Strategic Risk Assessment of Aircraft for New Aviation Operations

ORIVELT LIMITED
BUSINESS & STAKEHOLDER BRIEF

Excutive Summary

What we did:

- Assessed aircraft acquisition risk using historical crash records.
- Built a 0–100 scoring framework across Safety, Purchase (asset), and Geographic (operational) risk.
- Ranked aircraft types, operators, categories, and locations to surface high-risk exposure.

What it enabled:

- Faster aircraft shortlisting with clear, explainable risk drivers.
- Risk controls: avoid high-risk patterns; prioritize safer profiles.
- Action plan for due diligence and operational mitigations.

Data Overview

Data Scope

Data was gotten from the Aviation Safety Network (ASN). Historical crash records with outcome, operational, temporal, and spatial fields. Core columns used: acc.date, type, reg, operator, location, dmg (damage), fat (fatalities).

Key Fields used for Scoring

Fatalities (fat): human impact severity.

Damage severity (dmg → dmg_score): asset loss severity.

Location: operational / environmental context.

Aircraft type & operator: segmentation for decisions.

Data Preparation

- Standardized column names (lowercase, trimmed) to avoid processing errors.
- Converted accident date to datetime for time-based analysis.
- Cleaned fatalities to numeric; missing fatalities set to 0 (conservative).
- Normalized text fields (type/operator/location/reg/dmg) for consistent grouping.
- Replaced missing operator/registration values with 'unknown' to preserve rows.
- Encoded damage severity into a numeric score for comparable risk scoring.
- Ran validation checks (non-negative fatalities; damage score within expected range).

Risk Framework

- Safety Risk: focuses on severity of human outcomes (fatalities) when accidents occur.
- Purchase Risk (Financial/Asset): estimates likelihood of severe damage and total loss outcomes.
- Geographic Risk (Operational): highlights high-severity accident locations to inform routing and controls.
- Scores are min-max normalized within the dataset (0 = lowest observed risk, 100 = highest observed risk).

Safety Risk Scoring-By Aircraft Category

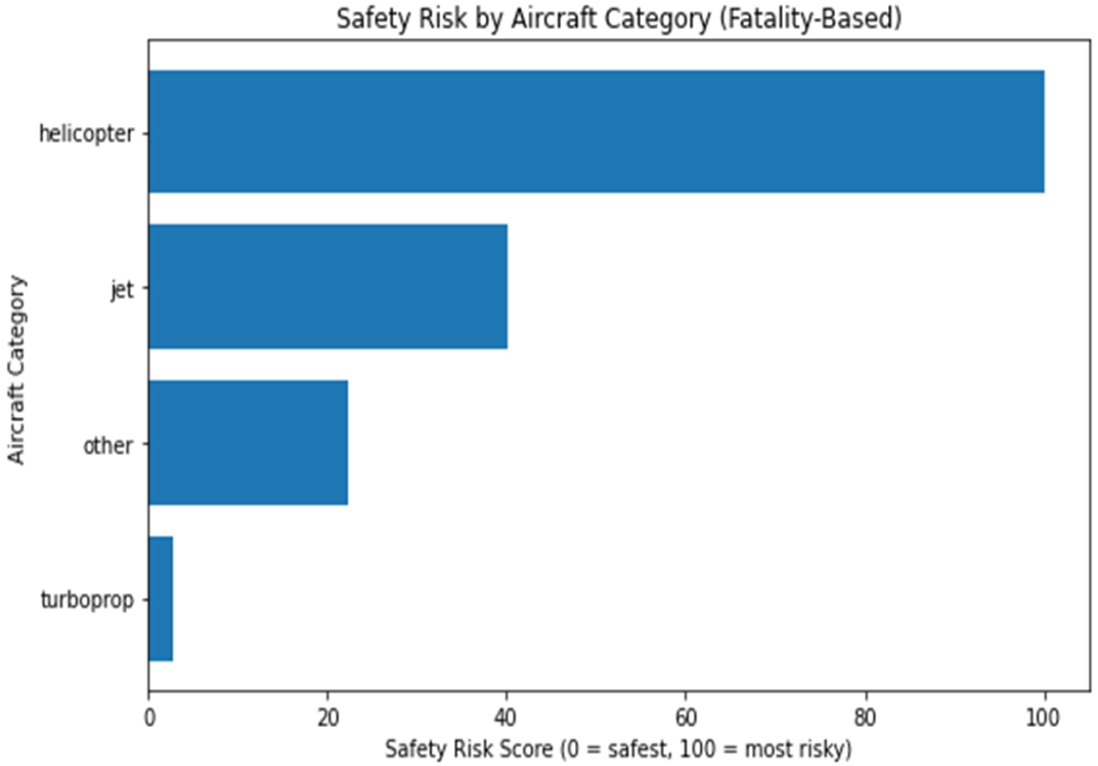
Metrix Scored

I. Number of Crashes: Total recorded incidents for the category and was used to ensure statistical reliability (categories with very few crashes are excluded)

II. Average Fatalities per Crash: Mean number of fatalities across all crashes in the category and Captures typical human impact severity

III. Fatal Crash Rate:Percentage of crashes that involved at least one fatality and Captures likelihood of a crash becoming fatalThese metrics focus on outcome severity, not frequency of operations.

Safety Risk Scoring-By Aircraft Category



Each metric is normalized to a **0–1 scale** using min–max normalization across categories, then combined into a weighted score:

$$\textbf{Safety } \textbf{\textit{Risk Score}} = (0.7 \times \textit{Normalized Avg Fatalities}) + (0.3 \times \textit{Normalized Fatal Crash Rate})$$

$$\textbf{Final Score} = \textit{Safety Risk Score} \times 100$$

Aircraft were grouped into Helicopter, Jet, Turboprop, and Other (keyword-based).

In this dataset, helicopters show the highest fatality-based risk.

Turboprops show the lowest risk on this specific metric.

Purchase Risk (Financial / Asset) Scoring

Metrics computed per aircraft type

avg_damage_severity: mean dmg_score for the type (1–3 scale).

total_loss_rate: % of incidents where dmg_score == 3 (destroyed / written-off).

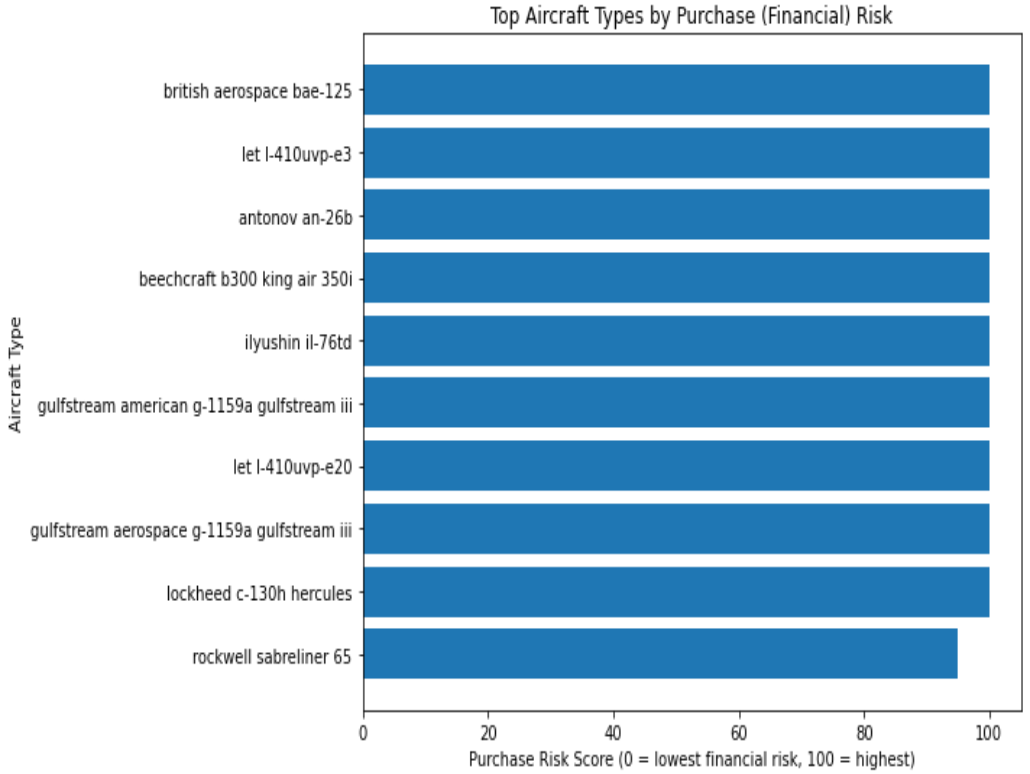
Filtering: aircraft types with <5 records excluded to reduce noise.

Score definition (normalized)

Purchase Risk Score = (0.7 × damage_norm + 0.3 × loss_rate_norm) × 100

Interpretation: higher score = higher expected repair/total-loss exposure.

Purchase Risk (Financial / Asset) Scoring



Ranks aircraft types by financial/asset exposure based on damage severity and total-loss rate.

Use case: informs expected insurance, maintenance reserves, and procurement negotiations.

Action: combine with acquisition cost and mission requirements for a final shortlist.

Geographic Risk (Operational) Scoring

Metrics computed per aircraft type

avg_fatalities_per_crash: mean fatalities by location.

avg_damage_severity: mean dmg_score by location.

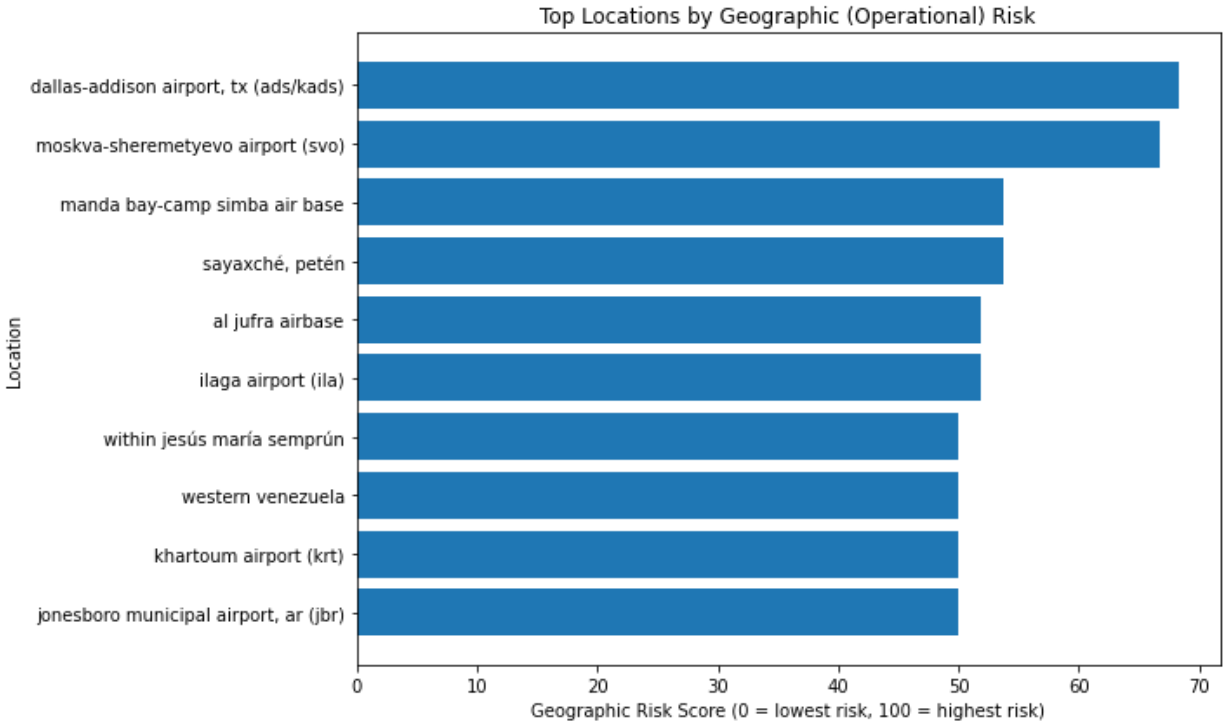
Filtering: locations with <3 crashes excluded to reduce noise.

Score definition (normalized)

Geographic Risk Score = (0.5 × fatal_norm + 0.5 × damage_norm) × 100

Interpretation: higher score = higher-severity outcomes observed in that location.

Geographic Risk (Operational) Scoring



Surfaces operational hotspots where incidents tend to have higher severity.

Use case: route selection, training emphasis, and emergency response readiness.

Action: prioritize mitigations for high-risk locations in operating plans.

Recommendations for Stakeholders

Procurement / Acquisition

- Use safety + purchase risk outputs to narrow the candidate aircraft list.
- Avoid high-risk patterns early; prioritize lower-risk profiles for deeper checks.
- Include insurance, maintenance reserves, and spare-parts availability in the final decision.

Operations / Risk Controls

- Use geographic risk to plan routes, alternates, and emergency response playbooks.
- Strengthen Standard Operating Procedures (SOPs) and training for higher-risk categories and operating contexts.
- Set key performance indicators (KPIs) monitoring: incidents, severity, and near-miss reporting as operations scale.

Limitations and Assumptions

Risk scores are relative to the provided dataset and depend on data quality and reporting completeness.

Aircraft type/operator names may include variants; normalization reduces but may not eliminate duplicates.

Filtering thresholds (min crashes) reduce noise but can exclude newer or rarer aircraft.

This analysis supports decision-making but should be paired with engineering, regulatory, and insurer review.

Questions