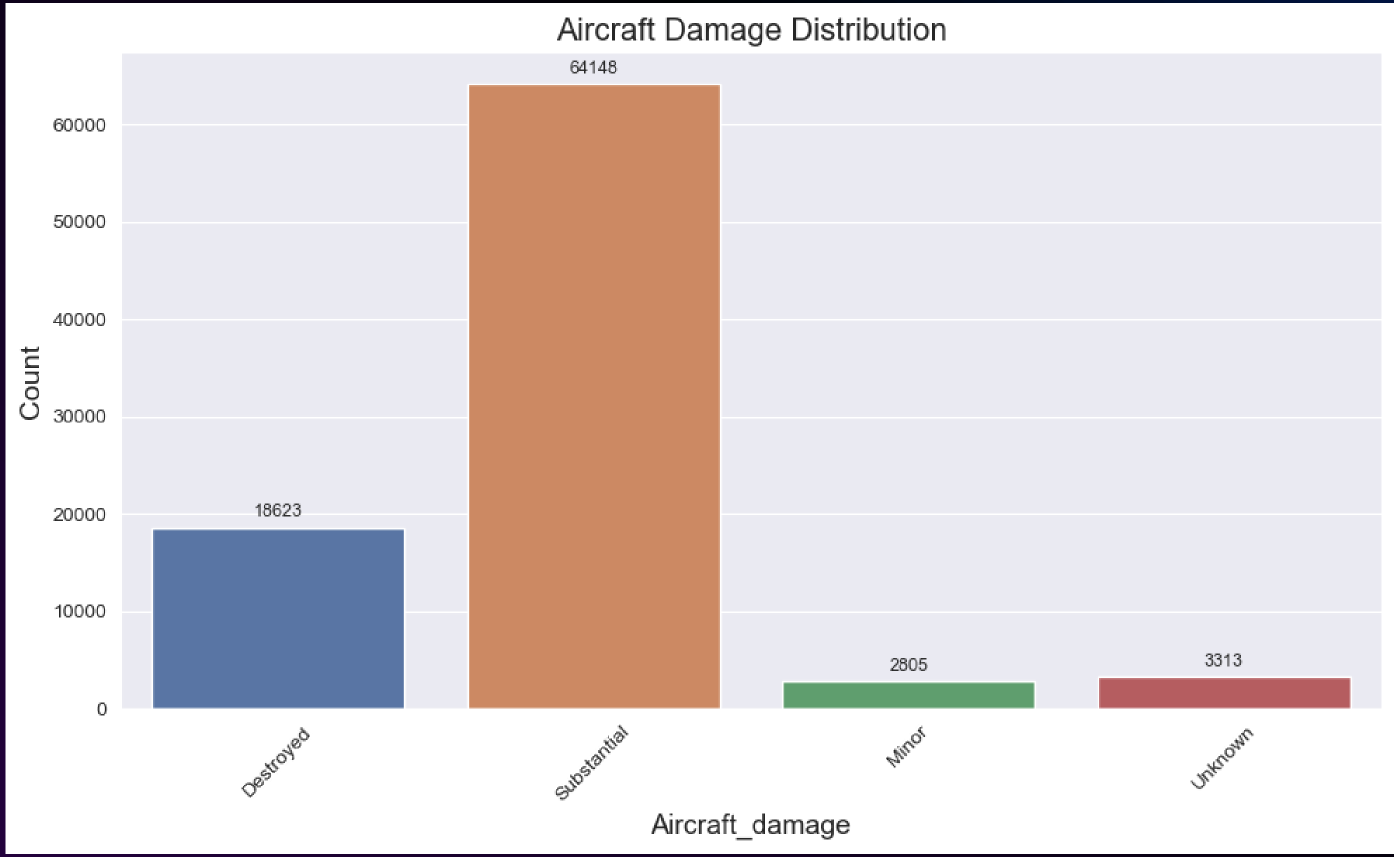
The Data shows that vast majority of incidences are non-fatal, however, there's a significant number of fatal injuries, showing a critical area of focus for aviation safety

Recommendation

Prioritize fatal incidences to identify the root causes and implement preventive measures to save lives. While non fatal incidences don't result in deaths, they could reveal underlying safety issues of planes, operational deficiencies or equipment failure

2. AIRCRAFT DAMAGE

A distribution showing the frequency of number of aircraft damage in different planes



OBSERVATION

So this shows majority of incidents result in 'Substantial' damages.

- 'Destroyed' is the 2nd most common and 'Unknown' is least common

Conclusion Conclusion

Shows that most prevalent type of aircraft incidences involves substantial damage.¶
-A significant number has been categorized as destroyed, though less frequent, could mean more fatalities

Recommendation

Prioritize substantial damage analysis: causes, circumstances leading to the damage. It will help with improvements in aviation safety

- Investigate Destroyed categories, since it indicates severe accidents with potentially more fatalities.It will aid in preventing future catastrophic events¶

- Minor and unknown categories should also be investigated to ensure data accuracy for safety analysis.

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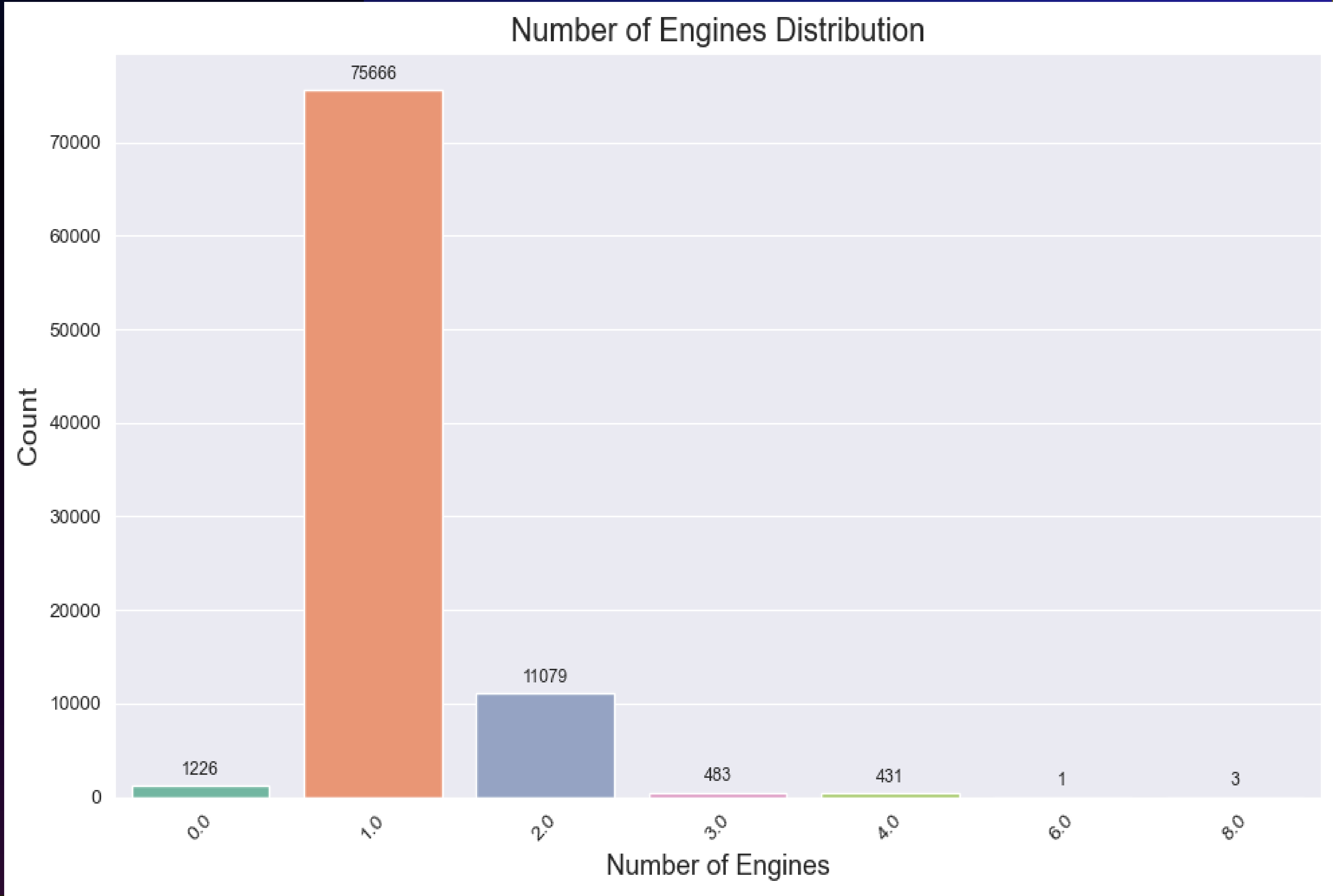
3. NUMBER OF ENGINES

A distribution showing the frequency of number of engines in different planes



OBSERVATION

Most air crafts have 1 engine, followed by planes with 2 engines

Planes with 0 engines are significantly higher than those with 3,4,6,and 8 engines which appear to have least planes

Conclusion

Conclusion

Research shows that planes with 0 engines are probably drones and gliders. could also mean that there was an anormaly in data recording for unpowered aircrafts.

Planes with 6 or 8 engines are extremely rare. Those with 4 engines are typical for larger commercial airliners and cargo planes

Recommendation

- Focus on planes with 1 or 2 engines, since they are the majority. So any resource allocation,maintenance planning,pilot training or operational considerations should be based on them.
- Confirm whether planes with 0 engines are indeed unpowered, or if this represents missing data

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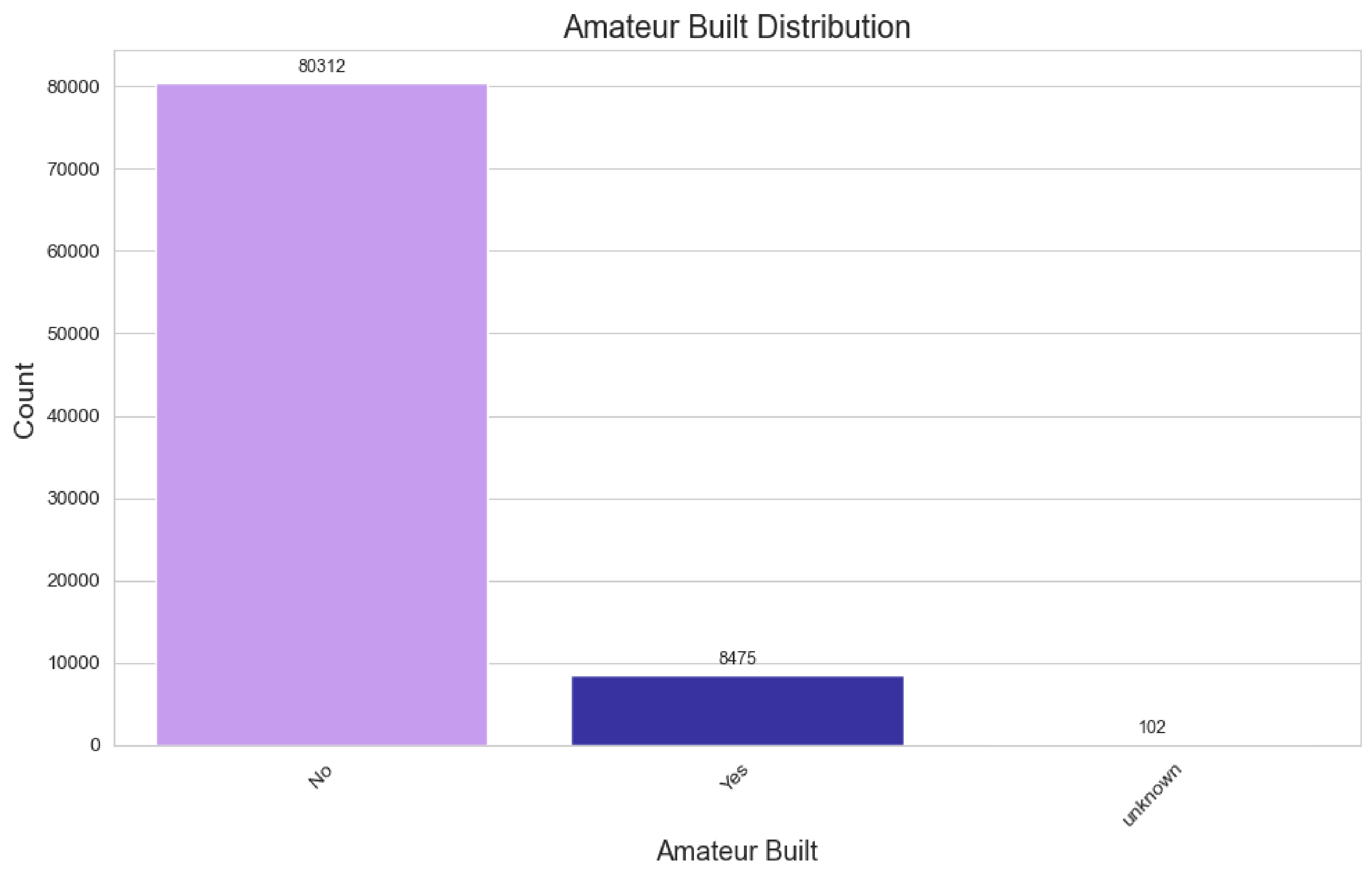
4. AMATEUR BUILT

A distribution showing the amateur and non amateur built planes



OBSERVATION

Shows that majority of the planes are not amateur built

Very few are amateur built(8475 entries) and less than 110 unknown values

Conclusion

Conclusion

Shows that majority of the planes are professionally manufactured and have passed all FAA regulations.

A smaller but still significant number shows that some planes are home-built/Amateur built and haven't passd regulations. A very small number has unknown built status

Recommendation

Focus resources more on non-amateur built planes

Ensure amateur built planes are still assessed and pass all regulations before use.

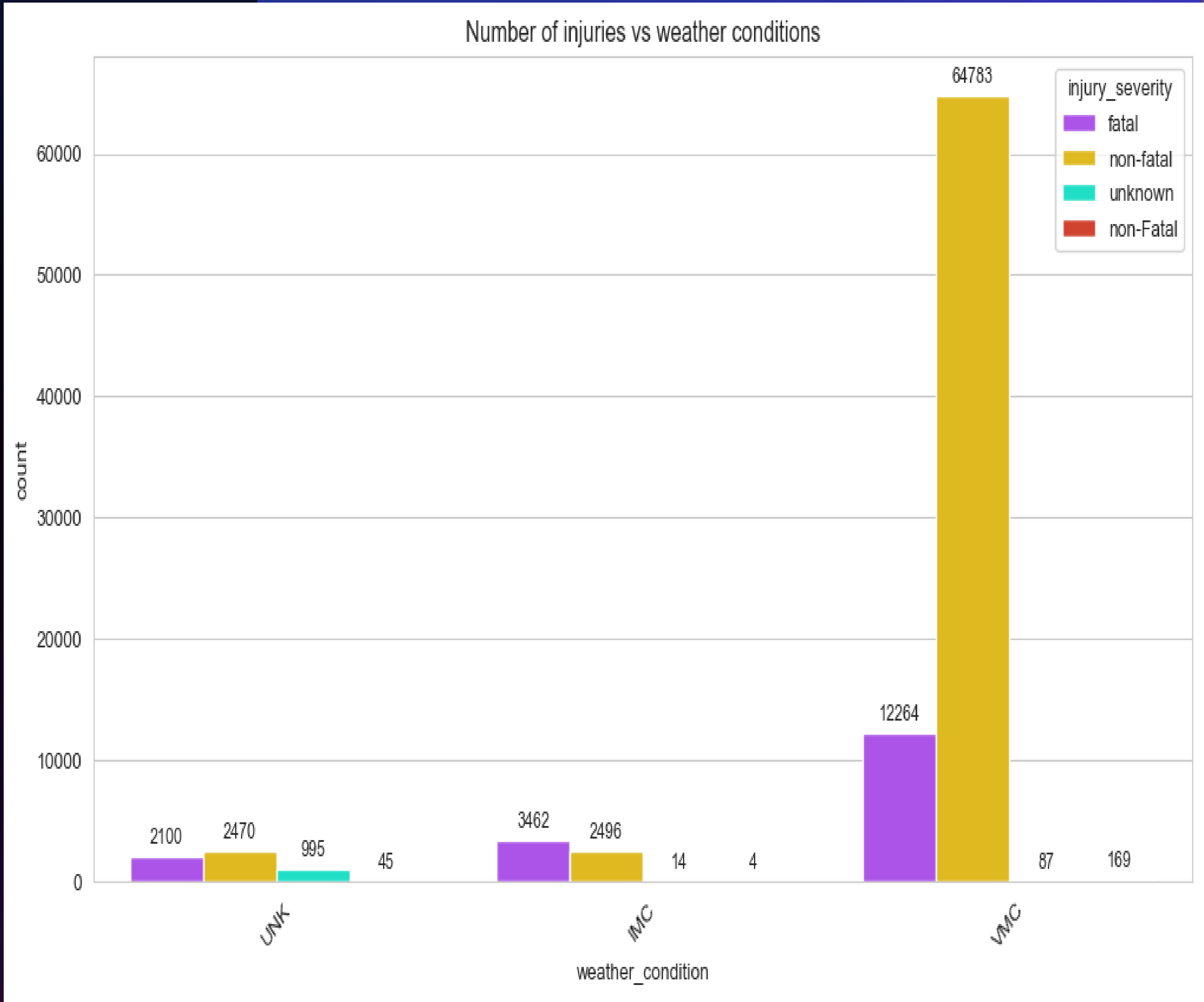
Clarify unknown built status planes to improve data integrity to enable for accurate safety analysis

BIVARIATE ANALYSIS

It examines the relationship between two variables

1. Check if there's a correlation between the number of injuries and specific weather conditions.

A distribution showing the correlation between number of injuries and specific weather conditions



Observation

- So this essentially shows that most injuries(both fatal and non fatal) occur when weather conditions are visual meteorological conditions(VMC). meaning more accidents happen during good visual weather rather than in bad weather conditions
- -non fatal and fatal injuries are also the highest in both Instrument Meteorological Conditions(IMC)

Conclusion

*Data clearly shows that majority of incidents, particularly those resulting in both fatal and non-fatal injuries occur in VMC.

*This shows that even in seemingly good weather conditions, a large number of injuries occur as compared to unknown/bad conditions(IMC).

*Unknown weather conditions also contribute to significant injuries, including fatalies

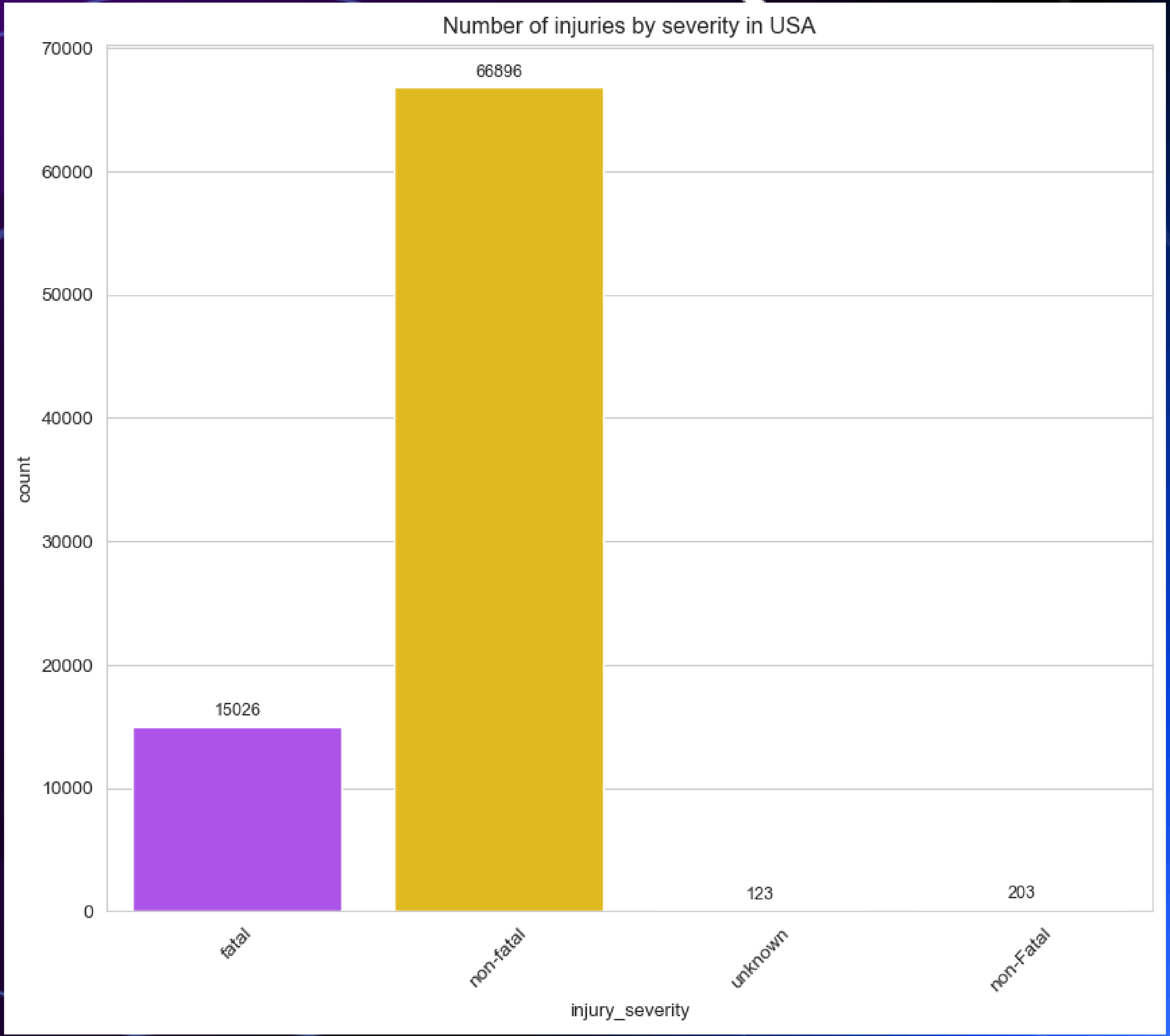
Recommendation

- Investigate VMC thoroughly and lean on contributing factors for the incidences e.g pilot errors, mid air collisions, system failures etc.

- -Analyze challenges that could lead to IMC fatalities, such as loss of control in instrument conditions,controlled flight into terrain, system failures and pilot proficiency in instrument flights

2. How Do The Number Of Accidents/ Injuries Vary By Country?

A distribution showing how number of accidents vary by country



Observation

- It shows that still 'non fatal' injuries are the most common, followed by 'fatal' injuries
- very few incidents noted and almost if not negligible values on unknown and fatal

Recommendation

- Focus on fatal injuries despite being lower than non fatal injuries, to prioritize on safety policy development.

- Analyze non fatal injuries to identify common patterns leading to the same, to prevemt leading to more severe outcomes

- Minimize unknown status to ensure accurate data collection and minimize ant missing information

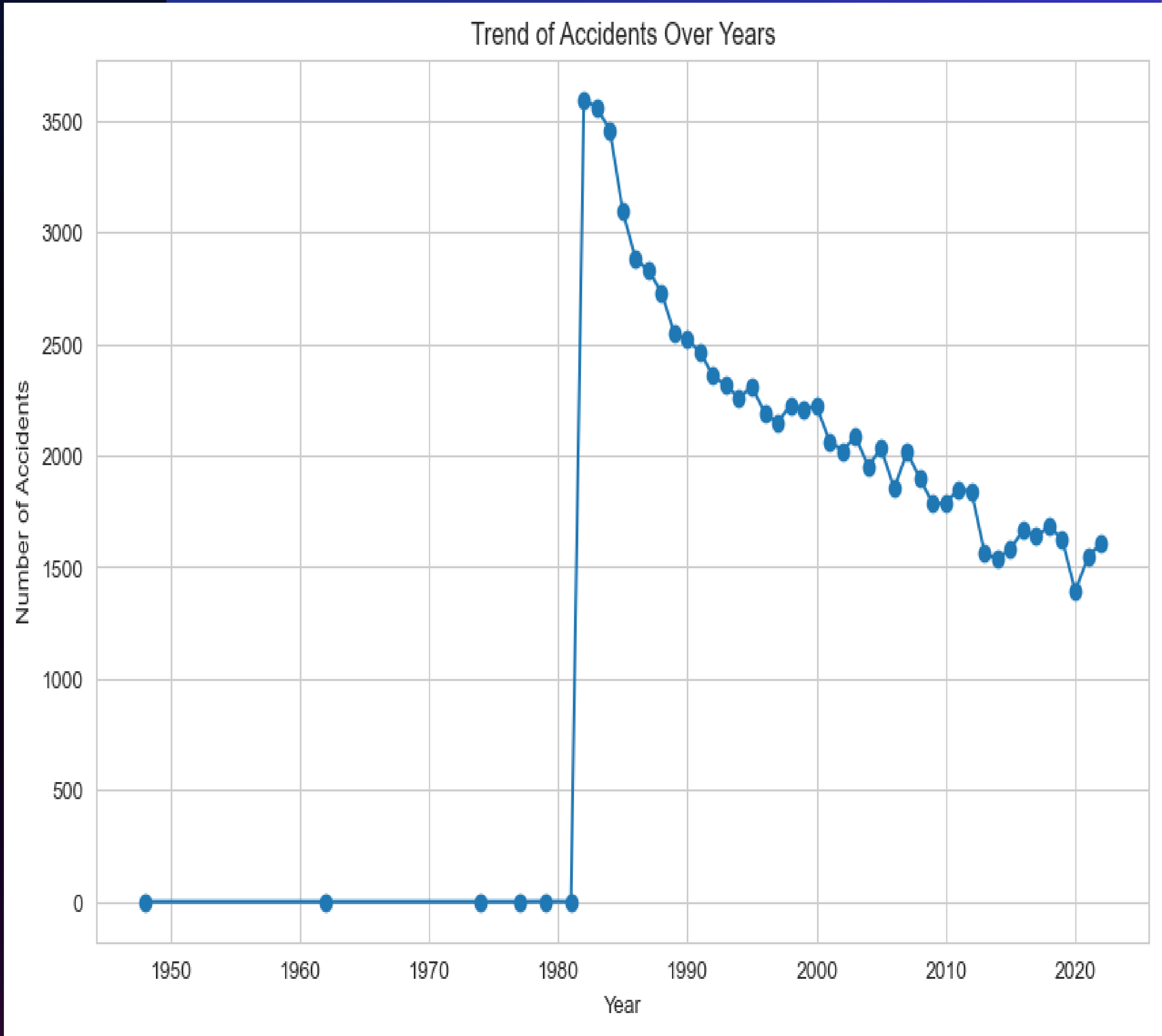
Conclusion

Conclusion

In USA, most aircraft incidences result in non fatal injuries, however a significant number of incidences are fatal, showing a critical area in aviation safety

3. What is the total number of accidents recorded over a specific period?

A distribution showing the recorded trend of accidents over a period of approximately 40 years



Observation

- The line graph shows that between 1950- early 80's, the number of accidents is basically at a 0. so, either there were very few accidents or there were no records done for the accidents
- There is a sudden increase in the number of accidents in early 80's around 1982 or 1983(probably because of the previous years being at 0)
- Number of accidents then shows a downward trend after hitting it's peak in 80's and shows a gradual decline till present time in the dataset. This could mean either better records done, or improvement in aviation safety over time

Conclusion Conclusion

- Shows a strong downward trend in the number of aviation accidents since the mid 80's, indicating significant improvements in aviation safety

- The initial period of near zero suggests potential data incompleteness for earlier years

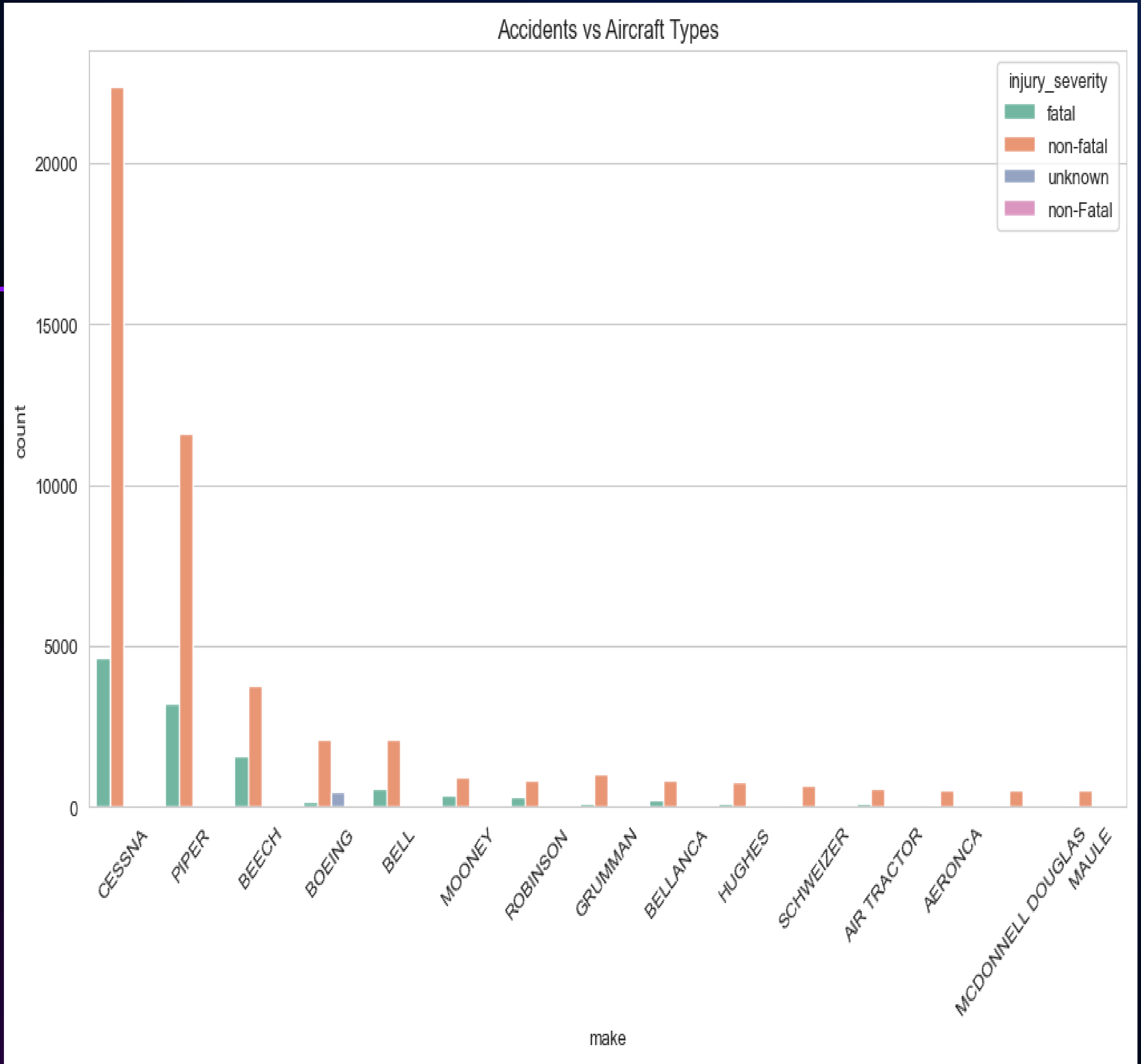
Recommendation

- Confirm if the near zero accidents before early 80's are accurate or simply missing.

- Confirm continued safety improvements that have led to decline in accidents e.g technological advancements, improved training, better air traffic control etc¶

4. Do certain types of flights/make of aircraft contribute in a higher incidence of injuries?

A distribution showing the relationship between aircraft types and frequency of severity of injuries



Observation

- Bar chart shows top 15 aicraft models with the highest number of injuries, with CESSNA showing highest number of injuries('non-fatal'), being over 20,000 counts
- 'PIPER' is the second highest in number of injuries.with 'non fatal' injuries as the common outcome. could be because of overuse?we'll see their engines maybe later.
- incidental, serious and unknown injuries are rare accross the whole graph

Conclusion Conclusion

- Shows that CESSNA,PIPER AND BEECH aircraft are involved in majority of accidents, likely due to their high prevalence in general aviation

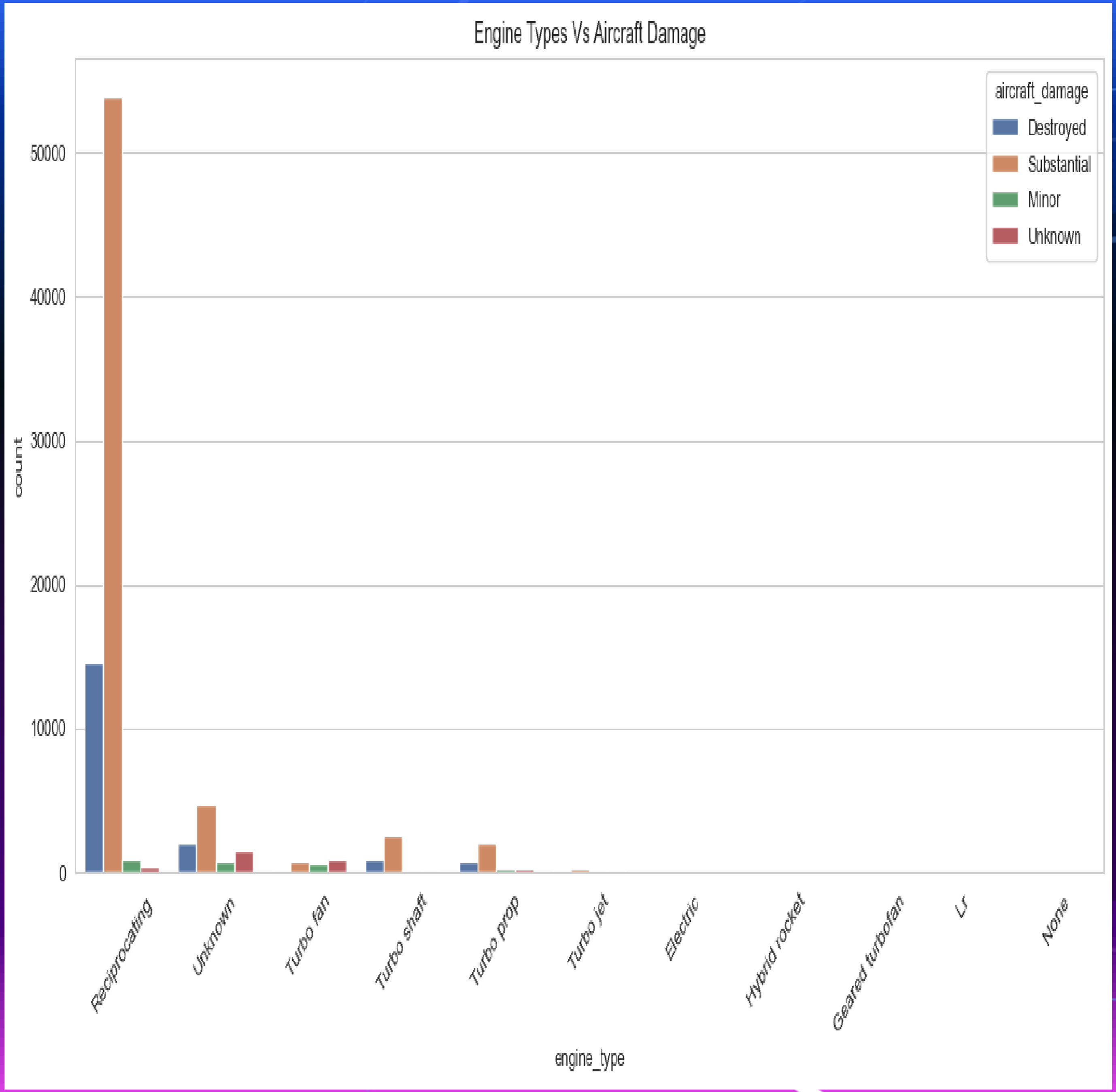
- BOEING, shows a significantly lower number of accidents, despite being a major manufacturer. This reflects different operational environments and fleet sizes

Recommendation

- Despite CESSNA,PIPER and BEECH having majority injuries, we should normalize accident counts by exposure i.e number of aircrafts in operations, total flight hours, total depatures
- Investigate whether said companied have other areas of concern that could increase their accidents(pilot training, aircraft system maintenance,weather conditions etc)¶

5. Is there A relationship between the extent of aircraft damage and the type of engine involved in an accident?

A distribution showing the extent of damages in different plane engines



Observation

- 'Reciprocating' types of engines are clearly disadavantaged since they have the highest number of incidents that result in 'substantial' aircraft damage. also with the highest number of 'destroyed' damages.
- turbine based engines('Turbo Fan','Turbo Shaft','Turbo Prop' and 'turbo jet) are involved in fewer incidents that result in aircraft damage
- less common engines types(electric,hybrid rocket, geared turbofan, lr, etc) have minimal or no damage at all¶

Conclusion Conclusion

- Data strongly indicates that majority of accidents involving damage occur in Reciprocating engines

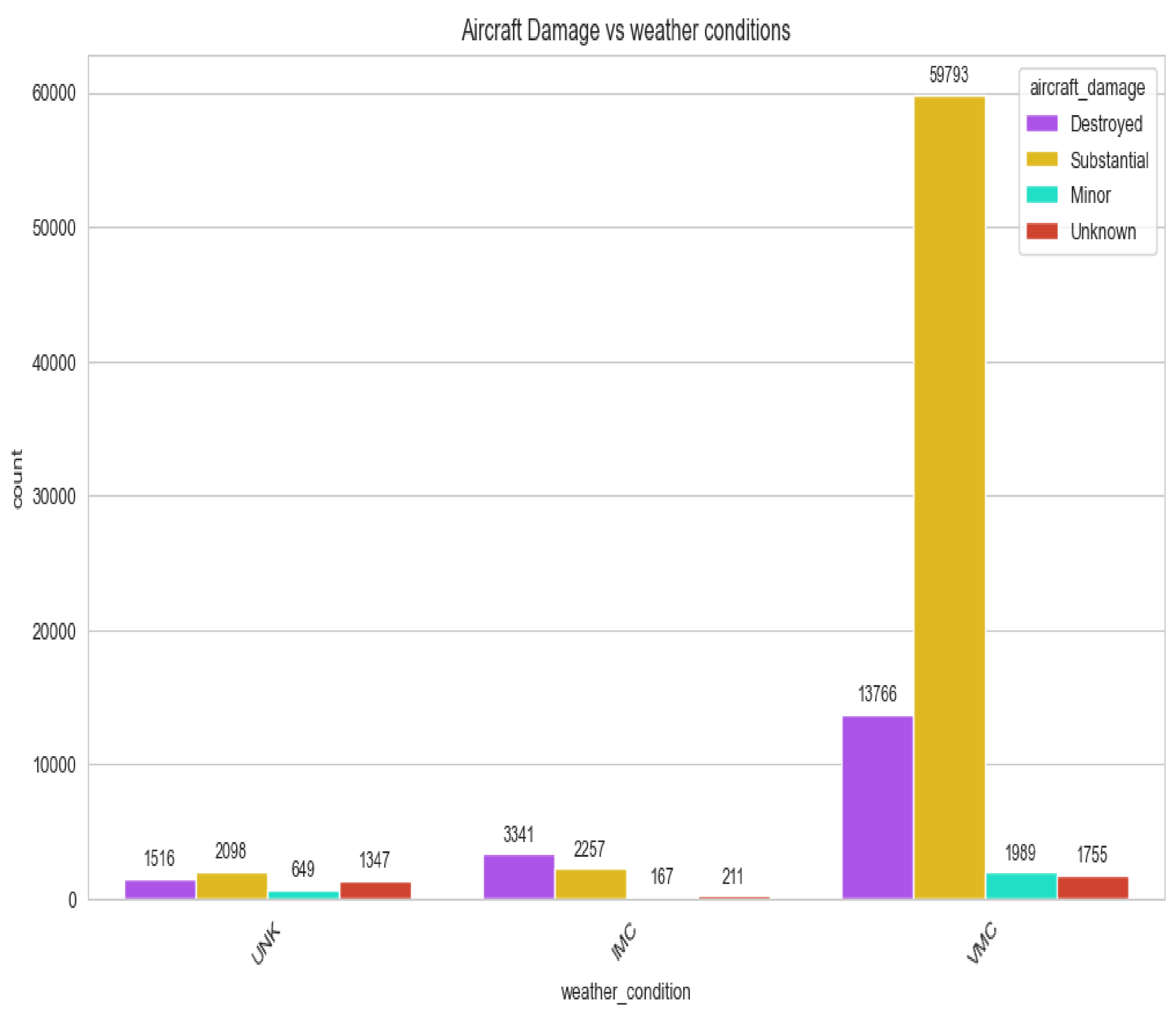
- Modern or less common engine types like electric, hybri rocket and geared turbofans have almost no recorded damage history either due to limited numbers or newer operational safety standards

Recommendation

- Focus on Reciprocating engines and figure out causes leading to increased accidents
- Monitor emerging engine technologies to prevent severe outcomes in future
- Normalize accident counts with fleet hours, departures for each engine type.

6. How do different weather conditions influence the extent of aircraft damage during an incident?

A count plot showing how different weather conditions influence the extent of aircraft damage



Observation

- Most aircraft damage is occurring in VMC. This shows that despite good weather conditions and visibility, a large number of incidents leading to substantial air damage still happens
- Second highest damage to planes is 'Destroyed', after ‘substantial', regardless of weather conditions
- Fewer aircraft damage incidents occur in IMC or UNK as compared to VMC

Conclusion

- Shows that majority of aircraft damage incidents, especially substantial and destroyed aircrafts occur in VMC

- IMC has a high number of destroyed aircrafts, but not as high as VMC.

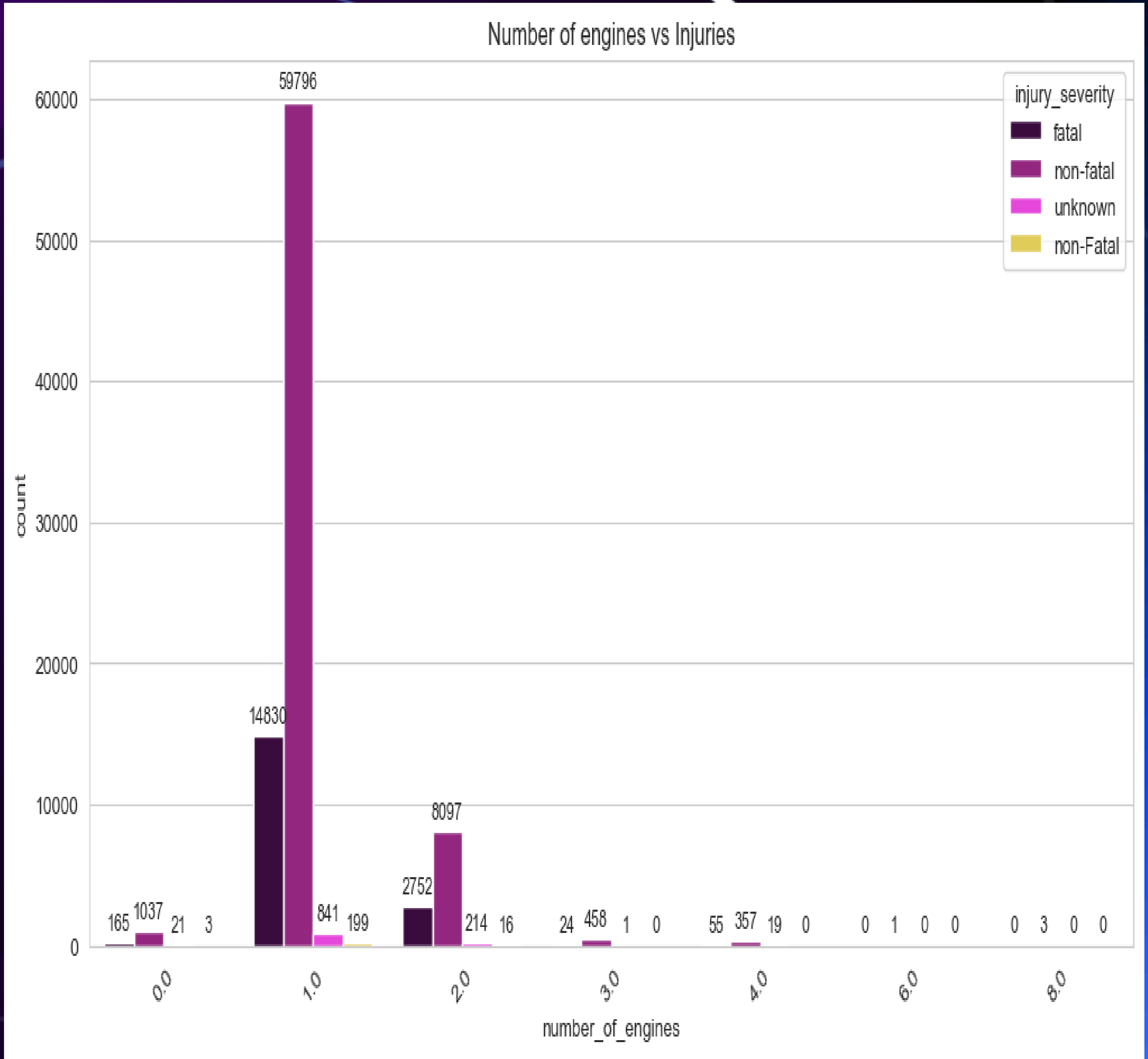
- There's also a significant number of incidents where weather conditions are unknown

Recommendation

- - Investigate underlying causes in VMC(to include: Pilot errors, mid air collisions, mechanical failures etc)
- Analyze IMC damages and challenges faced eg. loss of control due to instrument disorientation, controlled flight into terrain in low visibility, system failures etc
- Cross reference both VMC and IMC with pilot experience, ratings and flight hours

7. How do the number of engines in planes affect injuries?

A count plot showing the relationship between the number of engines on an aircraft and the number of associated injuries



Observation and Conclusion

- Aircrafts with 1 engine are associated with the highest number of injuries
- Aircrafts with 2 engines come in 2nd but those with 0 engines also show a significant number of injuries
- Those with 3 or more engines have the least number of injuries¶

Recommendation

-Prioritize single engine planes since they have highest number of injuries,both fatal and non fatal, and focus on causes leading to the same.

-Investigate risks associated with 2 engine planes despite their numbers being lower

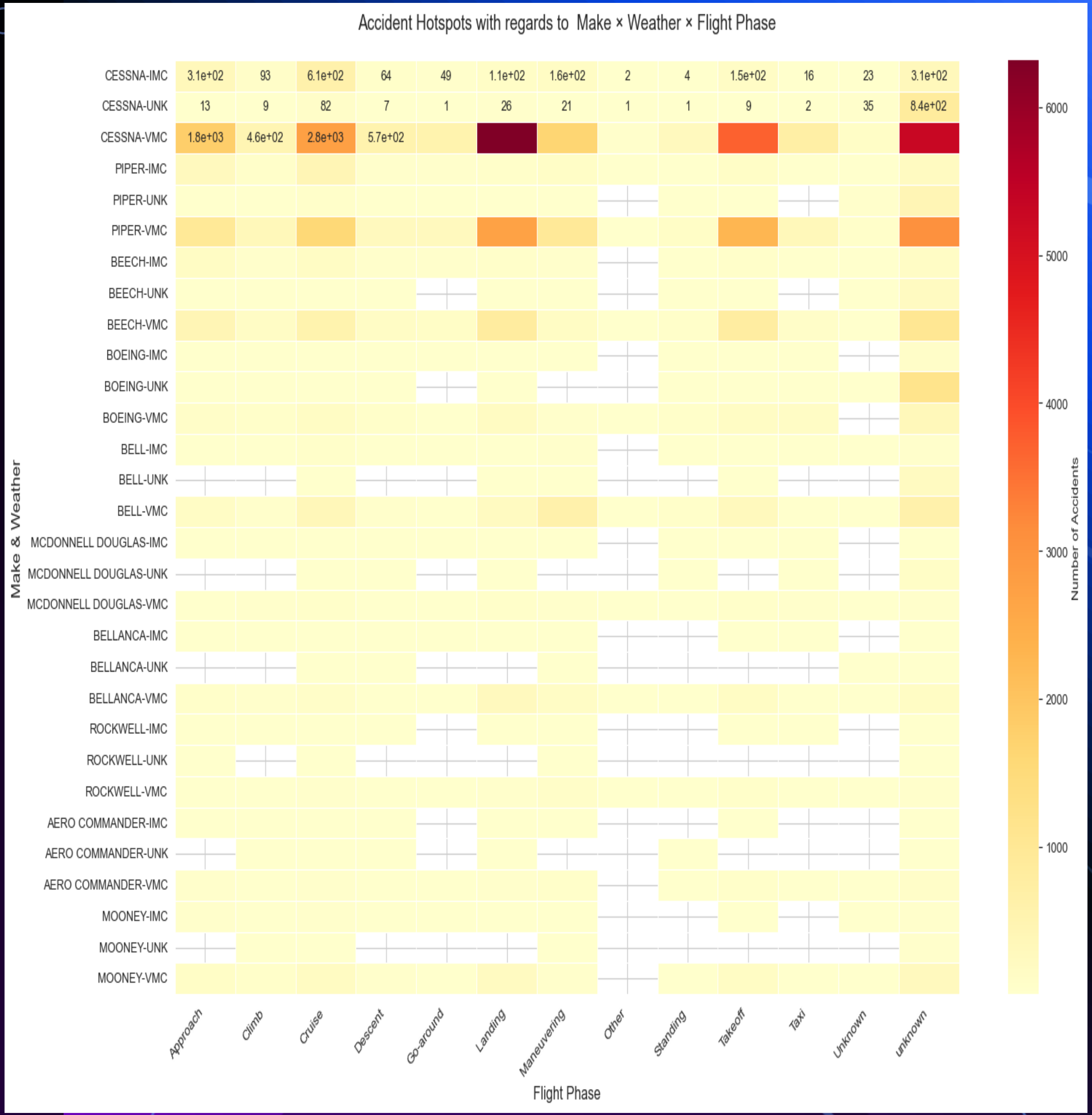
- Investigate 0 engine planes(e.g gliders and drones) and causes of their injuries, are they due to operational risks(weather, terrain, aerobatics etc)¶

Multivariate Analysis

Analyses datasets containing multiple variables simultaneously

1.Analyze how make, weather, and flight phase together influence accident rates

A heatmap that identifies patterns and hotspots of aircraft accidents based on the aircrafts make, weather conditions and flight phase.



Observations

* Dominance of Cessna and Piper: Consistent with previous observations, "CESSNA" and "PIPER" aircraft appear to be involved in the highest number of accidents across various weather conditions and flight phases.

* VMC Dominance: For Cessna and Piper, "VMC" (Visual Meteorological Conditions) combinations show the most prominent "hotspots" (darker cells).

* Significant "Unknown" Weather: "UNK" (Unknown weather conditions) for Cessna and Piper also shows considerable accident counts across various flight phases, highlighting a data reporting gap that affects accident analysis.

* IMC Accidents: While fewer than VMC, IMC conditions still contribute to accidents. For Cessna and Piper, IMC incidents show up across phases like "Landing" and "Maneuvering," though with lower counts than their VMC counterparts.

* Boeing and Other Large Aircraft: "BOEING" (both upper and lower case) shows very few accidents across all weather conditions and flight phases, reinforcing the idea of high commercial aviation safety rates (though, again, without normalization, this is just absolute count).

* "Maneuvering" and "Landing/Takeoff" as Critical Phases: Across Cessna and Piper, "Maneuvering," "Landing," and "Takeoff" consistently show the highest accident counts, regardless of weather, indicating these are inherently high-risk flight phases for these types of aircraft.

Conclusion

-This heatmap clearly identifies Cessna and Piper aircraft operating in Visual Meteorological Conditions (VMC) during the Maneuvering, Landing, and Takeoff phases as the primary "hotspots" for accidents in this dataset.

-While "Unknown" weather conditions also account for a substantial number of accidents, particularly for these manufacturers, the absolute highest counts are in VMC.

-The significantly lower accident counts for commercial aircraft manufacturers like Boeing suggest a stark difference in risk profile, likely due to fleet size, operational environment, and regulatory oversight.

Recommendation

*Focus investigative efforts on accidents involving Cessna and Piper aircraft in VMC, particularly during maneuvering, landing, and takeoff. Analyze the specific types of errors, environmental factors, or mechanical issues prevalent in these high-volume scenarios.

* Maneuvering: Investigate pilot training, decision-making, and specific maneuvers.

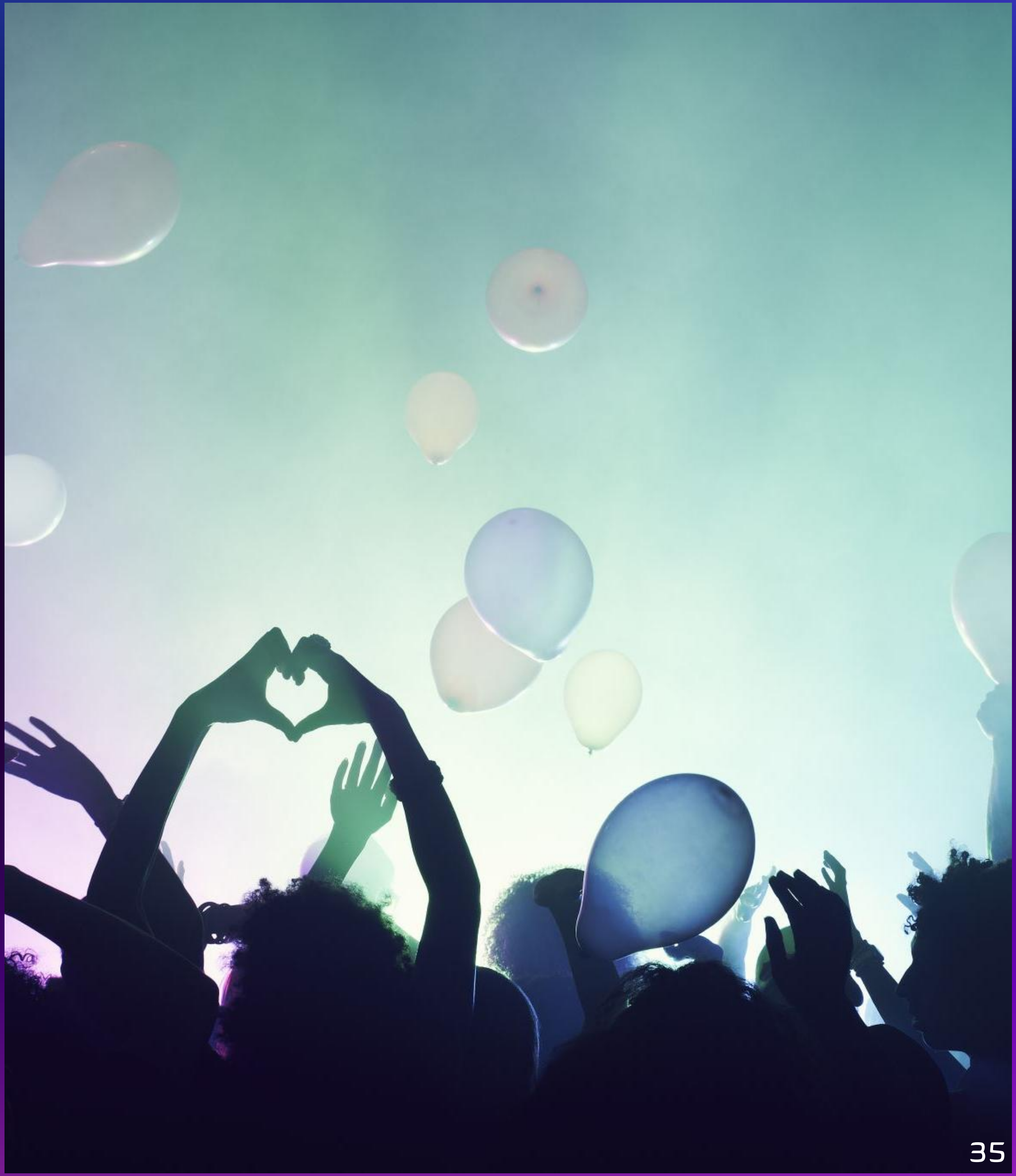
* Landing/Takeoff: Common phases for loss of control, runway excursions, or hard landings. Focus on short-field operations, crosswind techniques, and aircraft performance limits.

* Prioritize efforts to reduce incidents with "Unknown" weather conditions and "Unknown" flight phases. This missing information hinders precise accident analysis.

*Based on the normalized data, develop targeted safety programs, pilot training modules, and regulatory advisories specifically for general aviation pilots operating Cessna and Piper aircraft, with particular emphasis on high-risk phases like maneuvering, takeoff, and landing.

* Analyze Rare Categories: While lower in count, consider if any rare combinations (e.g., specific makes in IMC, or unique flight phases) represent unusually high rates once normalized, indicating specific niche risks.¶

THANK YOU!!



QUESTIONS??