

02 - Data Quality Checks (Phase 3)

This notebook runs row-count, null, and key-integrity checks for the Airline Business Intelligence Database.

- Validates Phase 2 ETL results
- Guides SQL cleanup in `sql/03_dml_cleanup.sql`
- Confirms constraints in `sql/04_constraints_indexes.sql`

```
In [4]: import os
import pandas as pd
from sqlalchemy import create_engine, text
from dotenv import load_dotenv
from typing import Optional, Dict

# Load environment variables
load_dotenv()
db_url = os.getenv("DATABASE_URL")
if db_url is None:
    raise RuntimeError("DATABASE_URL not set in environment or .env file")

# Create engine
engine = create_engine(db_url, future=True)

def run_sql(query: str, params: Optional[Dict] = None) -> pd.DataFrame:
    """Helper to run a SQL query and return a DataFrame."""
    with engine.connect() as conn:
        result = conn.execute(text(query), params or {})
        df = pd.DataFrame(result.fetchall(), columns=result.keys())
    return df
```

Row counts per table

```
In [5]: row_counts_sql = """
SELECT 'aircraft'           AS table_name, COUNT(*) AS row_count FROM airline.aircraft
UNION ALL
SELECT 'airlines',         COUNT(*) FROM airline.airlines
UNION ALL
SELECT 'airports',         COUNT(*) FROM airline.airports
UNION ALL
SELECT 'bookings',         COUNT(*) FROM airline.bookings
UNION ALL
SELECT 'flight_performance', COUNT(*) FROM airline.flight_performance
UNION ALL
SELECT 'flights',          COUNT(*) FROM airline.flights
UNION ALL
SELECT 'loyalty_accounts',  COUNT(*) FROM airline.loyalty_accounts
UNION ALL
SELECT 'miles_transactions', COUNT(*) FROM airline.miles_transactions
UNION ALL
```

```

SELECT 'passengers',          COUNT(*) FROM airline.passengers
UNION ALL
SELECT 'payments',           COUNT(*) FROM airline.payments
UNION ALL
SELECT 'routes',             COUNT(*) FROM airline.routes
ORDER BY table_name;
''''

row_counts = run_sql(row_counts_sql)
row_counts

```

Out [5]:

	table_name	row_count
0	aircraft	0
1	airlines	1108
2	airports	7697
3	bookings	40000
4	flight_performance	22595
5	flights	5000
6	loyalty_accounts	3000
7	miles_transactions	10576
8	passengers	5000
9	payments	40000
10	routes	0

FK / key null + orphan checks

```

In [6]: fk_issues_sql = '''
SELECT
    flights_missing_airline,
    flights_missing_origin_airport,
    flights_missing_destination_airport,
    bookings_missing_passenger,
    bookings_missing_flight,
    payments_missing_booking
FROM (
    SELECT
        SUM(CASE WHEN a.airline_id IS NULL THEN 1 ELSE 0 END) AS flights_missing
        SUM(CASE WHEN ao.airport_id IS NULL THEN 1 ELSE 0 END) AS flights_missir
        SUM(CASE WHEN ad.airport_id IS NULL THEN 1 ELSE 0 END) AS flights_missir
    FROM airline.flights f
    LEFT JOIN airline.airlines a ON f.airline_id = a.airline_id
    LEFT JOIN airline.airports ao ON f.origin_airport_id = ao.airport_id
    LEFT JOIN airline.airports ad ON f.destination_airport_id = ad.airport_id
) flights_issues,
(
    SELECT

```

```

        SUM(CASE WHEN p.passenger_id IS NULL THEN 1 ELSE 0 END) AS bookings_miss
        SUM(CASE WHEN f2.flight_id IS NULL THEN 1 ELSE 0 END) AS bookings_missir
    FROM airline.bookings b
    LEFT JOIN airline.passengers p ON b.passenger_id = p.passenger_id
    LEFT JOIN airline.flights f2 ON b.flight_id = f2.flight_id
) bookings_issues,
(
    SELECT
        SUM(CASE WHEN b3.booking_id IS NULL THEN 1 ELSE 0 END) AS payments_missi
    FROM airline.payments pay
    LEFT JOIN airline.bookings b3 ON pay.booking_id = b3.booking_id
) payments_issues;
"""

fk_issues = run_sql(fk_issues_sql)
fk_issues

```

Out[6]:

flights_missing_airline	flights_missing_origin_airport	flights_missing_destination_ai
0	0	0

Duplicate key checks

In [7]:

```

duplicates_sql = """
SELECT 'airlines_iata_duplicates' AS metric,
       COUNT(*) AS count
FROM (
    SELECT iata_code
    FROM airline.airlines
    WHERE iata_code IS NOT NULL
    GROUP BY iata_code
    HAVING COUNT(*) > 1
) t
UNION ALL
SELECT 'airports_iata_duplicates',
       COUNT(*)
FROM (
    SELECT iata_code
    FROM airline.airports
    WHERE iata_code IS NOT NULL
    GROUP BY iata_code
    HAVING COUNT(*) > 1
) t2
UNION ALL
SELECT 'passenger_email_duplicates',
       COUNT(*)
FROM (
    SELECT email
    FROM airline.passengers
    WHERE email IS NOT NULL
    GROUP BY email
    HAVING COUNT(*) > 1
)

```

```

) t3
UNION ALL
SELECT 'loyalty_multiper_passenger',
      COUNT(*)
FROM (
  SELECT passenger_id
  FROM airline.loyalty_accounts
  GROUP BY passenger_id
  HAVING COUNT(*) > 1
) t4;
"""

dup_counts = run_sql(duplicates_sql)
dup_counts

```

Out[7]:

	metric	count
0	airlines_iata_duplicates	0
1	airports_iata_duplicates	0
2	passenger_email_duplicates	0
3	loyalty_multiper_passenger	0

"Problem Counts" summary table

```

In [8]: # Melt FK issues into metric / count format
fk_problem_counts = fk_issues.melt(
    var_name="metric",
    value_name="count"
)

# Combine with duplicate counts
problem_counts = pd.concat(
    [fk_problem_counts, dup_counts],
    ignore_index=True
)

problem_counts

```

Out [8]:

	metric	count
0	flights_missing_airline	0
1	flights_missing_origin_airport	0
2	flights_missing_destination_airport	0
3	bookings_missing_passenger	0
4	bookings_missing_flight	0
5	payments_missing_booking	0
6	airlines_jata_duplicates	0
7	airports_jata_duplicates	0
8	passenger_email_duplicates	0
9	loyalty_multiper_passenger	0

Simple quality-check chart

```
In [9]: import matplotlib.pyplot as plt

# Filter to only metrics with non-null counts (keep zeros)
plot_df = problem_counts.copy()

plt.figure(figsize=(10, 5))
plt.bar(plot_df["metric"], plot_df["count"])
plt.xticks(rotation=45, ha="right")
plt.ylabel("Count")
plt.title("Data Quality Checks – Problem Counts (FK & Duplicates)")
plt.tight_layout()

# Make sure docs/ exists
os.makedirs("docs", exist_ok=True)

plt.savefig("docs/pipeline_quality_checks.png", dpi=200)
plt.show()
```

