Aircraft Risk Analysis for Portfolio Diversification

Project Goals

This project aims to Identify the safest, lowest-risk aircraft for commercial and private operations to minimize financial and operational risks.

Data Sources

the dataset is 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.

Business Understanding

Key Questions:

- Which aircraft models have the lowest accident rates?
- What are the common causes of accidents for high-risk aircraft?
- How does aircraft age, manufacturer, and operational use affect safety?
- Which aircraft offer the best cost-safety tradeoff?

1. Importation of necessary libraries

In [80]:
```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
```

In [81]:
```
# open the csv file
df= pd.read_csv('AviationData.csv', encoding='latin' ,  low_memory=False , heade
```

In [82]:
```
df.head()
```

Out[82]:

	Event.Id	Investigation.Type	Accident.Number	Event.Date	Location	Cou
0	20001218X45444	Accident	SEA87LA080	1948-10-24	MOOSE CREEK, ID	Ur S
1	20001218X45447	Accident	LAX94LA336	1962-07-19	BRIDGEPORT, CA	Ur S
2	20061025X01555	Accident	NYC07LA005	1974-08-30	Saltville, VA	Ur S
3	20001218X45448	Accident	LAX96LA321	1977-06-19	EUREKA, CA	Ur S
4	20041105X01764	Accident	CHI79FA064	1979-08-02	Canton, OH	Ur S

5 rows × 31 columns

In [83]:

```
# Afficher les 10 premières lignes
df.head(5)

# Afficher 10 lignes aléatoires
#df.sample(10)

# Afficher les 10 dernières lignes
#df.tail(10)
```

Out[83]:

	Event.Id	Investigation.Type	Accident.Number	Event.Date	Location	Cou
0	20001218X45444	Accident	SEA87LA080	1948-10-24	MOOSE CREEK, ID	Ur S
1	20001218X45447	Accident	LAX94LA336	1962-07-19	BRIDGEPORT, CA	Ur S
2	20061025X01555	Accident	NYC07LA005	1974-08-30	Saltville, VA	Ur S
3	20001218X45448	Accident	LAX96LA321	1977-06-19	EUREKA, CA	Ur S
4	20041105X01764	Accident	CHI79FA064	1979-08-02	Canton, OH	Ur S

5 rows × 31 columns

Exploration of the dataset

In [85]:

```
#See All the Columns
df.shape
```

Out[85]: (88889, 31)

In [86]:

```
df.isna().sum()
```

Out[86]:

```
Event.Id                     0
Investigation.Type           0
Accident.Number              0
Event.Date                   0
Location                    52
Country                    226
Latitude                 54507
Longitude                54516
Airport.Code             38640
Airport.Name             36099
Injury.Severity           1000
Aircraft.damage           3194
Aircraft.Category        56602
Registration.Number       1317
Make                        63
Model                       92
Amateur.Built              102
Number.of.Engines         6084
Engine.Type               7077
FAR.Description          56866
Schedule                 76307
Purpose.of.flight         6192
Air.carrier              72241
Total.Fatal.Injuries     11401
Total.Serious.Injuries   12510
Total.Minor.Injuries     11933
Total.Uninjured           5912
Weather.Condition         4492
Broad.phase.of.flight    27165
Report.Status             6381
Publication.Date         13771
dtype: int64
```

In [87]:

```
df= df[['Event.Id','Event.Date','Injury.Severity',
        'Make','Model','Number.of.Engines','Engine.Type','Purpose.of.flight',
        'Total.Fatal.Injuries','Total.Serious.Injuries','Total.Minor.Injuries','
```

In [88]:

```
# Check the Nan Value of the dataset
df.isna().sum()
df
```

Out[88]:

	Event.Id	Event.Date	Injury.Severity	Make	Model	Number.of.Engi
0	20001218X45444	1948-10-24	Fatal(2)	Stinson	108-3	
1	20001218X45447	1962-07-19	Fatal(4)	Piper	PA24-180	
2	20061025X01555	1974-08-30	Fatal(3)	Cessna	172M	
3	20001218X45448	1977-06-19	Fatal(2)	Rockwell	112	
4	20041105X01764	1979-08-02	Fatal(1)	Cessna	501	N
...	...	...	...	...	...	
88884	20221227106491	2022-12-26	Minor	PIPER	PA-28-151	N
88885	20221227106494	2022-12-26	NaN	BELLANCA	7ECA	N
88886	20221227106497	2022-12-26	Non-Fatal	AMERICAN CHAMPION AIRCRAFT	8GCBC	
88887	20221227106498	2022-12-26	NaN	CESSNA	210N	N
88888	20221230106513	2022-12-29	Minor	PIPER	PA-24-260	N

88889 rows × 14 columns

Eploration of Columns unique values.

In [90]:

```
#df['Aircraft.Category'].unique()
#df['Weather.Condition'].unique()

#df['Aircraft.damage'].unique()
#df['Injury.Severity'].unique()
#df['Amateur.Built'].unique()
#df['Engine.Type'].unique()
#df['Aircraft.Category'].unique()
#df['Purpose.of.flight'].unique()
#df['Weather.Condition'].unique()
#df['Broad.phase.of.flight'].unique()
#df['Engine.Type'].unique()
#df['Make'].unique()
```

Data Cleaning

Dealing with rows with unimportant charecters

In [93]:
```
# In that columns rows with values (fatal (x) should change into fatal
df['Injury.Severity'] = df['Injury.Severity'].str.replace(r"\(.*\)", "", regex=T
df['Injury.Severity'].unique()
# In that columns rows with values (UNK is equal to Unk ) should change into Unk
df['Weather.Condition'] = df['Weather.Condition'].str.replace(r"Unk", "UNK", reg
df['Weather.Condition'].unique()

#Rewrite all The Cuntry name in Sentences
#df.loc[: ,'Make'] = df['Make'].str.title()

#Rewrite all The Make and Model in Sentences
df['Make'] = df['Make'].str.upper().str.strip()
df['Model'] = df['Model'].str.upper().str.strip()
```

Drop Unecessary columns

In [95]:
```
#df=df.drop(['Registration.Number'], axis=1)
#df=df.dropna(subset=['Location'])

# Drop columns with excessive missingness (>50%)
##df = df.dropna(thresh=len(df)*0.5, axis=1)
#drop_cols = [
##    'Registration.Number',
#    'Airport.Code','Airport.Name'
#]

#df = df.drop(columns=drop_cols)
```

In [96]:
```
df.shape
```

Out[96]:
```
(88889, 14)
```

Data Imputation

Filling in missing or incomplete values in a dataset. It's a crucial step before analysis, especially when working with real-world data like aircraft specs or incident reports, which often have missing entries.

In [98]:
```
#df['Aircraft.damage'].fillna('Unknown', inplace=True)
df['Engine.Type'].fillna('Unknown', inplace=True)
df['Total.Fatal.Injuries'].fillna(0, inplace=True)
df['Total.Serious.Injuries'].fillna(0, inplace=True)
df['Total.Minor.Injuries'].fillna(0, inplace=True)
df['Total.Uninjured'].fillna(0, inplace=True)
df['Broad.phase.of.flight'].fillna('Unknown', inplace=True)
```

In [ ]:
```

```

In [99]:
```
df=df.dropna(subset=['Make','Model','Injury.Severity',
                'Number.of.Engines','Purpose.of.flight',
                'Weather.Condition'
                    ])
df.isna().sum()
```

Out[99]:
```
Event.Id                  0
Event.Date                0
Injury.Severity           0
Make                      0
Model                     0
Number.of.Engines         0
Engine.Type               0
Purpose.of.flight         0
Total.Fatal.Injuries      0
Total.Serious.Injuries    0
Total.Minor.Injuries      0
Total.Uninjured           0
Broad.phase.of.flight     0
Weather.Condition         0
dtype: int64
```

Print of the dataset to see how it look like after Clean it up and Impute it.

In [101…
```
df.head()
```

Out[101…

	Event.Id	Event.Date	Injury.Severity	Make	Model	Number.of.Engines
0	20001218X45444	1948-10-24	Fatal	STINSON	108-3	1.0
1	20001218X45447	1962-07-19	Fatal	PIPER	PA24-180	1.0
2	20061025X01555	1974-08-30	Fatal	CESSNA	172M	1.0
3	20001218X45448	1977-06-19	Fatal	ROCKWELL	112	1.0
6	20001218X45446	1981-08-01	Fatal	CESSNA	180	1.0

Operation sur les Date

In [103…
```
# Convert to datetime

df.loc[:, 'Event.Date'] = pd.to_datetime(df['Event.Date'])

# Extract year
df.loc[:, 'Event.Year'] = df['Event.Date'].dt.year
df.loc[:, 'Event.Year'].astype(int)
df.head()
```

```
C:\Users\teach\anaconda3\envs\learn-env\lib\site-packages\pandas\core\indexing.p
y:1745: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stabl
e/user_guide/indexing.html#returning-a-view-versus-a-copy
  isetter(ilocs[0], value)
C:\Users\teach\anaconda3\envs\learn-env\lib\site-packages\pandas\core\indexing.p
y:1596: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stabl
e/user_guide/indexing.html#returning-a-view-versus-a-copy
  self.obj[key] = _infer_fill_value(value)
```

Out[103…

	Event.Id	Event.Date	Injury.Severity	Make	Model	Number.of.Engines
0	20001218X45444	1948-10-24	Fatal	STINSON	108-3	1.0
1	20001218X45447	1962-07-19	Fatal	PIPER	PA24-180	1.0
2	20061025X01555	1974-08-30	Fatal	CESSNA	172M	1.0
3	20001218X45448	1977-06-19	Fatal	ROCKWELL	112	1.0
6	20001218X45446	1981-08-01	Fatal	CESSNA	180	1.0

Number of Injuries

In [105…

```
df.loc[:,'Total.injured'] = df['Total.Minor.Injuries'] + df['Total.Serious.Injur
```

```
C:\Users\teach\anaconda3\envs\learn-env\lib\site-packages\pandas\core\indexing.p
y:1596: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stabl
e/user_guide/indexing.html#returning-a-view-versus-a-copy
  self.obj[key] = _infer_fill_value(value)
C:\Users\teach\anaconda3\envs\learn-env\lib\site-packages\pandas\core\indexing.p
y:1745: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stabl
e/user_guide/indexing.html#returning-a-view-versus-a-copy
  isetter(ilocs[0], value)
```

In [106…

```
Number_of_injuries_perYear = df[['Total.Fatal.Injuries','Total.Serious.Injuries'
Number_of_injuries_perYear.head()
```

Out[106…

Event.Year	Total.Fatal.Injuries	Total.Serious.Injuries	Total.Minor.Injuries	Total.Uninjured
1948	2.0	0.0	0.0	0.0
1962	4.0	0.0	0.0	0.0
1974	3.0	0.0	0.0	0.0
1977	2.0	0.0	0.0	0.0
1981	4.0	0.0	0.0	0.0

In [107…

```
df.loc[:, 'Total.Fatal.Injuries'].astype(float)
df.loc[:, 'Total.Minor.Injuries'].astype(float)
df.loc[:, 'Total.Serious.Injuries'].astype(float)
df.loc[:, 'Total.Uninjured'].astype(float)
```

Out[107…

```
0        0.0
1        0.0
2        0.0
3        0.0
6        0.0
        ...
88859    1.0
88865    1.0
88873    1.0
88877    0.0
88886    1.0
Name: Total.Uninjured, Length: 78822, dtype: float64
```

Number of people envolve in accident per Make

In [109…

```
Aicraft_Category_Per_Injuries= df[['Total.Fatal.Injuries','Total.Serious.Injurie
Aicraft_Category_Per_Injuries.head()
```

Out[109…

Make	Total.Fatal.Injuries	Total.Serious.Injuries	Total.Minor.Injuries	Total.Uninj
107.5 FLYING CORPORATION	1.0	0.0	0.0	
1200	0.0	1.0	0.0	
177MF LLC	0.0	2.0	0.0	
1ST FTR GP	1.0	0.0	0.0	
2000 MCCOY	1.0	0.0	0.0	

Number People involve accident per Year

In [111…

```
Number_People_involve_accident_per_Year= df[['Total.Fatal.Injuries','Total.Seric
Number_People_involve_accident_per_Year.head()
```

Out[111…

Event.Year	Total.Fatal.Injuries	Total.Serious.Injuries	Total.Minor.Injuries	Total.Uninjured
1948	2.0	0.0	0.0	0.0
1962	4.0	0.0	0.0	0.0
1974	3.0	0.0	0.0	0.0
1977	2.0	0.0	0.0	0.0
1981	4.0	0.0	0.0	0.0

mean of unjuries

In [113…

```
Aicraft_Category_Per_Injuries.mean()
```

Out[113…

```
Total.Fatal.Injuries       4.299610
Total.Serious.Injuries     2.296405
Total.Minor.Injuries       3.201087
Total.Uninjured           33.201505
dtype: float64
```

Tendency Measurement

In [115…

```
df[['Total.Fatal.Injuries','Total.Serious.Injuries','Total.Minor.Injuries','Tota
```

Out[115…

	Total.Fatal.Injuries	Total.Serious.Injuries	Total.Minor.Injuries	Total.Uninjured
count	78822.000000	78822.000000	78822.000000	78822.000000
mean	0.391439	0.209066	0.291429	3.022684
std	2.810573	0.752558	1.271269	19.389403
min	0.000000	0.000000	0.000000	0.000000
25%	0.000000	0.000000	0.000000	0.000000
50%	0.000000	0.000000	0.000000	1.000000
75%	0.000000	0.000000	0.000000	2.000000
max	270.000000	81.000000	125.000000	699.000000

Number accident by Phase of flight

In [117…

```
df['Broad.phase.of.flight'].value_counts()
```

Out[117…

```
Unknown          19676
Landing          14948
Takeoff          12153
Cruise            9967
Maneuvering       7995
Approach          6235
Climb             1941
Taxi              1819
Descent           1787
Go-around         1342
Standing           848
Other              111
Name: Broad.phase.of.flight, dtype: int64
```

Find the Most Common Aircraft

In [119…

```
Common_Aircraft= df['Make'].value_counts()
name=Common_Aircraft.index[0]
NombreAcident=Common_Aircraft.iloc[0]
print('The most Common airplaine is ' , name ,' and the of acident', NombreAcide
```

```
The most Common airplaine is  CESSNA  and the of acident 25484
```

Data Preparation to a csv File for analysis with other tools (powerBI)

PowerBi a tools that will help to create beautiful Dasboard for the to represent the data. After preparing the data now it's ready for analysis.

In [121…

```
df.to_csv('Aircraft.csv')
```

Number with fatal uninjured and number of injuries per Make

In [123…

```
df.groupby('Make')['Total.Uninjured'].sum().sort_values(ascending=False).head(10
```

Out[123…

```
Make
BOEING                84283.0
CESSNA                32336.0
MCDONNELL DOUGLAS     29652.0
PIPER                 17020.0
AIRBUS INDUSTRIE       8499.0
LOCKHEED               7905.0
DOUGLAS                7585.0
BEECH                  7056.0
BELL                   2512.0
AEROSPATIALE           2231.0
Name: Total.Uninjured, dtype: float64
```

Number of Uninjured by Purpose.of.flight

In [125…

```
df.groupby('Purpose.of.flight')['Total.Uninjured'].sum().sort_values(ascending=F
```

Out[125...

```
Purpose.of.flight
Unknown                     156843.0
Personal                     50467.0
Instructional                12279.0
Business                      6073.0
Aerial Application            2887.0
Positioning                   2038.0
Public Aircraft               1613.0
Executive/corporate           1541.0
Other Work Use                1487.0
Aerial Observation             777.0
Ferry                          604.0
Skydiving                      510.0
Flight Test                    448.0
Public Aircraft - Federal      262.0
Public Aircraft - Local         91.0
Public Aircraft - State         65.0
Air Race show                   57.0
External Load                   56.0
Banner Tow                      51.0
Air Race/show                   36.0
Glider Tow                      31.0
Firefighting                    20.0
Air Drop                        10.0
PUBS                             5.0
PUBL                             2.0
ASHO                             1.0
Name: Total.Uninjured, dtype: float64
```

Total Uninjured

In [127...

```
df.groupby('Make')['Total.Uninjured'].sum().sort_values(ascending=False)
```

Out[127...

```
Make
BOEING                      84283.0
CESSNA                      32336.0
MCDONNELL DOUGLAS           29652.0
PIPER                       17020.0
AIRBUS INDUSTRIE             8499.0
                             ...
HAPHEY BRUCE FREDERIC           0.0
HANSON ROBERT H                 0.0
HANSON LONN                     0.0
HANSON GERALD                   0.0
107.5 FLYING CORPORATION        0.0
Name: Total.Uninjured, Length: 7176, dtype: float64
```

Calculate the total number of Injuries for each Categories

In [129...

```
df['Total.Serious.Injuries'].sum()
```

Out[129...

```
16479.0
```

In [130...

```
df['Total.Minor.Injuries'].sum()
```

Out[130...

```
22971.0
```

In [131…

```
df['Total.Fatal.Injuries'].sum()
```

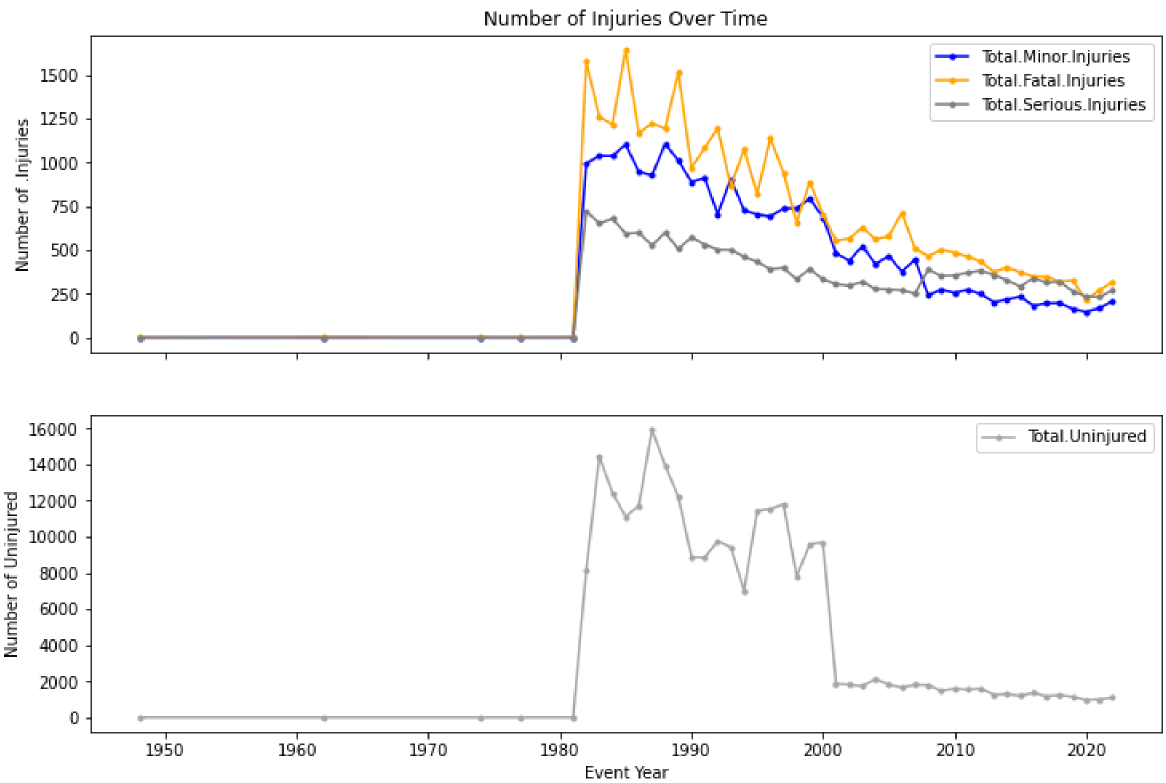
Out[131…

```
30854.0
```

Data Visualizations

In [133…

```
# Line plot (assuming a time series or ordered data)

fig , (ax,ax2) = plt.subplots(2, 1, figsize=(12,8), sharex=True)
injuries_by_year = df.groupby('Event.Year')[['Total.Minor.Injuries', 'Total.Fata

ax.plot(injuries_by_year['Event.Year'], injuries_by_year['Total.Minor.Injuries']
ax.plot(injuries_by_year['Event.Year'], injuries_by_year['Total.Fatal.Injuries']
ax.plot(injuries_by_year['Event.Year'], injuries_by_year['Total.Serious.Injuries

ax.set_title('Number of Injuries Over Time')
ax.set_ylabel('Number of .Injuries')

ax2.plot(injuries_by_year['Event.Year'], injuries_by_year['Total.Uninjured'], ma
ax2.set_ylabel('Number of Uninjured')
ax2.set_xlabel('Event Year')
ax2.legend()

ax.legend()
plt.savefig("my_plot.png")
plt.show()
```



In [ ]:

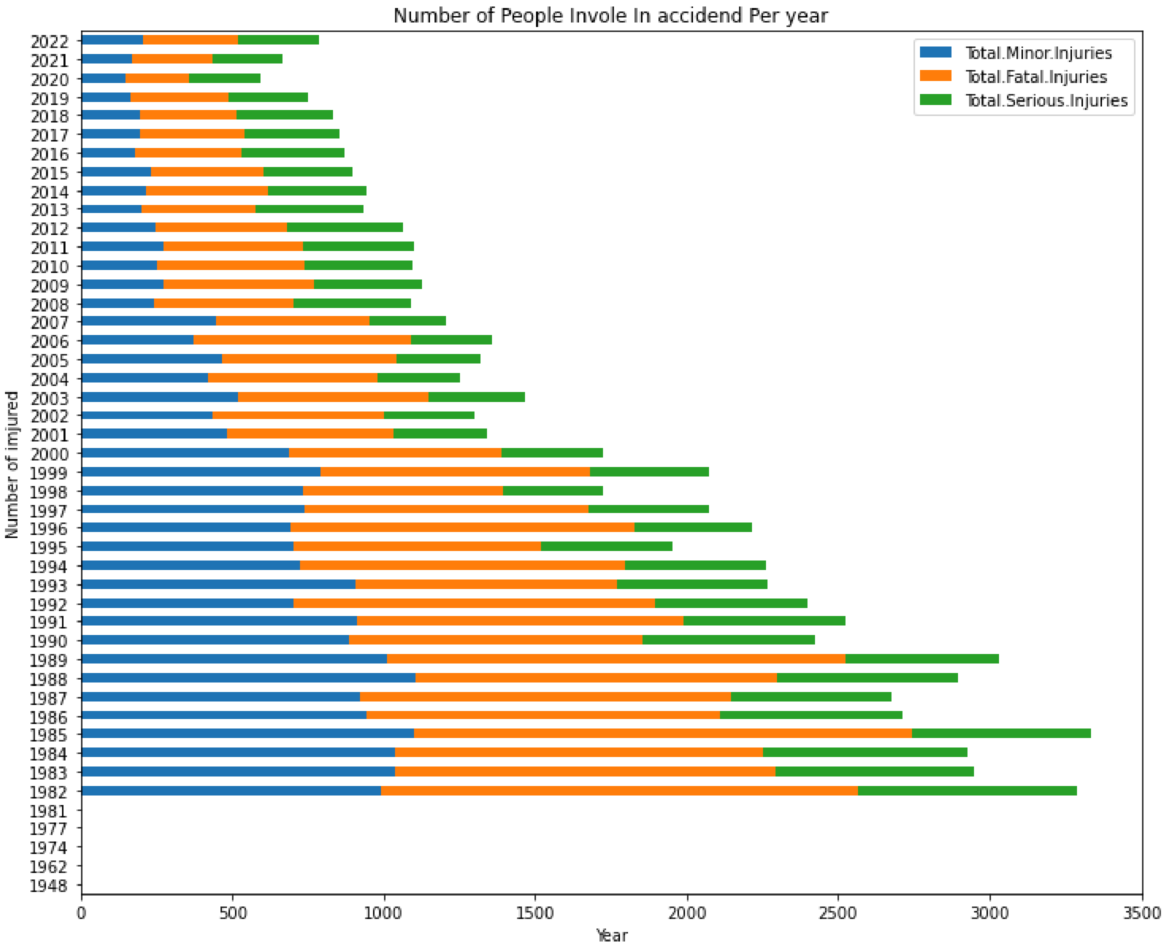
In [134…

```
injuries_by_year.to_csv('Total Injuries perYear.csv')
```

In [135…

```
# Colonnes numériques à agréger
import matplotlib.pyplot as plt
```

```
# Créer un graphique à barres empilées
injuries_by_year[['Total.Minor.Injuries','Total.Fatal.Injuries','Total.Serious.I
plt.title('Number of People Invole In accidend Per year')
plt.ylabel('Number of imjured')
plt.xlabel('Year')
plt.show()
```



In [136…

```
Sumary = df.groupby(['Make'])['Total.Uninjured'].sum().sort_values(ascending=Fal
Sumary
```

Out[136…

```
Make
BOEING                       84283.0
CESSNA                       32336.0
MCDONNELL DOUGLAS            29652.0
PIPER                        17020.0
AIRBUS INDUSTRIE              8499.0
                              ...
HAPHEY BRUCE FREDERIC            0.0
HANSON ROBERT H                  0.0
HANSON LONN                      0.0
HANSON GERALD                    0.0
107.5 FLYING CORPORATION         0.0
Name: Total.Uninjured, Length: 7176, dtype: float64
```

In [137…

```
Sumary = df.groupby(['Model'])['Total.Uninjured'].sum().sort_values(ascending=Fa
Sumary
```

Out[137…

```
Model
DC-10-10        6710.0
DC-10-30        4053.0
727-200         3695.0
DC-9-82         3161.0
L-1011-385-1    2775.0
                 ...
BA 3101            0.0
S64E               0.0
S6S                0.0
S6S 2-33           0.0
RUTAN              0.0
Name: Total.Uninjured, Length: 10167, dtype: float64
```

Recommend Aircraft Models to the Company

Use a Risk Scoring System Calculation of risk score for each aircraft model based on:

Number of incidents or accidents

Event date, Make and Model

Severity of incidents

Usage type

Based on the frequency and severity of incidents, we recommend considering aircraft such as the Boeing and Cessna. which show low incident rates and minimal injury severity.

In [ ]:

```

```

In [ ]:

```

```