AVIATION DATASET ANALYSIS: EVALUATING AIRCRAFT SAFETY AND RISK

HELPING THE AVIATION DIVISION MAKE INFORMED PURCHASING DECISIONS

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OVERVIEW

- **Purpose**
- This analysis evaluates the safety records of various aircraft models, focusing on identifying those with the lowest risk for both commercial and private operations.
- Findings will assist the company in making informed purchasing decisions by minimizing risk exposure.
- **Scope**
- The analysis focuses on civil aviation accident data involving both commercial and private aircraft models.
- It highlights models with high reliability and safety, and provides insights into low-risk aircraft profiles.

BUSSINESS UNDERSTANDING

- **Stakeholders**
- **Aviation Division Leadership**: Responsible for making purchasing decisions.
- **Risk Management Team**: Focused on minimizing risk exposure.
- **Purchasing Department**: Involved in sourcing aircraft for the company’s aviation portfolio.
- **Key Business Questions**
- Which aircraft models have the lowest safety-related incidents over time?
- Are there any significant patterns in safety data related to aircraft model types or manufacturers?
- What factors contribute to the likelihood of aircraft accidents and fatalities?
- Which aircraft should the company consider purchasing to minimize exposure to aviation risks

DATA UNDERSTANDING AND ANALYSIS

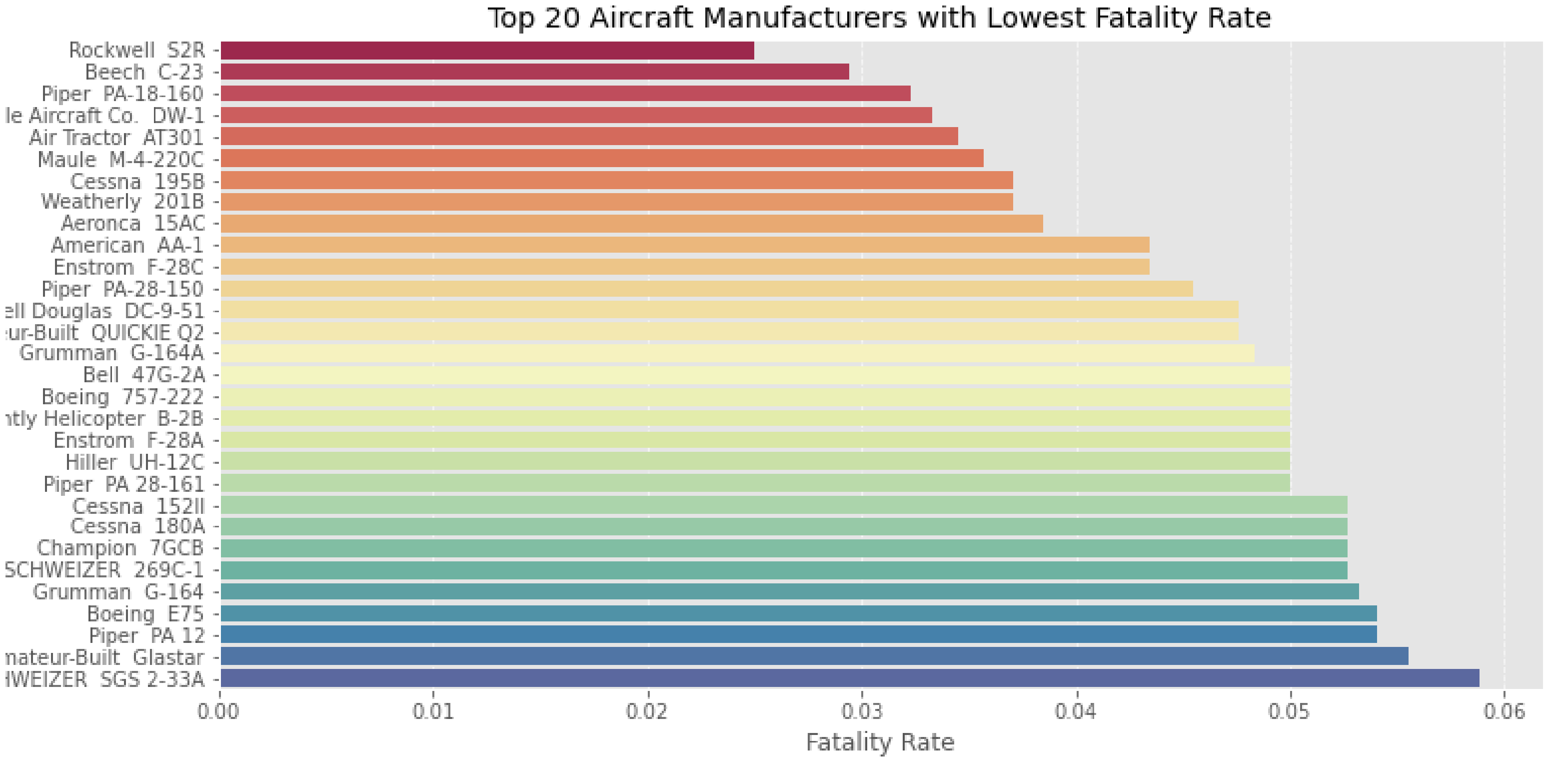
- **Source of Data**
- Data is sourced from the **National Transportation Safety Board (NTSB)** aviation accident database, covering civil aviation accidents from 1962 to the present.
- Available on **Kaggle**, containing valuable details like aircraft types, weather conditions, and other variables.
- **Description of Data**
- **Event.Date**: Date of the accident/incident.
- **Location**: Geographical location of the accident.
- **Aircraft Make**: The manufacturer (e.g., Boeing, Cessna).
- **Model**: The specific aircraft model.
- **Injury Severity**: Number of fatalities, serious injuries, minor injuries, and uninjured passengers.
- **Engine Type**: Type of engine (e.g., piston, jet).
- **Weather Conditions**: Weather during the incident.
- **Phase of Flight**: Whether the accident occurred during takeoff, cruising, or landing.
- **Accident Severity**: Severity of the accident (fatal, serious, minor).

DATA CLEANING

- **Handling Missing Data**: Imputing or excluding rows with missing data.
- **Data Consistency**: Ensuring consistency across model names, injury severity, and date formats.
- **Duplicates**: Removal of duplicate entries where necessary.

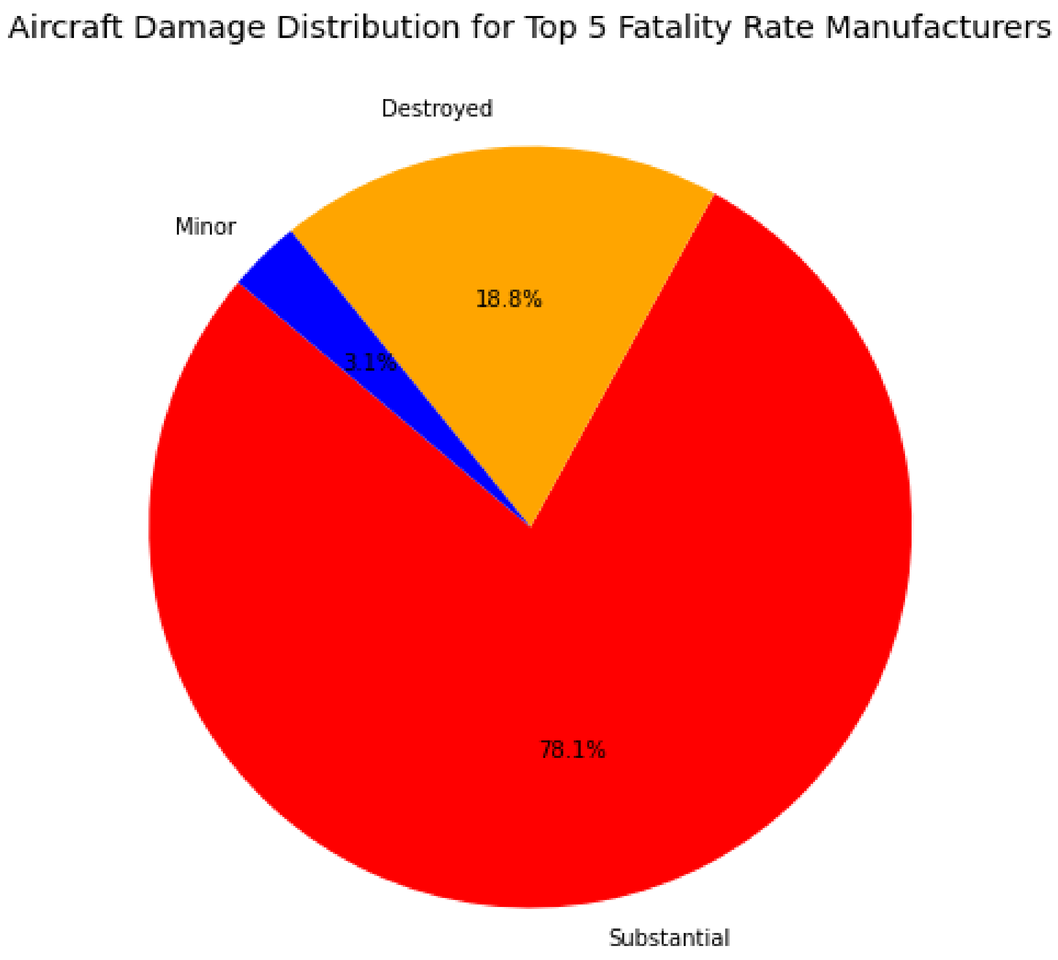
VISUALIZATIONS – MODEL VS FATAL INJURIES

- **Description**
- A bar plot showing the **fatality rate** for the top 20 aircraft models with ~~lower fatality rates. It allows a clear~~ comparison of how different models contribute to fatal accidents, helping to identify those with lower fatality rates for our analysis.
- **Insight**
- Some aircraft models have higher fatality rates, indicating a potential risk for future purchasing decisions.



VISUALIZATIONS - AIRCRAFT DAMAGE DISTRIBUTION FOR TOP 5 MODELS

- **Description**:
- A pie chart that visualizes the **damage severity distribution** (e.g., "Destroyed", "Substantial", "Minor") for the top 5 aircraft models with the most incidents.
- **Insight**
- We can infer from the pie chart below that a high percentage of them (78.1%) had major but repairable damage. Structural integrity was affected, but the aircraft was not completely destroyed.
- 3.1% of the make_Models had minor damages and 18.8% were complety destroyed
- Because of the inferences above, we still hold on to the Makes because they seem to be in a repairable condition even after the accident and not completely destroyed



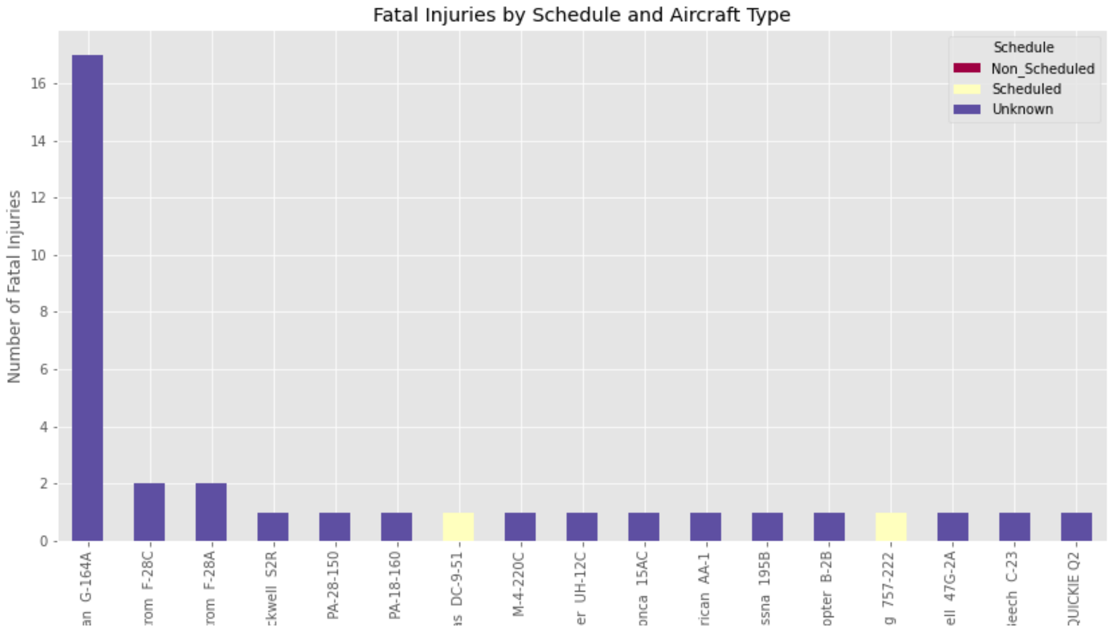
FAR DESCRIPTION

- I chose to filter the aircraft models based on Part 121 and Part 91 regulations because these parts specifically govern commercial and private aviation operations, respectively. Part 121 includes stricter safety measures for commercial use, while Part 91 is typically associated with private, general aviation, which can have varying levels of safety protocols

	Make_Model	FAR.Description	Incident_Count	Part_Type
0	Aeronca 15AC	Part 91	2	Part 91
3	American AA-1	Part 91	1	Part 91
5	Beech C-23	Part 91	3	Part 91
8	Bell 47G-2A	Part 91	2	Part 91
10	Boeing 757-222	Part 121	5	Part 121
12	Brantly Helicopter B-2B	Part 91	2	Part 91
14	Cessna 195B	Part 91	9	Part 91
17	Enstrom F-28A	Part 91	4	Part 91
19	Enstrom F-28C	Part 91	3	Part 91
23	Grumman G-164A	Part 91	1	Part 91
25	Hiller UH-12C	Part 91	1	Part 91
27	Maule M-4-220C	Part 91	3	Part 91
29	Mcdonnell Douglas DC-9-51	Part 121	2	Part 121
31	Piper PA-18-160	Part 91	3	Part 91
33	Piper PA-28-150	Part 91	4	Part 91
37	Rockwell S2R	Part 91	2	Part 91
39	Unknown Amateur-Built QUICKIE Q2	Part 91	3	Part 91

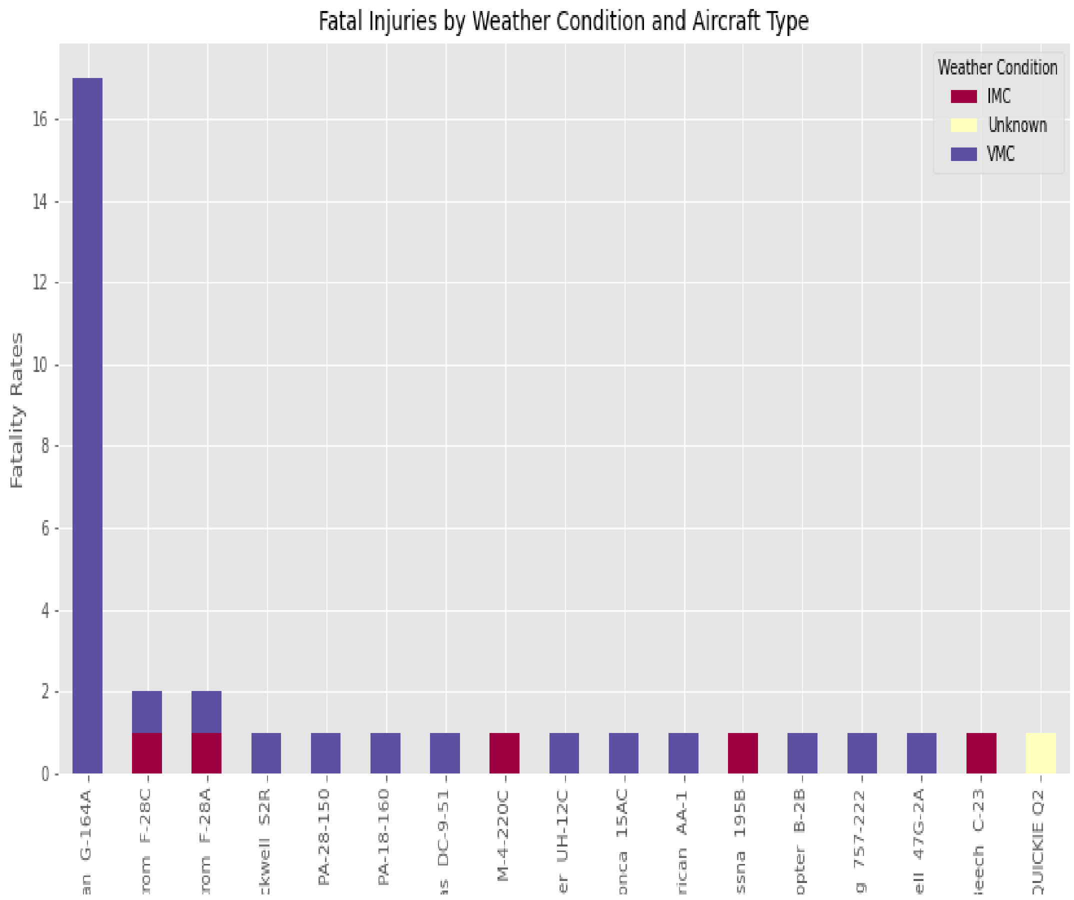
VISUALIZATIONS - FATALITY INJURIES BY SCHEDULE AND AIRCRAFT TYPE

- The data suggests fatality injuries occurred on unpredictable schedules, with some incidents involving specific make and model planes. Scheduling plays a critical role in aviation safety due to factors like pilot fatigue, weather conditions, air traffic congestion, and operational efficiency.
- **Pilot Fatigue:** Long hours, short turnarounds, and frequent flights increase fatigue, impairing alertness and decision-making.
- **Adverse Weather:** Early morning or night flights are more prone to poor weather like fog, thundersto
- rms, or snow, increasing risks.
- **Air Traffic Congestion:** Rush hours can lead to delays, traffic, and communication errors, raising accident chances.
- **Operational Balance:** Over-scheduling causes stress on pilots and ground operations, while under-scheduling leads to inefficiencies. Balancing scheduling optimizes safety and performance



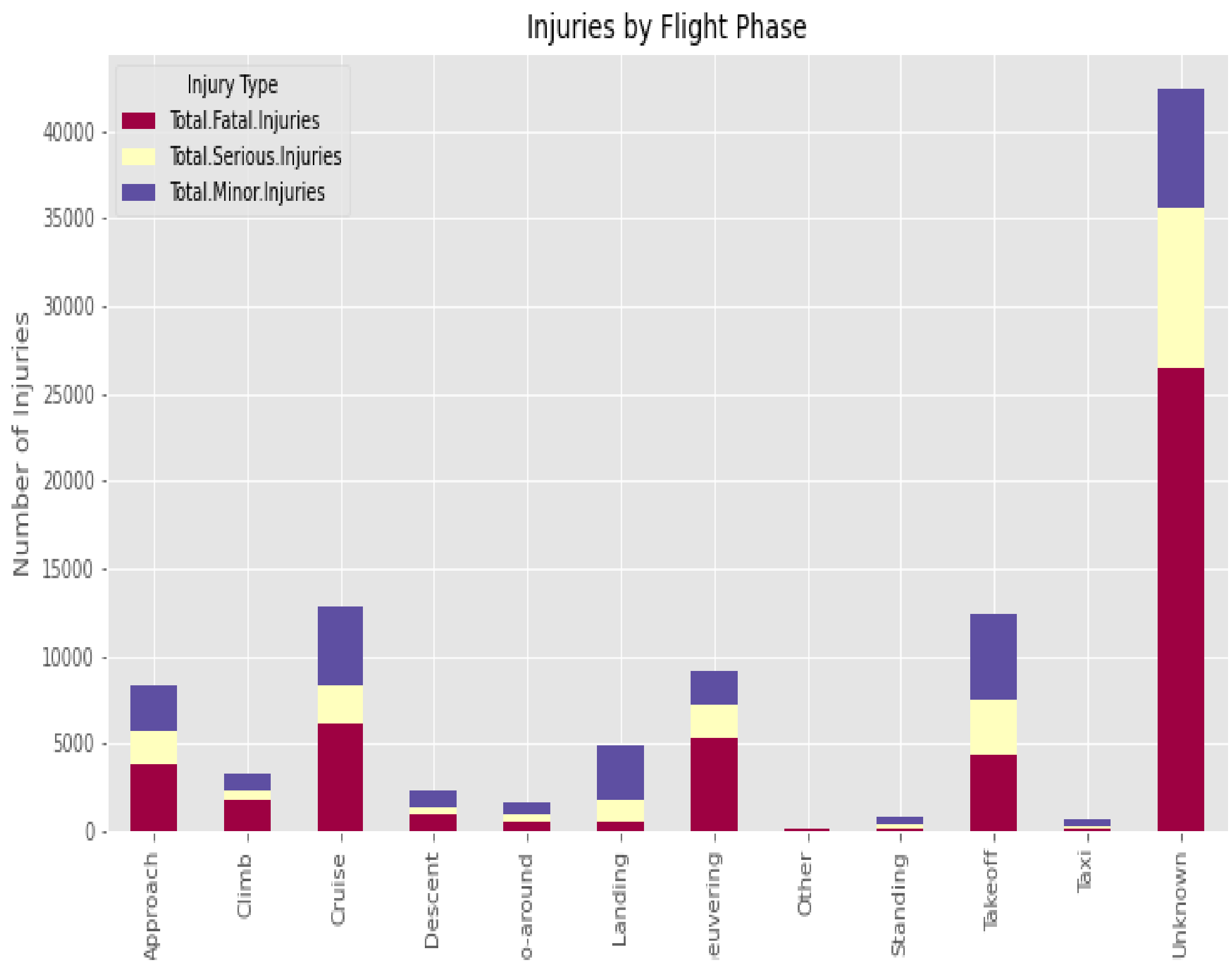
FATAL INJURIES BY WEATHER CONDITIONS AND AIRCRAFT MODELS

- The **Grumman G-164A** has higher fatality rates even in good weather, indicating possible design flaws. It should be eliminated.
- The **Enstron F-28C**, **Enstron F-28A**, **Maule M-4-220C**, **Cessna 195B**, and **Beech C-23** have higher fatality rates in poor visibility and bad weather, suggesting vulnerability to adverse weather conditions like thunderstorms or ice.
- Other models seem better equipped for bad weather, with fatalities likely due to operational issues rather than weather.



VISUALIZATIONS - INJURIES BY FLIGHT PHASE

- There is higher injury counts during Approach, cruise maneuvering and Takeoff
- Fatalities are concentrated on Cruise, Landing and Takeoff and this shows high impact crashes
- These phases are critical in aviation, where most accidents occur due to pilot error, mechanical failure or external conditions
- There is also alot of injuries and fatalities that are actually uknown
- most injuries occur during these phases, aviation safety efforts (improved pilot training, better aircraft design, enhanced air traffic control procedures) shou focus on that phase



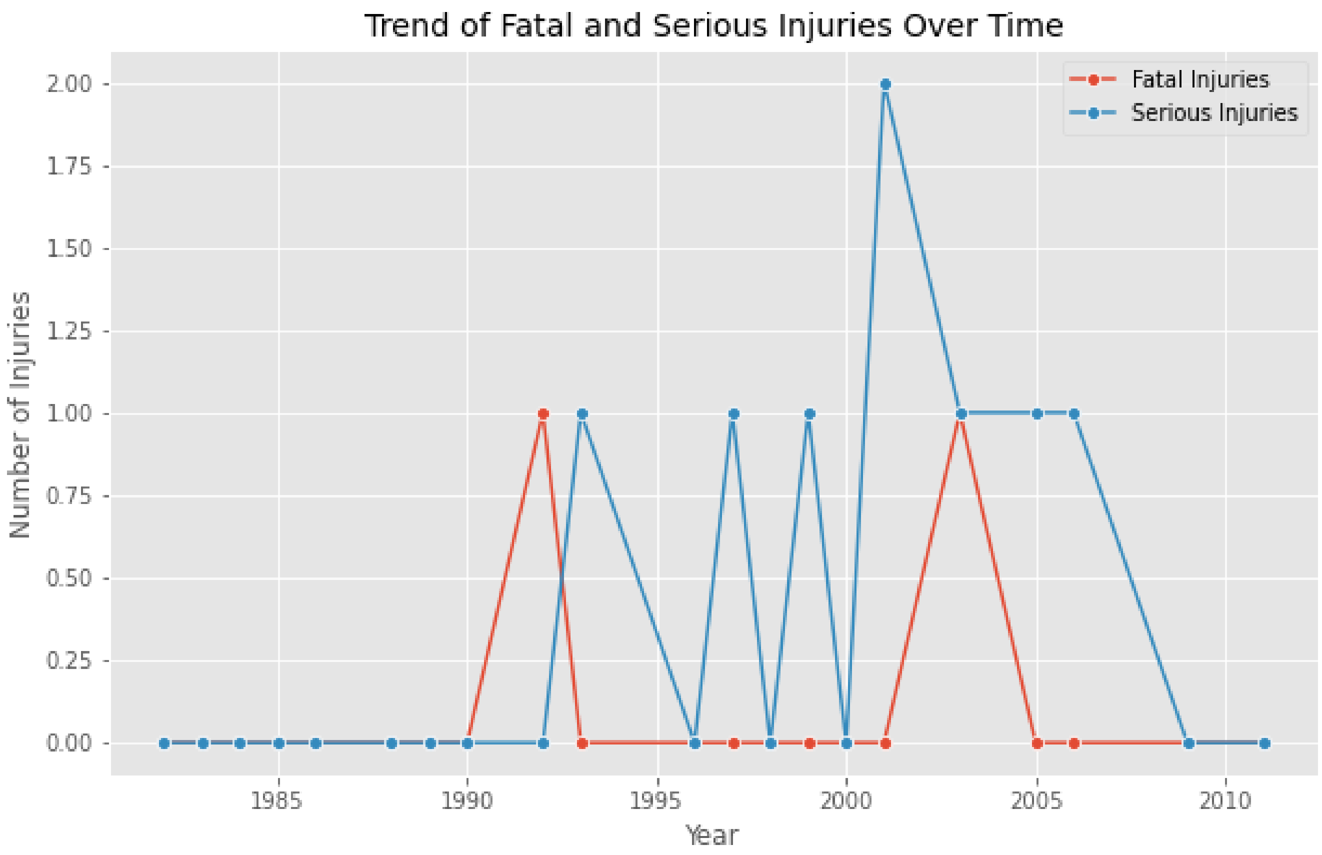
VISUALIZATIO N:NUMBER OF ENGINES

- From the analysis above,Boeing 757-222 and Mcdonnell Douglas DC-9-51 have two engines while the rest have single engines
- Single engines may be more susceptible to complete failure if the engine malfunctions
  - Aircraft with fewer engines (especially single-engine) could have higher fatality rates due to the total reliance on one engine. If this engine fails, there are no backups, which could result in a fatal accident
- The presence of multiple engines allows for redundancy—if one engine fails, the other can continue to power the aircraft.
- In this case, we will elliminate all other Make_Models and remain with the two with 2 engines

	Make_Model	Number.of.Engines
0	Aeronca 15AC	1.0
1	American AA-1	1.0
2	Bell 47G-2A	1.0
3	Boeing 757-222	2.0
4	Brantly Helicopter B-2B	0.95
5	Hiller UH-12C	1.0
6	Mcdonnell Douglas DC-9-51	2.0
7	Piper PA-18-160	0.967741935483871
8	Piper PA-28-150	1.0
9	Rockwell S2R	0.975

TRENDS OF FATAL AND SERIOUS INJURIES OVER TIME

- -Between the year 1983 to 1990,there were relatively 0 fatality rates, this might be because the models had just been introduced into the market and therefore there were less amount of flights taken using these models.
- While the two models has been involved in some accidents over the years, the number of fatal accidents and fatalities is relatively low given the vast number of flights.This is corelated to the statistics between the year 1990 to 2010.
- From the year 2010 to the year 2020 there has been a zero fatality rate -This could be because of the technology that has been dedicated to develop those models hence making them reliable



KEY INSIGHTS

- Boeing 757-222: This model demonstrates a low fatality rate, indicating that it has a proven safety record over time. The design and engineering of the aircraft contribute to minimizing fatal incidents.
- Mcdonnell Douglas DC-9-51: Similarly, Mcdonnell Douglas DC-9-51 also shows a low fatality rate, affirming that it is built with safety at the forefront. Its safety systems, whether newer or enhanced, are highly effective in reducing risk.

RECOMMENDATIONS

- For Operators: Both models should be maintained and operated in line with best practices to continue their safety performance. Regular checks and adherence to safety protocols should be a priority.
- For Future Aircraft Decisions: Either Boeing 757-222 or Mcdonnell Douglas DC-9-51 can be considered for purchase or operation, depending on factors such as cost, maintenance history, and operational needs. Given their low fatality rates, both options are safe and viable choices.
- Ongoing Monitoring: Continuous data collection and monitoring of both models will be important to ensure that their low fatality rates are sustained over time, particularly as they age or as new technology is introduced

FINAL THOUGHTS

- With both Boeing 757-222 and Mcdonnell Douglas DC-9-51 showing low fatality rates, they both represent excellent choices for safe operations. Operators can feel confident that either model will perform well in terms of safety, offering reliability and peace of mind. Regular maintenance and adherence to safety standards will ensure that both aircraft models continue to operate at optimal safety levels.

THANK YOU

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