HIGH-LEVEL DESIGN DOCUMENTATION

ON

DATA VISUALIZATION OF BIRD FLIGHT STRIKES

Contents

Abstract

A bird strike is strictly defined as a collision between a bird and an aircraft which is in flight or on a take-off or landing roll. The term is often expanded to cover other wildlife strikes - with bats or ground animals. Bird Strike is common and can be a significant threat to aircraft safety. For smaller aircraft, significant damage may be caused to the aircraft structure and all aircraft, especially jet-engine ones, are vulnerable to the loss of thrust which can follow the ingestion of birds into engine air intakes. This has resulted in several fatal accidents. Bird strikes may occur during any phase of flight, but are most likely during the take-off, initial climb, approach and landing phases due to the greater numbers of birds in flight at lower levels.

What is High-Level Design Document?

The goal of the Low-level design document (LLDD) is to give the internal logic design of the actual program code for the Bird flight collisionanalysis dashboard. LLD describes the class diagrams with the methods and relations between classes and programs spec. It describes the modules so that the programmer can directly code the program from the document.

Introduction

Gooddata-driven systems for predicting bird flight collision can improve the entire research and prevention process, and can help aircraft industries to develop enhanced engine control systems, especially for smaller aircraft. A PowerBI was created for the Bird strike data analysis after performing EDA on data points.

Problem statement

Bird Strikes can be a significant threat to aircraft safety. For smaller aircraft, significant damage is caused to the aircraft structure and all aircraft. They are vulnerable to the loss of thrust which results in the ingestion of birds into the engine air intakes causing several fatal accidents.

Data Preprocessing

Bird strikes may occur during any phase of flight, but are most likely during the take-off,initial climb, approach and landing phases due to the greater numbers of birds in flight at lower levels. To have a closer look the following document visually depicts the data collected on Bird Strikes by the FAA between2000-2011.

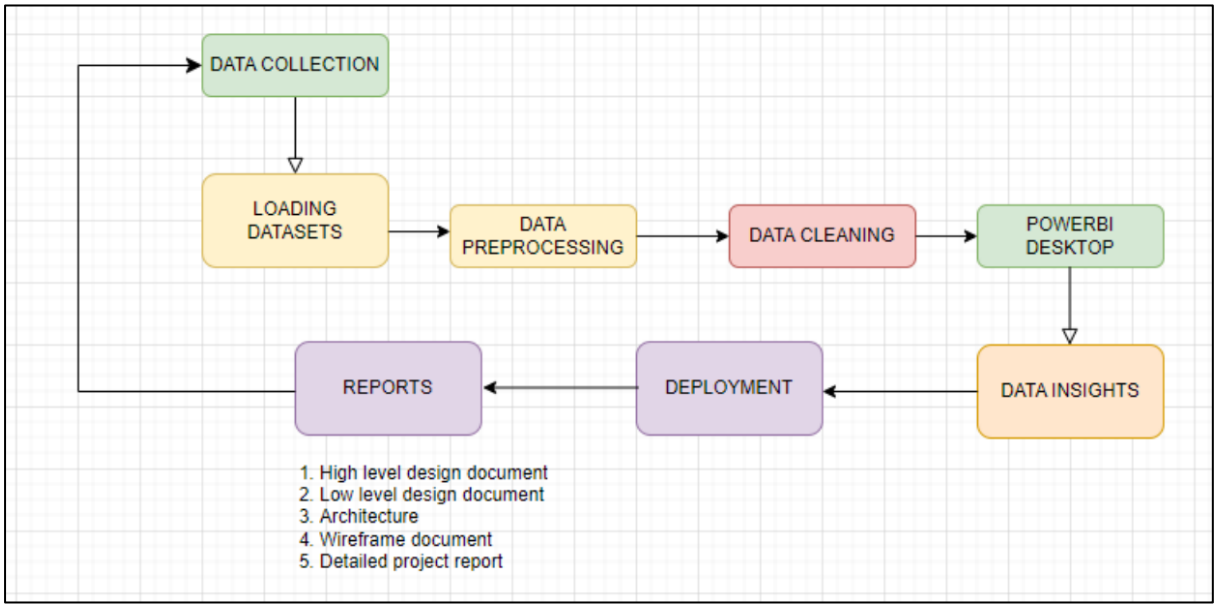
We will be using Python Numpy and Pandas to perform Preprocessing on the dataset. Observations after Exploratory Data Analysis:

1. The data in the dataset showed that there are some columns in the dataset which are categorical variables but when loaded into PowerBI behave as numerical variables. Even though they contain numeric data the values in them are repeating and only limited to a few numbers which means they have been encoded to represent some specific class/category under the variable.
2. No column contains missing data as indicated by the count parameter. But still, we need to check for incorrect data.
3. The old peak column has many values as zeros and the data is also skewed. As a part of the transformation, we will impute the zeros with either the mean/median of the column values because the old peak values cannot be zero for a human being and also remove skewness by using Logarithmic transformation.
4. Remaining numerical columns seem normally distributed.

Architecture Design Document

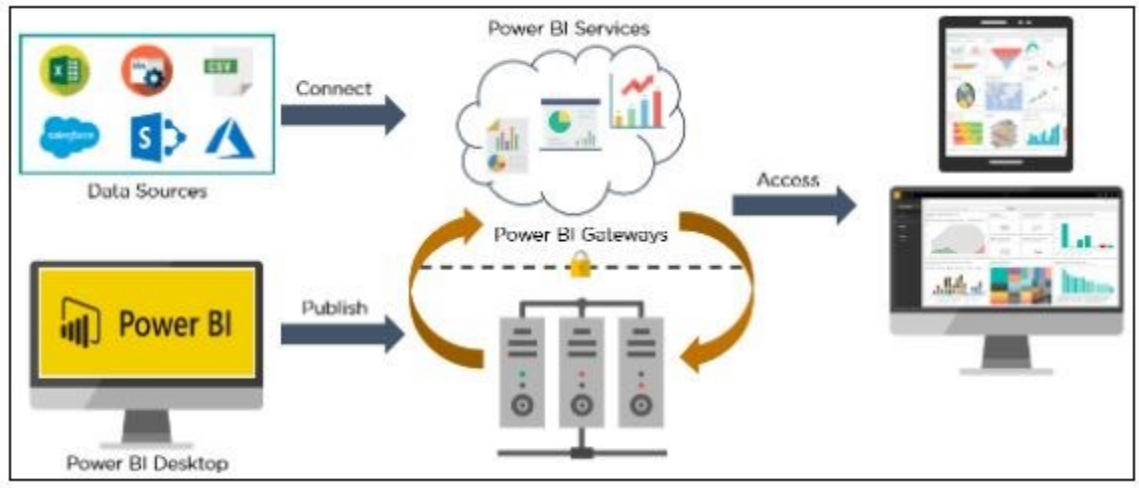
Architecture Design Document (ADD) is an architectural design process that follows a step-by-step refinement process. The process can be used for designing data structures, required software architecture, source code and ultimately, performance

algorithms. Overall, the design principles may be definedduring requirement analysis and then refined during architectural design work.



PowerBI Architecture

Power BI architecture is a service built on top of Azure. There are multiple data sources that Power BI can connect to. Power BI Desktop allows you to create reports and data visualizations on the dataset. Power BI gateway is connected to on-premise data sources to get continuous data for reporting and analytics. Power BI services refer to the cloud services that are used to publish Power BI reports and data visualizations. Using Power BI mobile apps, you can stay connected to their data from anywhere. Power BI apps are available for Windows, iOS, and Android platforms.



Components of Power BI

i Power Query

Power Query is the data transformation and mash up the engine. It enables you to discover, connect, combine, and refine data sources to meet your analysis need. It can be downloaded as an add-in for Excel or can be used as part of the Power BI Desktop.

ii **Power Pivot**

Power Pivot is a data modeling technique that lets you create data models, establish relationships, and create calculations. It uses Data Analysis Expression (DAX) language to model simple and complex data.

iii **Power View**

Power View is a technology that is available in Excel, Sharepoint, SQL Server, and Power BI. It lets you create interactive charts, graphs, maps, and other visuals that bring your data to life. It can connect to data sources and filter data for each data visualization element or the entire report.

iv **Power Map**

Microsoft's Power Map for Excel and Power BI is a 3-D data visualization tool that lets you map your data and plot more than a million rows of data visually on Bing maps in 3-D format from an Excel table or Data Model in Excel. Power Map works with Bing maps to get the best visualization based on latitude, longitude, or country, state, city, and street address information.

v **Power BI Desktop**

Power BI Desktop is a development tool for Power Query, Power Pivot, and Power View. With Power BI Desktop, you have everything under the same solution, and it is easier to develop BI and data analysis experience.

vi **Power Q&A**

The Q&A feature in Power BI lets you explore your data in your own words. It is the fastest way to get an answer from your data using natural language. Once you've built your data model and deployed that into the Power BI website, then you can ask questions and get answers quickly.

Deployment

Deployment pipelines are designed as a pipeline with three stages:

- **Development**

  This stage is used to design, build, and upload new content with fellow creators. This is the first stage in deployment pipelines.

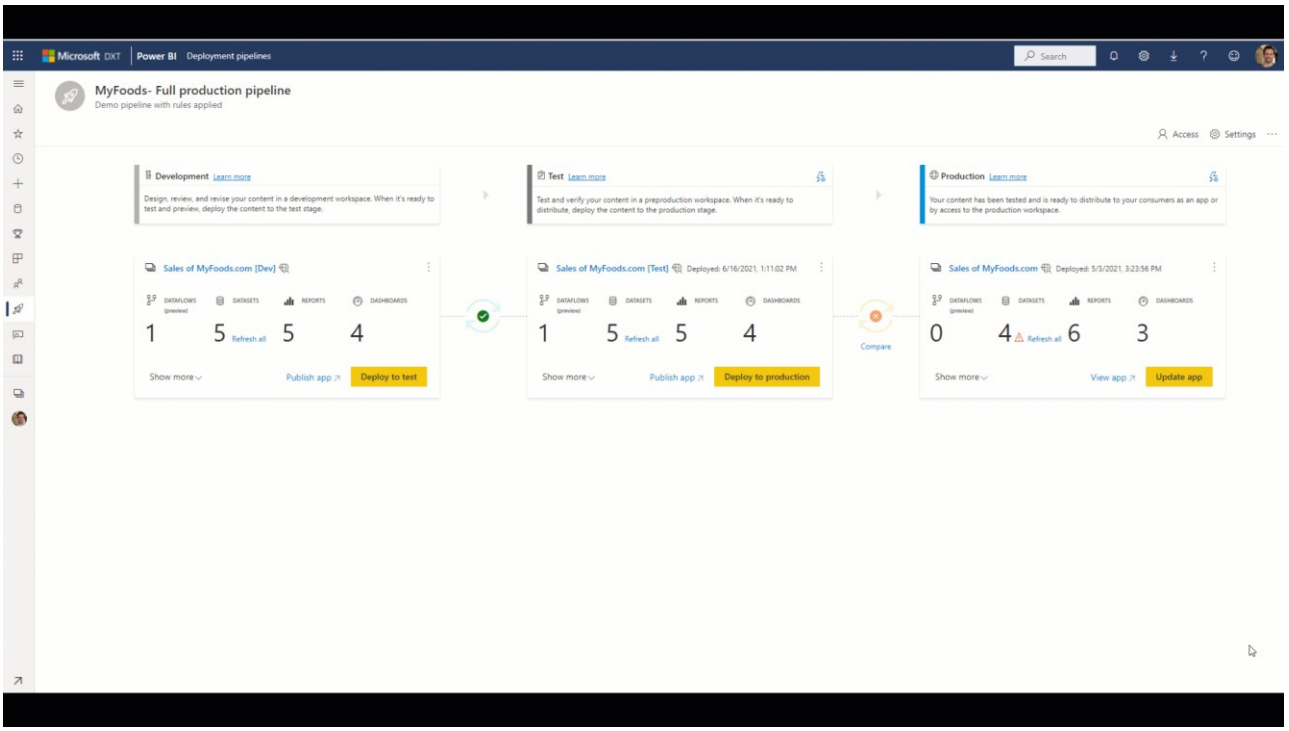
- **Test**

  You're ready to enter the test stage after you've made all the needed changes to your content. You upload the modified content so it can be moved to this test stage. Here are three examples of what can be done in the test environment:

  - Share content with testers and reviewers
  - Load and run tests with larger volumes of data
  - Test your app to see how it will look for your end users

- **Production**

  After testing the content, use the production stage to share the final version of your content with business users across the organization.



Data Insights

The following are the results obtained after the analysis:

1. Number of Bird Strikes in a year with a count of strike

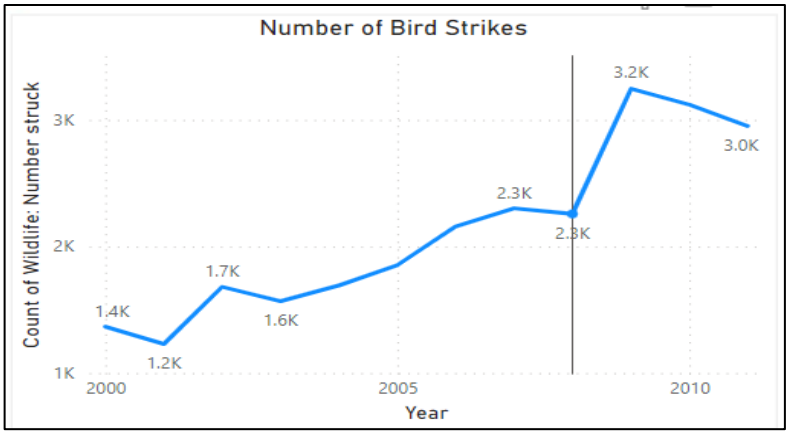


Figure: Bird strikes in a year

- It is observed that in the year between 2005-2010, the maximum number of bird

strikes are reported (2.3K to 3.0K).

- The trend reported a peak of 3.2 K in bird strikes in the year 2009 causing severe casual accidents.

2. Top 10 US Airlines

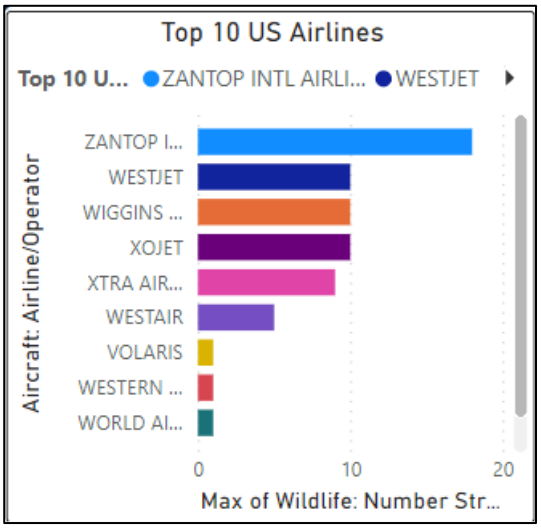


Figure: Top 10 US Airlines

- Zantop Airlines reported a maximum number of bird strikes and posed a significant threat to the aircraft structure.
- World Airlines reported a minimum number of bird strikes.

3. Variation of Total cost vs Wild bird species

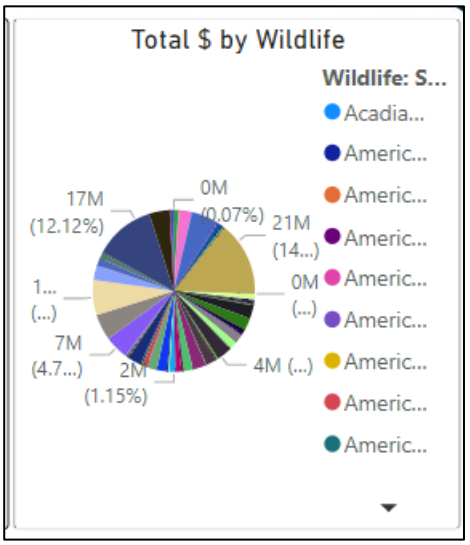


Figure: Total cost vs Wildlife US Airlines

- A maximum cost of 21 million was suffered with Wildlife - Canada goose.
- Canada goose are large birds with big populations and it collides with the windscreen or gets sucked into the engine of jet aircraft.
- A minimum cost of 0.05 million was suffered with Redhead wildlife species.
- Decline in Redhead wildlife population because of destruction of the brackish marshes.

4. Pilots warned of birds

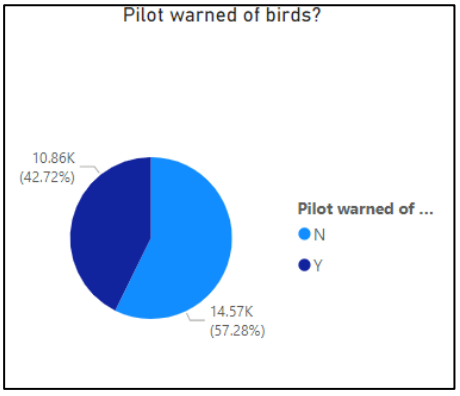


Figure: Pilot warned of birds

- Pie chart distribution illustrated that 57.8% of the pilots were warned of bird strikes and 42.7% were not warned of bird strikes.

5. Variation of phase of flight with altitude

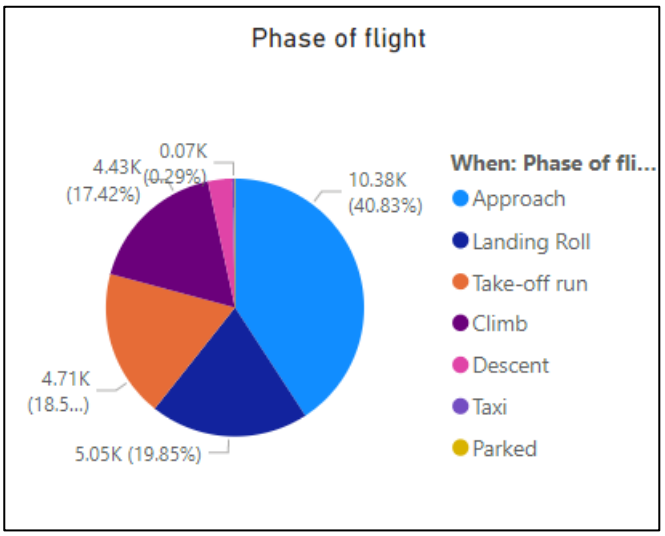


Figure: Bird Strike with phase of flight

- Bird strikes are most likely during the takeoff, initial climb, approach, and landing phases due to the greater numbers of birds in flight at lower levels.
- Maximum strikes were observed at approach position 40.83%.
- Minimum strikes were observed at descent position 0.29%.

6. Variation of Impact to flight with altitude

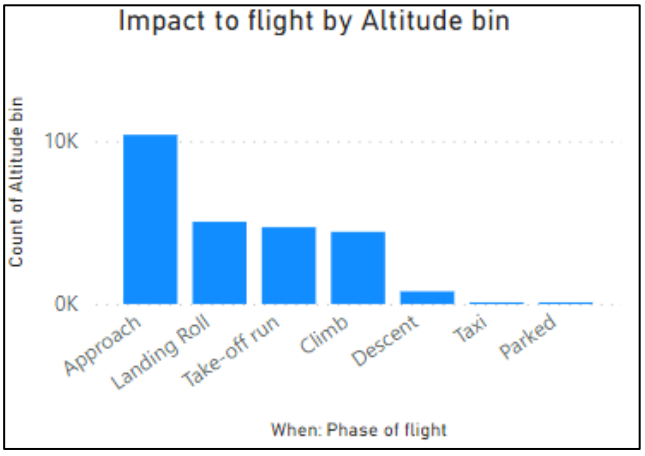


Figure: Impact to flight with altitude

- Bird strikes are maximum for the at approach position due to the greater numbers of birds (10K feet).

- Bird strikes above 500 feet (150 m) altitude are about 7 times more common at night than during the day during the bird migration season.
- Bird strikes are least for taxed or parked position.

7. Variation of flight impact to aircraft size

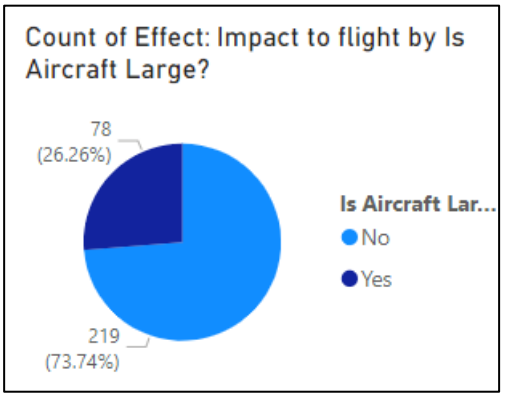


Figure: Flight impact to aircraft size

- Impact to flight is maximum for smaller aircrafts (73.74%).
- Loss of thrust due to ingestion of birds into engine air intakes.
- Windscreen penetration has resulted in injuries to pilots and results in a loss of control.
- Least for larger aircrafts (26.26%).
- Larger aircrafts have design features that ensures shut-down after "ingesting" a bird weighing up to 1.8 kg.

8. Top 50 Airports

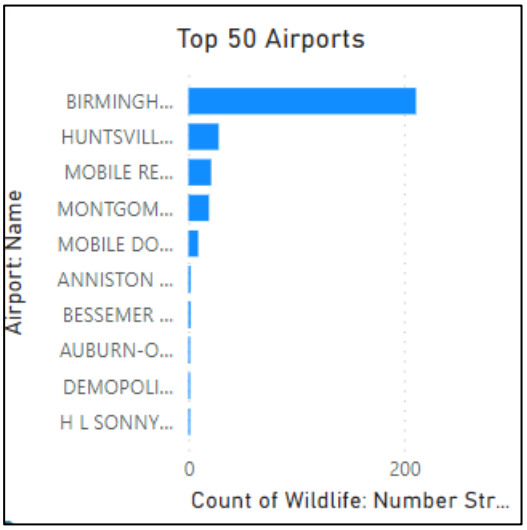


Figure: Top 50 airports

- Maximum bird strike – Birmingham Shuttlesworth Airport (200).
- Birmingham Shuttlesworth Airport-Habitat to birds - trees, brush, and standing water in the fence.
- Least affected-H L Sonny Callahan airport.

9. Effect of strike at different altitude

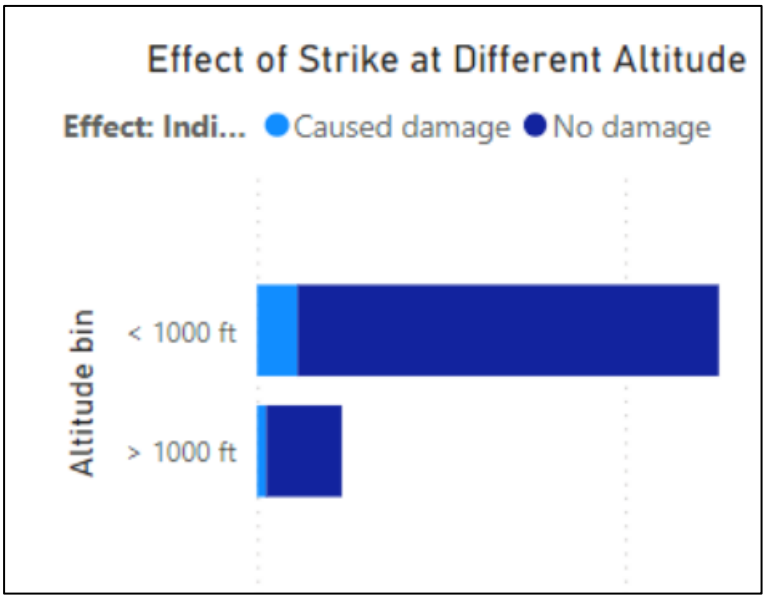


Figure: strike at different altitude

- Altitude < 1000 ft – caused major damage due to ducks and geese at high concentrations are observed.

- Altitude > 1000 ft – caused minor damage due to lesser concentrations.
- High altitudes have lesser bird flocks due to winds aloft, weather fronts, terrain elevations, cloud conditions, and other environmental variables.

10. Pilot warning and effect of strike

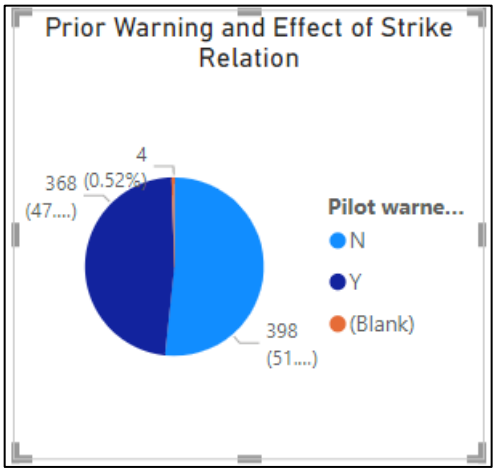


Figure: Pilot warnings to bird strikes

- 47% warned of bird strike.
- 51% not warned of bird strike.

KPI

1. . Variation of wildlife size by species
2. Bird strikes in a year 3.
3. Top 10 US Airlines
4. Variation of Total cost vs Wild bird species
5. Variation of phase of flight with altitude
6. Variation of Total cost vs Wild bird species

CONCLUSIONS

- Significant damages are caused for smaller aircraft, and it impacted majorly for engine air intake structures.
- Bird strikes are most likely during the take-off, initial climb, approach, and landing phases due to the greater numbers of birds in flight at lower levels.
- Maximum cost of 21 Million was suffered with Wildlife - Canada goose (large size and tendency to fly in

flocks exacerbate their impact) and minimum cost of 0.05 Million was suffered with Redhead wildlife species