Aviation Accident Rate Comparison in Recent Events

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Problem Description

Media coverage over aviation accidents is giving the impression that accident rates are on the rise, raising suspicion that air travel is becoming unsafe for the general population. Our analysis during this project of reviewing the National Transportation Safety Board (NTSB) records tells a different story. Accident rates over the past 30 years have been on a steady decline due to the Federal Aviation Administration (FAA) implementing regulations to prevent future accidents.

Our focus during this project was to focus on three major regulatory changes:

1. Traffic Collision Avoidance System (TCAS) in aircraft operating in Part 121 aircraft (1993)
2. Post- 9/11 regulatory changes (2001)
3. Automatic Dependent Surveillance – Broadcast (ADS-B) system in all aircraft operating in congested airspace. (2020)

In addition to the regulatory changes listed above, we examined the frequency of accidents during phases of flight and examined engine data as contributing factors.

Data Curation

The National Transportation Safety Board (NTSB) maintains all recorded aviation accidents since 1962. Information is open to the public and the NTSB has over 200,000 records of aviation accidents. Each record contains information regarding aircraft, location, weather, and crew experience.

We consolidated the information by using the Homebrew Installer (enabling MacBook users the ability to read the Microsoft Assess Files) and cleaned all the data from 1986 to present day. Our priority for cleaning the data was to standardize date formatting, engine manufacture names, and accident codes. The result was a consolidated dataset that was suitable to track trends for analysis.

Analysis and Computational Methods

Various Python libraries were used during our analysis:

1. Pandas, NumPy – Used to read CSV files as data frames and utilized functions to concatenate and merge data frames together to enable numerical calculation of data arrays.
2. FuzzyWuzzy – Used for grouping names of engine manufactures (i.e. Pratt and Whitney versus P&W) and grouping events by phase of flight.
3. MatPlotLib and Folium – Used to provide data visualization.
4. Seasonal-Trend Decomposition Using Loess – Used to identify season trends over the years.

Results

Long-Term Trends: Aviation accidents are on the decline. While short-term spikes were observed during the analysis, the yearly change demonstrates negative or near-zero growth. Supporting the hypothesis that each major regulatory intervention did improve aviation safety. The implementation of TCAS had a distinct reduction in mid-air collisions, post-9/11 security measures lowered accident rates, and early evidence of the ADS-B data contributed to the reduction of mid-air incidents. STL decomposition indicates that, while the long-term trend is downward, there is a recurring seasonal effect with peaks in summer months, suggesting higher operational risk during increased flight activity.

Phase of Flight: Nearly 50% of all aviation accidents occur during a critical phase of flight (takeoff and landing) which only makes up about a two-minute window of the entire flight. By FAA Part Category, Part 91 (General Aviation) accounts for 78.15% of all accidents, Part 121 (Airlines and Cargo) represent only 2.22%, and Part 135 (Commuter and On-Demand Cargo) contributes 3.69% of the accident rates.

Engine Data Analysis: Our analysis revealed that engine failure accidents account for 2.07% of the accidents recorded since 1981. Engine failures are disproportionately concentrated among the smaller rotary and piston-engine manufactures, particularly among Lycoming and Continental. In contrast, large turbofan manufacturers (e.g. General Electric and Rolls-Royce) show lower incident rates relative to flight hours, consistent with their higher regulatory and maintenance standards.

Conclusion

Despite increased attention in media reporting, our data suggests that aviation travel is safer today than it was at any point in the last 30 years. FAA regulations have reduced accident rates, especially concerning mid-air collisions. However, takeoff and landings accidents continue to be a common trend of when accidents occur. Moreso, for pilots flying in general aviation.

Future work and Recommendations

Future research should incorporate additional variables such as fatality rates, weather conditions, and crew factors. Machine learning approaches may also be leveraged to forecast accident trends and identify emerging risks. Expanding seasonal analysis to engine-specific data could provide further insights into risk mitigation strategies.