

INAD Analysis Tool

User Documentation

Enhanced Version 2.1 – Multilingual Edition

For Legal Team Review

December 2024

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01 — Introduction and Purpose

What is This Tool?

The INAD Analysis Tool is designed to identify airlines and routes with systematically elevated rates of inadmissible passengers (INADs). Its purpose is to support legal review by distinguishing between:

- Isolated incidents that may not require action
- Systemic patterns that warrant investigation or enforcement

The tool processes two data sources:

Data Source	Description
INAD records	Cases of passengers refused entry at Swiss borders
BAZL passenger data	Total passenger volumes by airline and route

By comparing INAD counts against passenger volumes, we can identify which airlines or routes have disproportionately high INAD rates relative to their traffic, suggesting potential systemic issues with passenger screening.

Who Should Use This Documentation?

This documentation is written for members of the legal team who will review the analysis results and make decisions about further investigation, warnings, or enforcement actions. Technical knowledge of statistics or programming is not required.

02 — The Three-Step Analysis Process

The analysis follows a progressive filtering approach, each step narrowing down the focus to identify the most significant cases.

Step 1: Airline-Level Screening (Prüfstufe 1)

PURPOSE

Identify airlines with a meaningful number of INAD cases

HOW IT WORKS

- Count the total number of INADs for each airline in the semester
- Flag airlines with 6 or more INADs (configurable threshold)
- Airlines below this threshold are excluded from further analysis

WHY 6 INADs?

A small number of INADs (1-5) could easily be random occurrences. Setting a minimum threshold ensures we focus on statistically meaningful patterns rather than isolated incidents.

Step 2: Route-Level Screening (Prüfstufe 2)

PURPOSE

From airlines identified in Step 1, identify specific routes with elevated INAD counts

HOW IT WORKS

- For each airline that passed Step 1, count INADs by route (origin airport)
- Flag routes with 6 or more INADs
- Routes below this threshold are excluded from Step 3

WHY ANALYZE BY ROUTE?

An airline might have high total INADs but concentrated on one route. This helps identify specific problem origins rather than penalizing an airline's entire operation.

Step 3: Density Analysis (Prüfstufe 3)

PURPOSE

Compare INAD counts against passenger volumes to identify disproportionately high rates

HOW IT WORKS

1. For each route from Step 2, retrieve the passenger count (PAX)
2. Calculate the INAD density: $(\text{INADs} / \text{PAX}) \times 1000$

This gives INADs per 1,000 passengers

3. Calculate the threshold (median of all densities)
4. Flag routes above the threshold for legal review

WHY USE DENSITY INSTEAD OF RAW COUNTS?

Raw INAD counts favor large airlines unfairly. A route with 20 INADs and 500,000 passengers (0.04‰) is performing better than a route with 10 INADs and 20,000 passengers (0.50‰). Density provides a fair, relative comparison across different traffic volumes.

03 — Understanding the Enhanced Features

The enhanced version introduces several improvements to make the analysis more reliable and actionable for legal review.

3.1 Robust Threshold Calculation

Approach	Method	Issue / Benefit
PREVIOUS	Simple arithmetic mean (average)	Highly sensitive to outliers; one extreme value can skew results
NEW	Median (middle value)	Not affected by outliers; one bad data point cannot skew analysis

The median is the middle value when all densities are sorted. Unlike the mean, it provides robust statistics that are standard in scientific research, financial analysis, and regulatory contexts.

3.2 Minimum Passenger Threshold

Approach	Method	Issue / Benefit
PREVIOUS	All routes included regardless of volume	Routes with few passengers produce unreliable densities
NEW	Routes with <5,000 passengers marked UNRELIABLE	Clear warnings; excluded from threshold calculation

Routes marked UNRELIABLE are still shown but flagged with a warning. The legal team can see them but should interpret with caution. They do not influence the threshold calculation.

3.3 Priority Classification System

The new approach uses a four-tier priority classification system instead of simple "above/below average" binary classification:

Priority Level	Criteria	Action
[RED] HIGH PRIORITY	Density $\geq 1.5 \times$ threshold AND $\geq 0.10\%$ AND ≥ 10 INADs AND $\geq 5,000$ PAX	Immediate legal review required
[ORANGE] WATCH LIST	Density \geq threshold but does not meet all HIGH criteria	Monitor; may escalate
[GREEN] CLEAR	Density $<$ threshold	No action required
[GREY] UNRELIABLE	Fewer than 5,000 passengers or incomplete data	Do not take enforcement action

3.4 Confidence Scoring

Each route receives a confidence score from 0-100% based on INAD count and passenger volume:

Confidence Range	Interpretation
0-30%	Low confidence – treat results with caution
30-60%	Medium confidence – results are indicative
60-100%	High confidence – results are reliable

3.5 Data Quality Checks

Automatic data quality checks with warnings:

Warning	Meaning
Incomplete PAX data (2/6 months)	Passenger data exists for fewer than 4 of 6 months; density may be inaccurate
Low PAX volume (<5,000)	Total passengers too low for reliable statistics
High variance in monthly PAX data	Unusual fluctuations may indicate data recording issues

3.6 Systemic Case Detection

Multi-semester analysis identifies SYSTEMIC cases — routes that appear on the WATCH LIST or HIGH PRIORITY in 2 or more consecutive semesters. This helps the legal team distinguish between one-time issues and persistent patterns.

Additional information provided for systemic cases:

- Total appearances across all semesters
- Maximum consecutive appearances

- Trend direction (IMPROVING or WORSENING)
- Percentage change in density over time

3.7 Refusal Code Categorization

Refusal codes are now categorized to understand the nature of problems:

Category	Examples
Documentation	Missing or invalid travel documents
Fraud	Forged or falsified documents
Visa	Visa-related issues (expired, wrong type, overstay)
Security	Security concerns, entry bans

This categorization helps understand the NATURE of the problem and informs appropriate responses.

04 — The Dashboard Interface

The dashboard provides six main tabs for navigating the analysis, with support for three languages (English, German, French) via the language switcher in the sidebar.

Tab 1: Overview

Quick summary of the entire analysis:

- Summary metrics (total INADs, counts by priority level)
- Priority distribution pie chart
- Confidence score distribution
- Data quality warnings
- Top routes by density
- Refusal category breakdown for flagged routes

Tab 2: Step 1 — Airlines

Review airline-level screening results:

- List of all airlines with INAD counts
- Color-coded status (Review / OK)
- Summary statistics
- Distribution histogram

Tab 3: Step 2 — Routes

Review route-level screening results:

- List of all routes with INAD counts
- Filter to airlines passing Step 1 only

- Top airports by INAD count

Tab 4: Step 3 — Priority Analysis

Detailed priority classification with full metrics:

- Classification criteria explanation
- Complete route list with density, confidence, and priority
- Interactive scatter plot (density vs. passengers)
- Summary of HIGH PRIORITY and WATCH LIST counts

Tab 5: Systemic Cases

Identify persistent patterns across multiple semesters:

- Count of confirmed systemic cases
- Trend analysis (improving/worsening)
- Historical chart of flagged routes over time
- Individual route history viewer

Tab 6: Legal Summary

Export-ready summary for legal team:

- Analysis parameters used
- List of HIGH PRIORITY routes with details
- List of WATCH LIST routes with details
- Data quality notes
- Export buttons for CSV downloads

05 — Interpreting Results for Legal Review

Recommended Review Process

Step	Action
1. Start with Legal Summary Tab	Review HIGH PRIORITY routes first. These have the strongest statistical basis for action. Note confidence scores.
2. Check for Systemic Cases	Routes appearing as systemic have persisted over time. Review their trend — worsening trends are more concerning.
3. Review Watch List	Routes above average but not meeting all HIGH criteria. May escalate to HIGH PRIORITY next semester.
4. Note Data Quality Warnings	Be cautious with UNRELIABLE classifications. If a route has quality warnings, results may not support action.
5. Export for Documentation	Use export buttons to create records. Include analysis parameters in your documentation.

What Each Priority Level Means for Action

Priority	Statistical Basis	Recommended Action
[RED] HIGH PRIORITY	Strong	Formal investigation, potential warning or fine
[ORANGE] WATCH LIST	Moderate	Monitor, consider informal outreach
[GREEN] CLEAR	Below threshold	No action required
[GREY] UNRELIABLE	Insufficient data	Do not take enforcement action

Important Caveats

1. Statistical indicators are not proof — High density indicates a pattern worth investigating, but root cause analysis is still required before action.
2. Context matters — Some origins may have inherently higher INAD rates. Consider geopolitical factors, visa regimes, etc.
3. Data limitations — Passenger data may be incomplete for some routes. Always check data quality warnings.
4. Threshold is relative — Being above the median means above half of peers. It does not mean the absolute rate is necessarily problematic.

06 — Why the New Approach is More Robust

Comparison: Old vs. New Methodology

Issue	Old Approach	New Approach
Outlier Sensitivity	One route with bad data could skew entire semester results	Median-based threshold ignores extreme values; data quality checks
Classification	Binary: "above average" or "below average" with no distinction	Four-tier system with clear criteria; proportionate response
Temporal View	Each semester analyzed in isolation	Systemic case detection across semesters; trend analysis
Confidence	All results presented with equal weight	Confidence scores based on sample size; clear warnings
Data Quality	Issues not detected or reported	Automatic quality checks; visible warnings in dashboard

Statistical Validity

The new approach follows established statistical best practices:

- Robust statistics — Using median instead of mean is standard when outliers may be present. It is used in scientific research, financial analysis, and regulatory contexts worldwide.
- Minimum sample size — The 5,000 passenger threshold ensures density calculations are based on sufficient data.
- Multi-period analysis — Looking at patterns across multiple semesters reduces the chance of acting on random fluctuations.

- Confidence scoring — Provides an intuitive measure of reliability that helps non-statisticians interpret results appropriately.

07 — Configuration Parameters

All parameters can be adjusted in the dashboard sidebar to customize the analysis sensitivity and thresholds.

Minimum INAD Threshold (Default: 6)

What it does: Sets the minimum number of INADs for Step 1 and Step 2

Setting	Recommendation
6 (default)	Standard setting, balances sensitivity and specificity
Lower (3-5)	More sensitive, catches smaller patterns
Higher (8-10)	More conservative, only flags clear patterns

Minimum PAX for Reliable Data (Default: 5,000)

What it does: Routes with fewer passengers are marked UNRELIABLE

Setting	Recommendation
5,000 (default)	Standard setting, reasonable statistical basis
Lower	Include more routes but with less confidence
Higher	More conservative, only highest-confidence results

Threshold Calculation Method (Default: Median)

Options for calculating the density threshold:

Method	Recommendation
Median	Middle value, most robust against outliers (RECOMMENDED)
Trimmed Mean	Removes top/bottom 10% then averages
Mean	Simple average (NOT RECOMMENDED — sensitive to outliers)

Minimum Density for HIGH PRIORITY (Default: 0.10‰)

What it does: Even if above threshold, must exceed this absolute minimum

Setting	Recommendation
0.10‰ (default)	Standard setting
Lower	More routes qualify as HIGH PRIORITY
Higher	Only the most severe cases flagged

HIGH PRIORITY Multiplier (Default: 1.5x)

What it does: Must be this multiple of threshold for HIGH PRIORITY

Setting	Recommendation
1.5x (default)	Standard setting (50% above threshold)
Lower (1.2-1.3)	More sensitive
Higher (2.0+)	Only extreme cases flagged

08 — Glossary of Terms

Term	Definition
BAZL	Bundesamt für Zivilluftfahrt (Swiss Federal Office of Civil Aviation). Source of passenger volume data.
Confidence Score	A 0-100% score indicating how reliable the density calculation is, based on INAD count and passenger volume.
Density (INAD-Dichtewert)	INADs per 1,000 passengers: (INAD count / PAX) × 1000. Expressed in per-mille (%).
HIGH PRIORITY	Routes requiring immediate legal review. Meet all criteria: high density, high INAD count, reliable data.
INAD	Inadmissible Passenger. A passenger refused entry at the border for various reasons.
Last Stop	The final departure airport before arriving in Switzerland. Used to identify the origin of INAD cases.
Median	The middle value in a sorted list. Unlike the mean, it is not affected by extreme values.
PAX	Passengers (abbreviation used in aviation industry).
Semester	Six-month period used for analysis. H1: January-June, H2: July-December.
Systemic Case	A route flagged in 2+ consecutive semesters. Indicates a persistent pattern.
Threshold	The density value used to separate "above average" from "below." Calculated using median of reliable route densities.
UNRELIABLE	Classification for routes with insufficient data. Should not be used as basis for enforcement action.
WATCH LIST	Routes above threshold but not meeting all HIGH PRIORITY criteria. Should be monitored.

Document Information

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Languages Supported	English, German (Deutsch), French (Français)

For technical support or questions about this documentation, contact the data analysis team.