

## Introduction

Aviation safety is very important to keep passengers, crew and flights safe. In our report, we used Statistics Canada's Air Transportation dataset to analyze aviation incidents and accidents. By using this dataset, our team found how these incidents change over time, during different seasons, and in different places and locations. In addition to that, we explore how injuries could be related to aircraft parts or manufacturers. We analyzed the dataset, and we have found multiple patterns and ideas that help us to improve safety, so we can reduce risks in the future. We used the Power BI tool to create visuals that show these findings, and it helped us to make useful recommendations.

## How did aviation incidents and accidents change over time and during different seasons? What can we learn to make aviation safer?

Aviation safety is very important to keep flights safe and protect people. By studying air transportation occurrence data, we can find patterns to understand when and why problems happen, which could help us prevent them in the future.

With our visualization, users can answer numerous questions:

- How have aviation incidents and accidents changed over the years?
- During which months of the year do incidents happen more often?
- How many total and average incidents happened from 1970 to 2024?
- What types of aviation issues happen the most?
- At what times of the day are accidents more common?

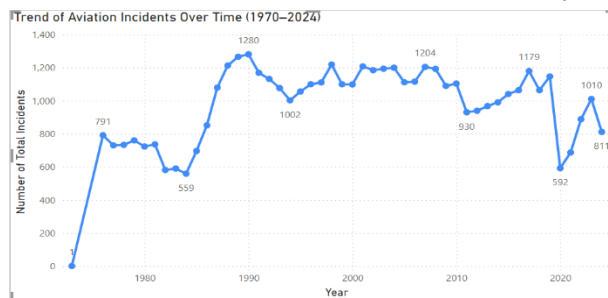


Figure 1 : Aviation Incidents over time, 1970-2024

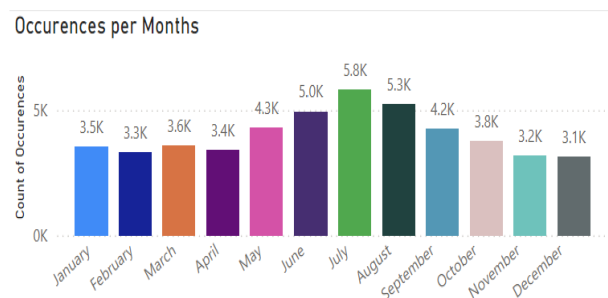


Figure 2 : Occurrences per months, 1970-2024

The line chart demonstrates how incidents and accidents in aviation changed from 1970 to 2024. For instance, there were more incidents in the 1980s and early 2000s than in the other years. In 2020, there was a decrease, because of COVID-19, and fewer flights happened. According to the Transportation Safety Board of Canada, aviation incidents dropped a lot in 2020, because air travel was reduced by 75% due to COVID-19 restrictions (Government of Canada, 2020). We found that July has the most incidents during the year. During this month, there could be a lot of flights because of the vacations (Pawlyk, 2024). We also observed that there were about 49,000 aircraft incidents, with an average of almost 883 events annually from 1970 to 2024.

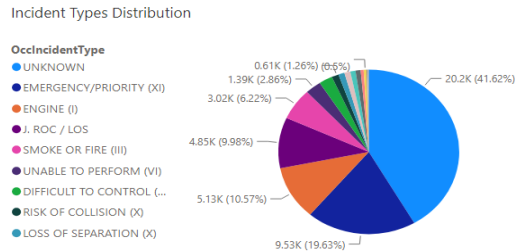


Figure 3: Aircraft Incident Types

when incidents happen during the day. Most incidents happen in the afternoon, followed by the morning. These times could be busier for flights.

This data helped us find useful patterns. For instance, incidents happen more during the summer months and in the afternoon. Companies need to focus on these times because most incidents happen at that time. Extra safety checks and staff training should be prioritized in the summer to avoid incidents. Engine problems are also common and require better maintenance.

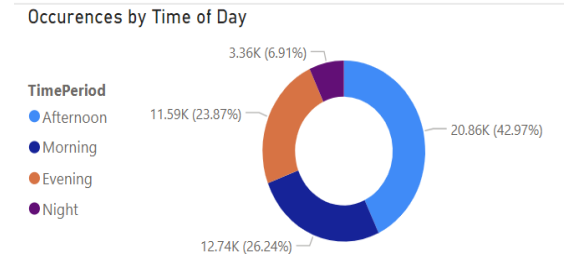


Figure 4 : Aircraft Occurrences by time of day

## What patterns can be found in aviation incident severity and geographic location of the occurrences?

Exploring the *Air Transportation dataset*, we found that there were sufficient details to find out if there are in fact logical patterns in the severity of aviation incidents based on the geographic location where the occurrence was recorded. Therefore, we created an interactive set of maps in Power BI that we believe has allowed us to identify multiple interesting patterns that will further be discussed in this section.

### The geographic patterns:

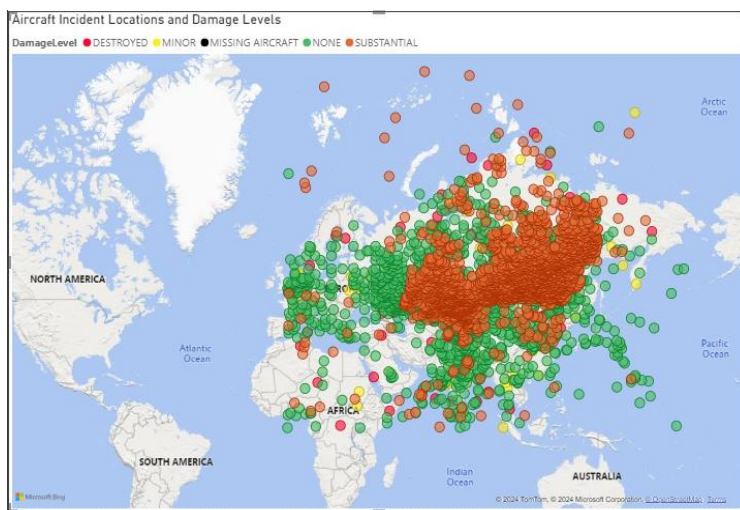


Figure 5 : Aircraft Incidents and Damage Level Distribution, 1900-2024.

From using the latitude and longitude of Statistics Canada's *Air Transportation* dataset, we can see that most occurrences were recorded in Europe and Asia between the 1900s and today. We also observe a cluster of substantial to destroyed damage level in the north end of China, in Mongolia, Kazakhstan and in the south-East end of Russia. The areas where we can see recurrent records of high severity incidents have in common harsh climate and low population density (Wikipedia, 2024). It is possible that these two factors are correlated to the number and severity of incidents recorded in the area.

### Incident severity patterns:



Figure 7 : Substantial Damage and Destroyed Occurrences in Aircrafts Incidents, 1976-1999.

Knowing that the number of flights and aircrafts all together has been increasing over the years, this is a good indicator that aircraft transportation is getting safer over the years. It may also indicate that aircrafts and pilots have adapted to these more dangerous areas of the world.

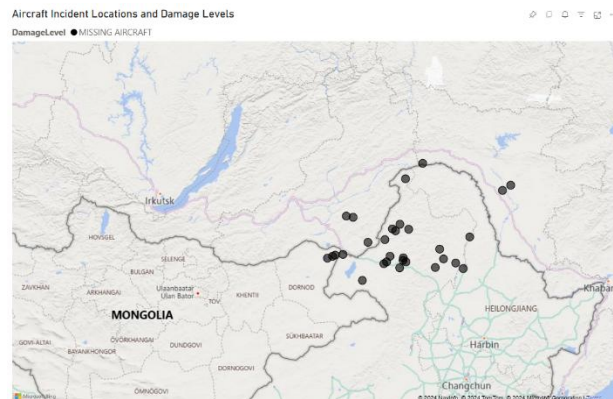


Figure 8 : Missing Aircrafts Incidents, January 1976.

would recommend that the American aircraft transportation agencies study further the risks of navigating in these foreign areas, as there are still many tragedies occurring every year in these same areas. They should then invest in incident prevention and adapting their aircrafts to harsh weathers and long trips over unpopulated lands.

With the same visualization, we can compare time periods to see how incidents have evolved over time. Even though the geographic tendencies seem to have persisted over time, we notice that the number of severe incidents has decreased over the past decades.



Figure 6 : Substantial Damage and Destroyed Occurrences in Aircrafts Incidents, 2000-2024.

Another interesting element found with this visualization concerns the missing aircrafts, from which most occurrences happened in the north of China nearing Russia's borders in January of 1976. This could be related to the political crisis that China experience in the 1970s, or to the harsh climate and low population density of the area. However, these are just speculations, as we do not have the necessary data to prove that these were in fact the causes of these aircrafts going missing.

Based on the patterns we've observed, we

## Causes of Injuries and Incidents and how they evolved over time

Serious injuries have generally been low, while minor injuries have been a common occurrence indicating that there may still be areas that need improvement in terms of passenger protection. The trends shown below indicate that there have been a lot of improvements made in aviation safety, and this shows that there is still the need for more efforts to be made to enhance the safety of passengers and crew.

It shows the evolution of the rates of aviation-related injuries divided into Fatal Injuries, Serious Injuries and Minor Injuries during a period of 50 years from 1974 to 2024. The data reveals variations in these categories thus enabling an analysis of the trends that have occurred in the past as well as the developments in the measures that have been taken to enhance the safety of aviation. There is a sharp

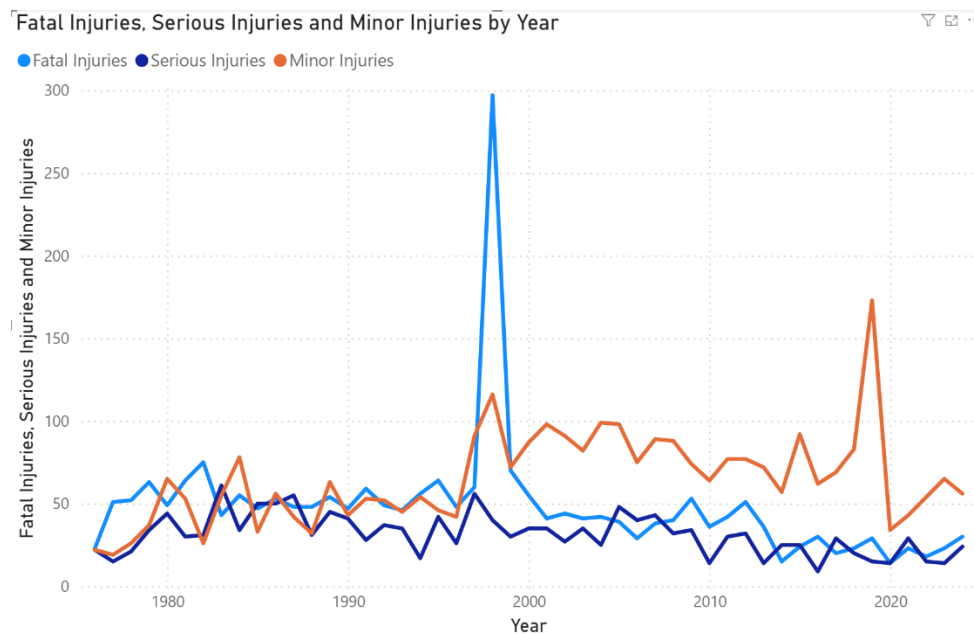


Figure 9 : Injuries by year, 1974-2024

increase in fatality rate in the initial years of 2000 and then it levels off and does not show much fluctuation in the later years.

- How have fatal, serious, and minor injuries in aviation incidents changed over the years from 1974 to 2024?
- What significant spikes or trends can we observe?
- Which category of injuries—fatal, serious, or minor—occurs more frequently throughout the timeline?
- Can patterns in injury reduction indicate the success of safety improvements in aviation?

The analysis of aviation injuries in the recent 50 years shows some clear tendencies and specific periods of interest. The fatal injuries increased dramatically around the year 2000 which can be attributed to major aviation accidents that occurred during that period but have since been reduced due to improved safety measures, technologies and regulations. The serious injuries have been generally low which indicates that the severe accidents have been well controlled while the minor injuries which are the most common have had spikes after the year 2020 suggesting that there is still room for improvement in terms of safety

practices and passenger satisfaction. In general, it is possible to see that the post-2000 period is characterized by the stabilization of all the injury categories, which proves the companies' efforts to improve the safety of operations and readiness.

To understand the aviation injury trends, it is crucial to do a specific analysis of certain incidents, particularly, to study the trends of fatal injuries which were at their highest in 2000 and the rising trends of minor injuries. Some of the mitigation measures that can help reduce both minor and severe injuries include enhanced safety measures such as improved passenger restraint systems and enhanced crew training regimes. This means that by investing in predictive analytics and advanced monitoring systems, risks can be identified early, and the operational integrity of the company can be enhanced. Also, it is important to note that the long-term strategies which include safety audits after certain intervals and international cooperation in the implementation of best practices are necessary for the maintenance of the trend of decreasing aviation related injuries and enhancing the improvement of the passengers and crew safety.

## Conclusion

Our analysis, using Power BI on the Air Transportation Dataset provided by Statistics Canada, has shown great possibilities but also the challenges of data visualization in the realm of aviation safety. The interactive visualizations allowed us to explore complex trends over time, geography, and incident types that might get lost in static reporting.

Power BI is powerful but has its shortcomings. What proved to be trickier than expected was collaborative work; editing in real time was fraught with difficulty. On the other hand, some features surprised us with brilliance, like bookmarks for map visualizations that allowed us to tell the story of our insights dynamically.

Despite data sparsity and "Unknown" labeled sections, we managed to translate unprocessed information into meaningful narrative related to aviation safety trends. Throughout the visualization journey, attention was brought to the evolutionary frontiers of business intelligence as well as the all-surmounting role of human interpretation in data interpretation.

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