Aviation

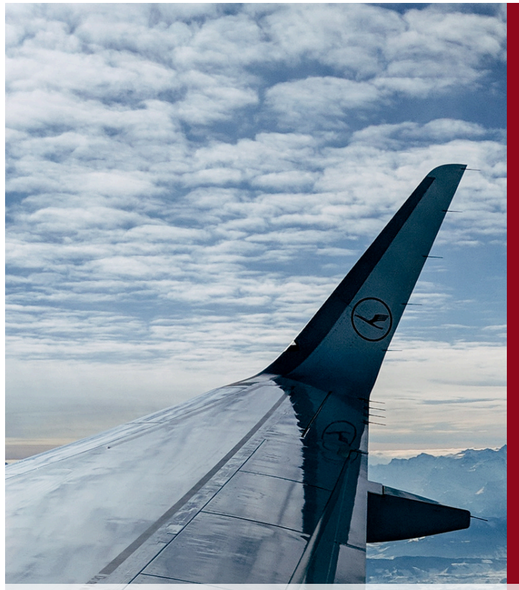
Diving into the aviation business

Strategic Risk Assessment for Aviation Asset Acquisition

PROJECT OVERVIEW

Aircraft operations businesses, both commercial and private, involve complex activities spanning manufacturing to flight, with a focus on safety, efficiency, and profitability. These businesses encompass airline services, airport management, air traffic control, and support services such as maintenance and logistics, all driven by strategic planning, revenue management, and strict regulations.

This project provides a data-driven roadmap for the company's expansion into the aviation sector. By analyzing 61 years of National Transportation Safety Board (NTSB) aviation accident data, this research identifies high-reliability aircraft makes and models that represent the lowest risk for commercial and private operations. Our findings bridge the gap between historical safety records and future investment strategies.



Aircraft purchases involve high capital cost and liability.

Poor choices increase insurance costs, downtime, and reputational risk.

Entering aviation without historical insight creates “blind entry risk.”

BUSINESS PROBLEM

Risk is any event leading to loss. The aviation industry, too, is a venture with many risks. Entering the aviation industry involves significant capital expenditure and high liability. Without historical expertise, the company faces the "Blind Entry" risk—purchasing aircraft that may be prone to mechanical failure or high fatality rates. In the Aviation venture, risk can be categorized in terms of Severity, Structure, and Mechanical aspects, among others. Severity looks at the percentage of incidents that result in fatal or serious injuries. A high-risk aircraft is one where incidents are rarely survivable. Structural damage risk is the likelihood of a plane being "Destroyed" vs. sustaining "Substantial" or "Minor" damage. This impacts the financial risk and insurance costs for the company. Mechanical risk is the failure rate of specific engine types across different phases of flight. Solving the aforementioned risks will significantly enhance portfolio growth, strategic agility, revenue, and overall company performance.

KEY QUESTIONS AND OBJECTIVES

The main goal and objective of this project is to identify the safest aircraft profiles, with the lowest risks,for both commercial and private operations. Looking at different factors to come up with a solid conclusion on which aircrafts to purchase, I will need to answer the following questions;

1. Which combination of Make, Model, Engine Type, and Aircraft Category offers the highest level of occupant safety and the lowest risk of total loss?
2. Which aircraft categories have the most and least frequent accidents?
3. Which aircraft categories provide the highest chance of survival in the event of an accident?
4. Which Engine types provide the most reliable performance?

Key Risks to Address

Safety Risk: How often occupants survive accidents

Financial Risk: Likelihood an aircraft is totally destroyed

Operational Risk: Engine reliability and aircraft category performance

Business Question

Which aircraft should you buy to maximize safety and minimize risk?

DATA UNDERSTANDING

Data source is a csv file named Aviation_Data, from the National Transportation Safety Board that includes aviation accident data from 1962 to 2023 about civil aviation accidents and selected incidents in the United States and international waters.
It contains 90348 rows and 31 columns.

What the Data Includes;

- Aircraft make and model
- Engine type
- Aircraft category
- Injury outcomes
- Damage severity

among many columns.

DATA ANALYSIS

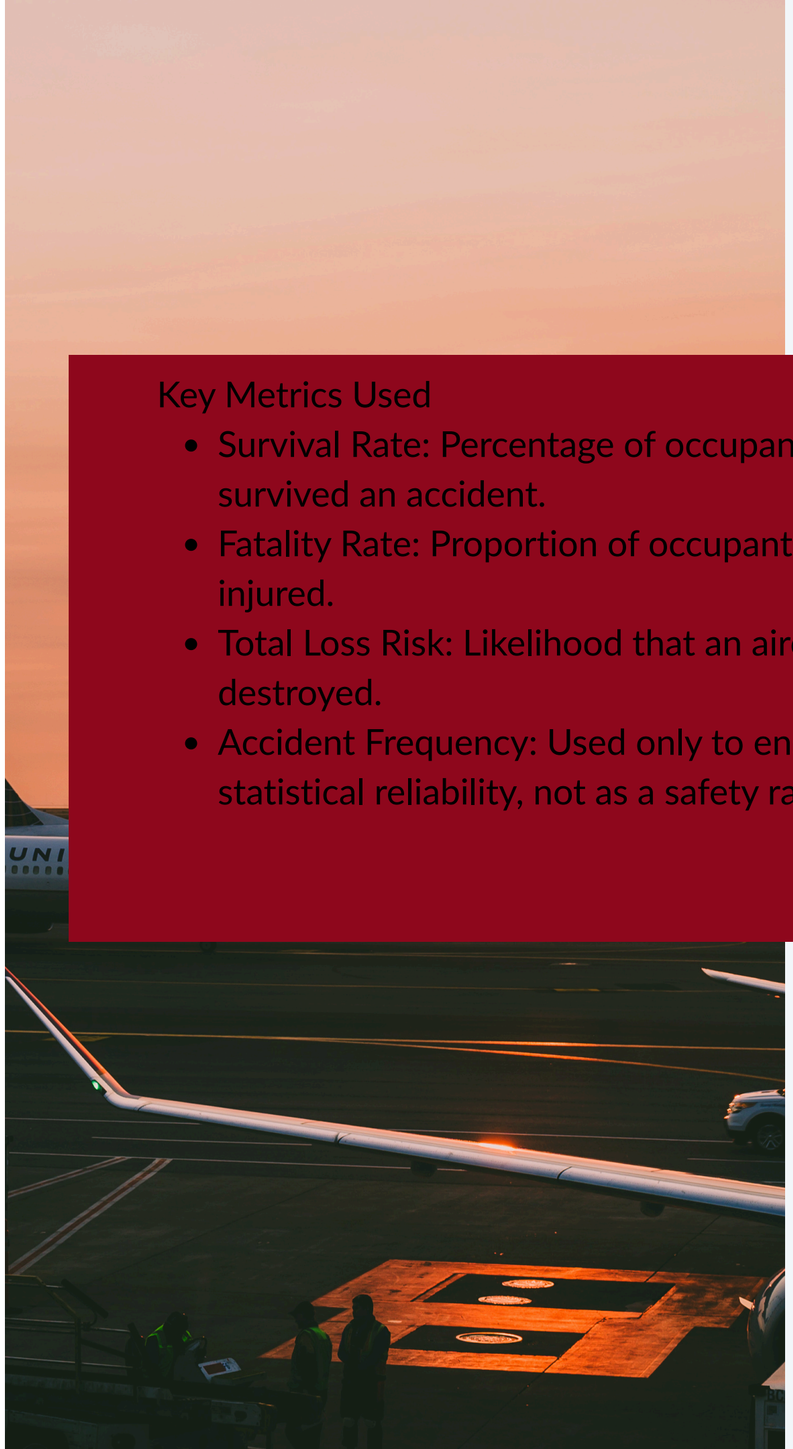
What I did to prepare the data involved:

- Cleaning missing and inconsistent data
- Standardized aircraft names and categories
- Removed incomplete records that could distort results

I used feature Engineering which is a process used to better represent which aircraft have lesser risks, by creating new insightful columns. I have added new columns like Total Occupants, Total Injuries, and survival rate columns to better my analysis, on which planes have Highest surival rates and lowest financial risks.

METHODS AND APPROACH

My approach focused on long-term safety performance rather than isolated incidents.
With more than 60 years of real-world accident data to measure how well aircraft protect occupants when things go wrong.
To ensure credibility, I only evaluated aircraft with enough historical data to produce reliable results.
The goal was not to find accident-free aircraft, but to identify aircraft that consistently deliver high survivability and low financial risk over time



Key Metrics Used

- Survival Rate: Percentage of occupants who survived an accident.
- Fatality Rate: Proportion of occupants fatally injured.
- Total Loss Risk: Likelihood that an aircraft was destroyed.
- Accident Frequency: Used only to ensure statistical reliability, not as a safety ranking.

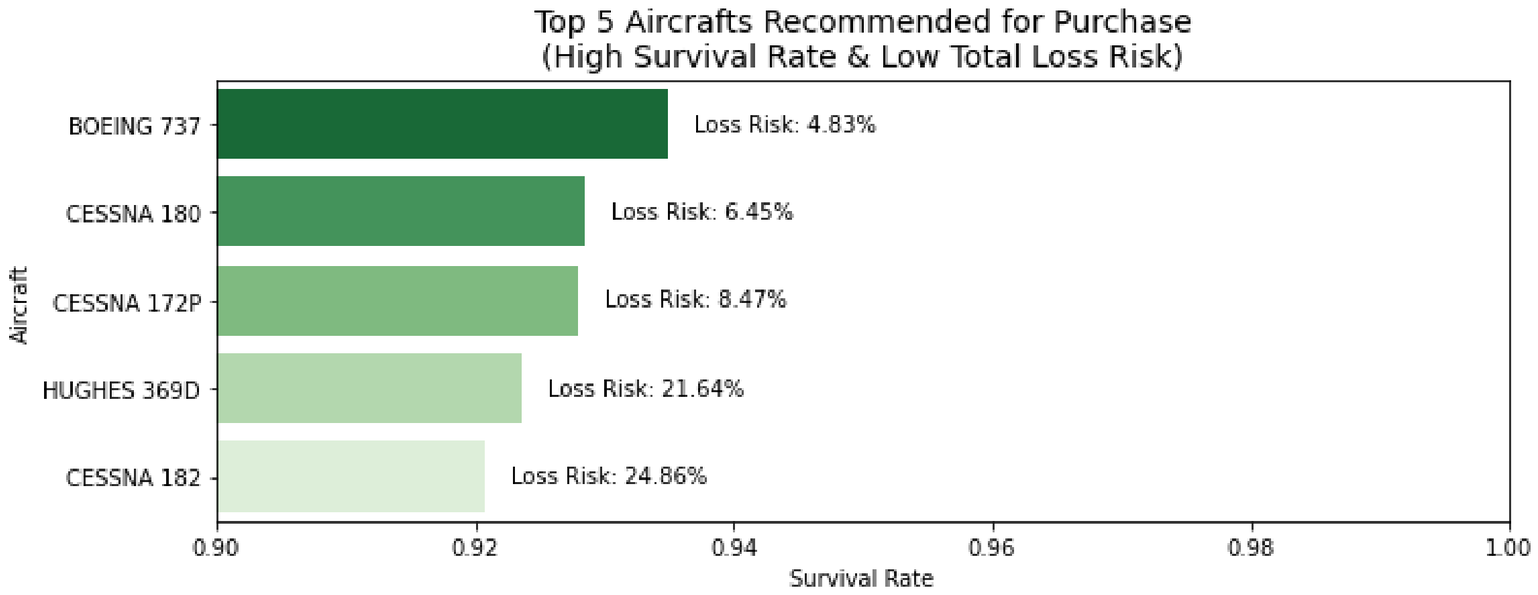
ANALYTICAL APPROACH

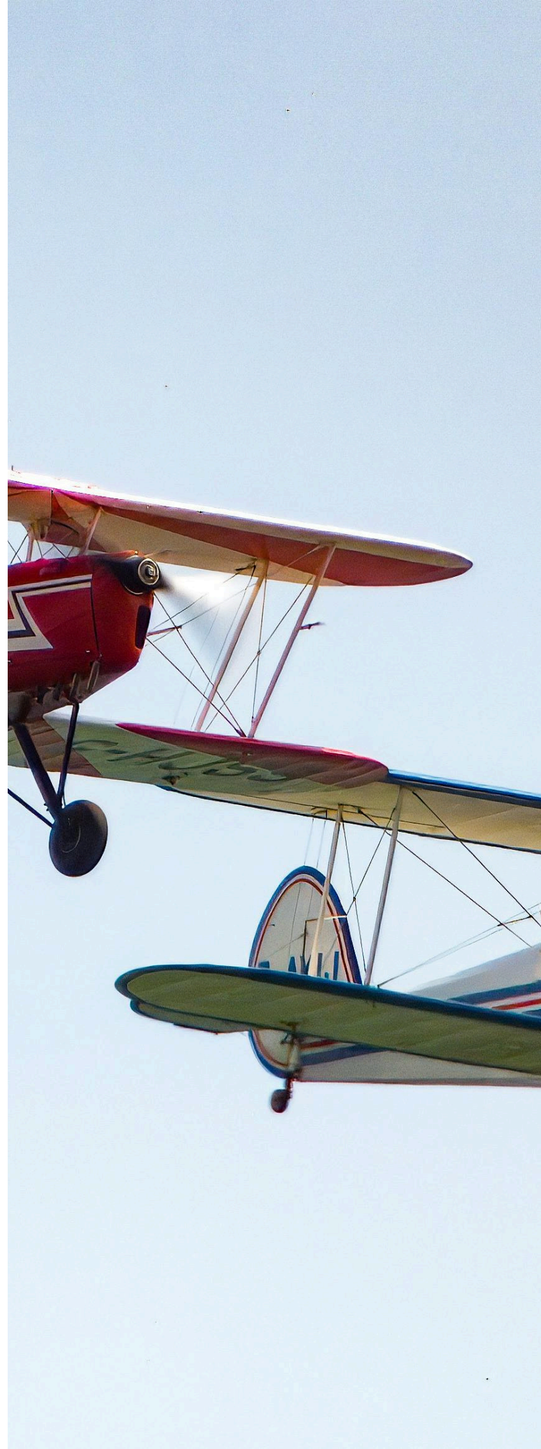
Analytical Approach

- I grouped aircraft by Make, Model, Engine Type, and Aircraft Category.
- Applied a minimum accident threshold to exclude rare models with unreliable data.
- Ranked aircraft using combined safety performance, prioritizing:
  - High survival rates
  - Low fatality exposure
  - Low probability of total structural loss.

VISUALS

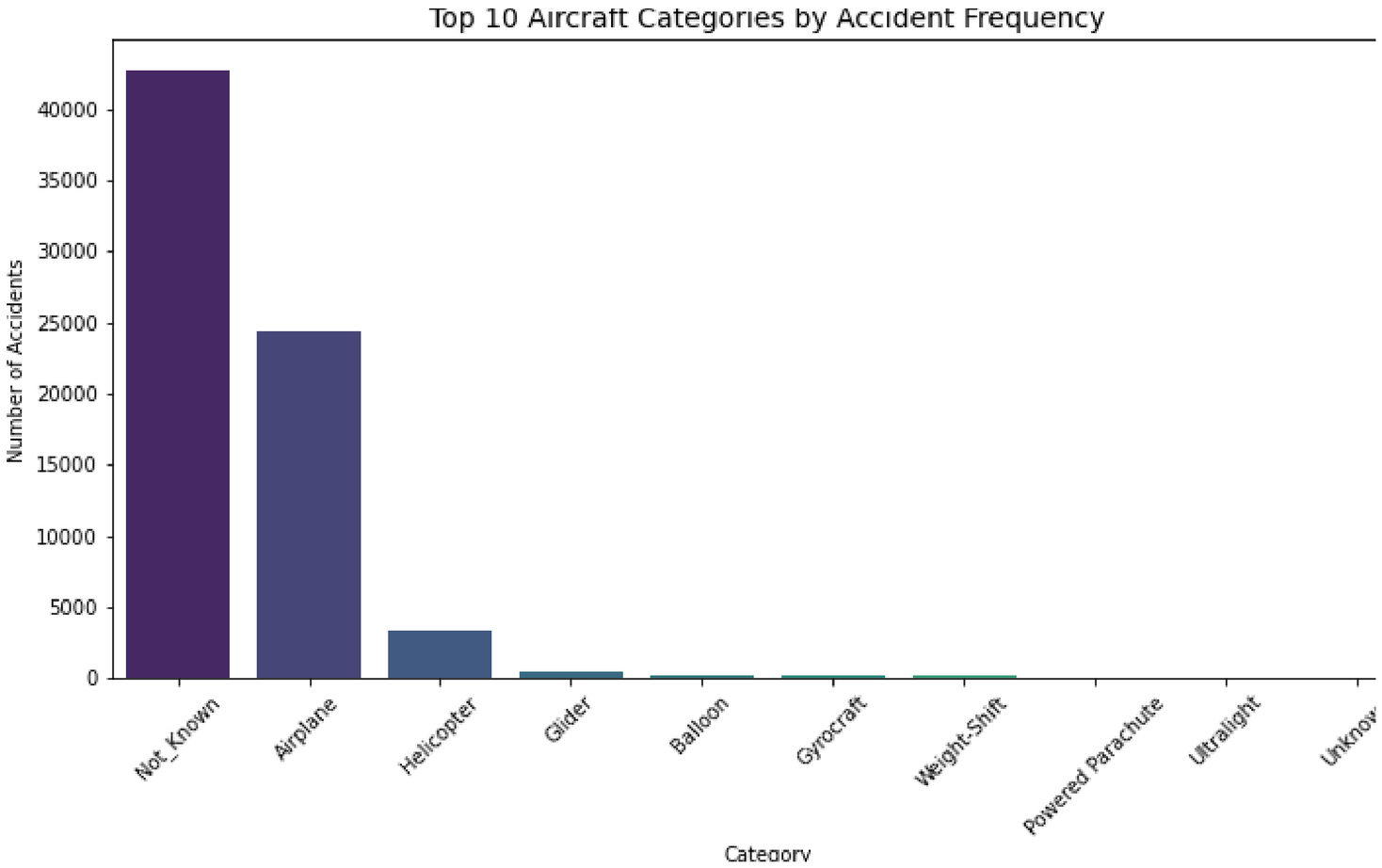
Which combination of Make, Model, Engine Type, and Aircraft Category offers the highest level of occupant safety and the lowest risk of total loss?





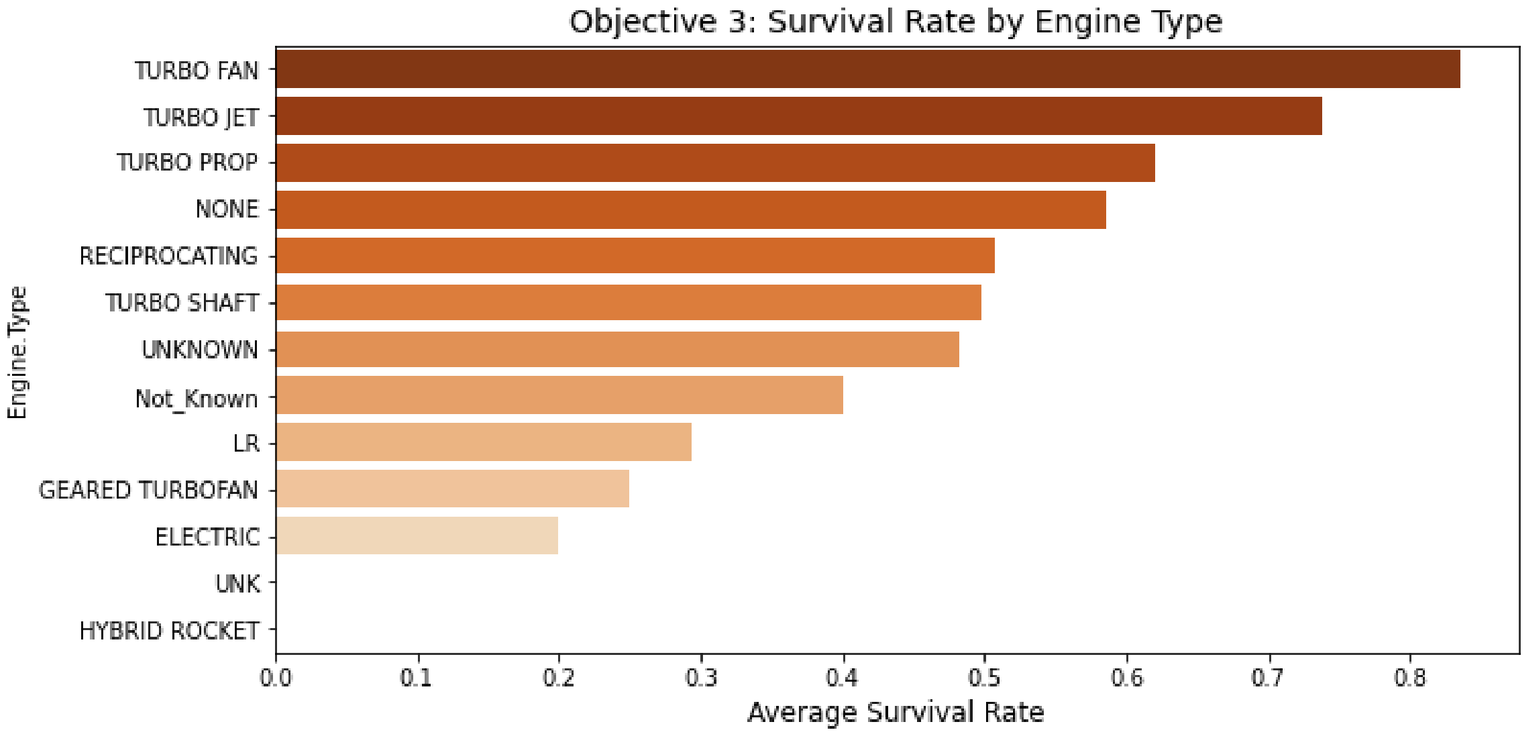
The visual identifies aircraft combinations with the highest levels of occupant safety and the lowest risk of total loss by examining historical accident data grouped by Make, Model, Engine Type, and Aircraft Category. After applying a minimum accident threshold of 100 to ensure statistical reliability, survival rate and total loss risk emerged as effective indicators of overall safety performance.

Which aircraft categories have the most and least frequent accidents?



This visual shows how aircraft accidents are spread across different aircraft categories to understand which types are involved most often in accidents.

Which Engine types provide the most reliable performance?



A visual on how occupant safety varies across different engine types by looking at average survival rates. It highlights which types of aircraft engines have generally better occupant survival outcomes. The visual below makes it easy to compare engine types to see which ones tend to perform better regarding safety.

RECOMMENDATIONS

ASSET ACQUISITION

Acquire Boeing or Cessna aircrafts that fall within aircraft categories with the highest average survival rates and low total risks, as identified in the analysis. Having planes with lower levels of risk will help maximize revenue in the business, and they have long-term asset value preservation. Acquiring these planes will balance safety, operational efficiency, and financial resilience, ensuring that fleet investments align with both risk mitigation objectives and sustainable revenue growth.

CONSIDER ENGINE TYPES WITH PROVEN RELIABILITY AND SURVIVAL OUTCOMES

Turbo fans, Turbo jets, and Turbo props are the types of engines that have guaranteed higher levels of survival as compared to other engines. I therefore highly recommend aircraft with these types of engines when considering which aircraft to purchase. Mechanical designs directly affect accident outcomes. Engines with consistent safety performance reduce the likelihood of severe accidents across different phases of flight. Considering these engines will have a value to your business in that there will be lower mechanical failure risk, reduced maintenance-related downtime and improved long-term operational reliability.

AIRCRAFT CATEGORY

In my analysis, Balloon, Airplane, and Helicopter consistently emerge as the strongest categories, and each serves very different operational needs, considering the business wants to venture into both commercial and personal aviation. First, Balloons, which can fall under personal use, are ideal for low-risk personal or tourism-focused operations where safety, simplicity, and low capital exposure are priorities. Airplane,s athe s number two best category, is the overall best choice for both personal and commercial use. They have strong survival rates across decades. Having this type of aircraft category will bring a steady source of income, as they are widely used for transportation. It is efficient for the generation of revenue and portfolio growth. Fixed-wing airplanes represent the most versatile and scalable investment, offering the best balance of safety, operational range, and financial viability. Helicopters, as number 3, are best for specialized commercial and emergency operations. Helicopters offer capabilities that fixed-wing aircraft simply cannot provide, making them high-value assets when used for the right missions. While they are not general-purpose aircraft, they deliver strong strategic returns in specialized business operations.3 major advantages to the business are that helicopters have reduced infrastructure costs, faster deployment to hard-to-reach location,s and increased operational flexibility.

Conclusion

This analysis identifies Boeing, Cessna, and Hughes as the top three aircraft manufacturers recommended for purchase based on their strong safety performance and low financial risk. These manufacturers have long operational histories and remain widely used today, demonstrating proven reliability and industry maturity.

Rather than focusing on how often accidents occur, the analysis emphasizes consistent safety outcomes over time. High-usage aircraft naturally appear more frequently in accident data, but several models from these manufacturers consistently show high occupant survival rates and low likelihood of total loss, even across hundreds of incidents.The study highlights three specific Make–Model combinations that offer the best balance of survivability, low fatality risk, and reduced structural loss.

These aircraft are especially well suited for organizations entering aviation operations, as they provide predictable risk profiles and lower exposure to catastrophic loss.

Finally, the findings confirm that aircraft category and engine type play a critical role in safety outcomes. When combined with a proven manufacturer and model, these factors support informed, data-driven acquisition decisions that maximize safety, financial stability, and long-term operational success.

ANGELA WANGUI WACHIRA

CONTACT:+254 795799763

EMAIL:angelawachira64@gmail.com

Thank You