ITCS413: Database Design

Project 1 – Database Planning and Requirement Analysis

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Motivation

Efficient management of airline operations is crucial for ensuring smooth travel experiences for passengers and reliable cargo transportation. The airline industry is highly complex, involving multiple interdependent systems that require accurate data handling, strict security compliance, and real-time updates. However, many airlines still struggle with outdated systems, manual processes, and fragmented databases that lead to inefficiencies.

Key Challenges

- **Booking inefficiencies** – Many existing systems struggle to handle large volumes of reservations efficiently, leading to delays, double bookings, and scheduling conflicts. These issues negatively impact customer satisfaction and disrupt airline operations.

- **Manual processes increase security and compliance risks** – Airlines still relying on paper-based or partially digitized systems face greater risks of human error, data inconsistencies, and security breaches. Compliance with international aviation regulations like PDPA, GDPR, ICAO, IATA, FAA, and CAA becomes more difficult when processes are not fully automated.

- **Lack of real-time tracking for passenger check-ins and cargo shipments** – The inability to provide up-to-the-minute updates on passenger check-ins and cargo movements creates operational bottlenecks. Passengers may face delays at boarding gates, and cargo handlers may struggle with tracking shipments, especially for multi-leg transfers.

- **Limited data security increases unauthorized access risks** – Weak security protocols can lead to unauthorized access to sensitive passenger and financial data, creating privacy risks and regulatory non-compliance. Protecting critical airline information becomes a major challenge without a centralized and secure database.

Proposed Solution

To address these challenges, the proposed airline database system will:

- Automate key airline operations, reducing human errors and improving overall efficiency.

- Integrate passenger booking, flight management, and cargo tracking into a centralized system, enabling real-time updates and better communication between departments.

- Enhance security through role-based access control, encryption, and strict compliance with international data protection laws.

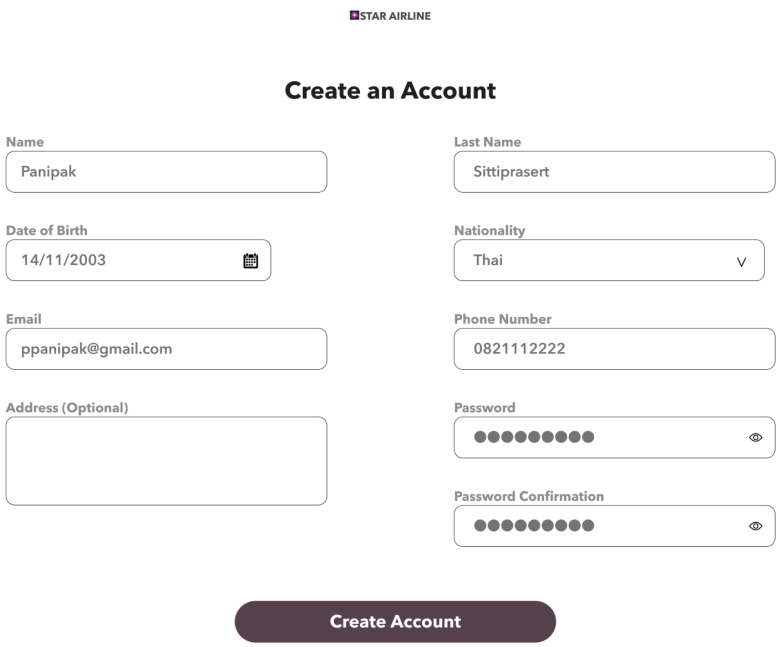
- Improve decision-making by generating accurate reports on passenger flow, cargo shipments, and security compliance.

By implementing this advanced, scalable, and secure database system, airlines can optimize their workflows, enhance customer experiences, and ensure compliance with industry regulations. Ultimately, this system will drive business growth and improve operational efficiency.

As-Is Analysis

The following will discuss the key characteristics of the Airline.

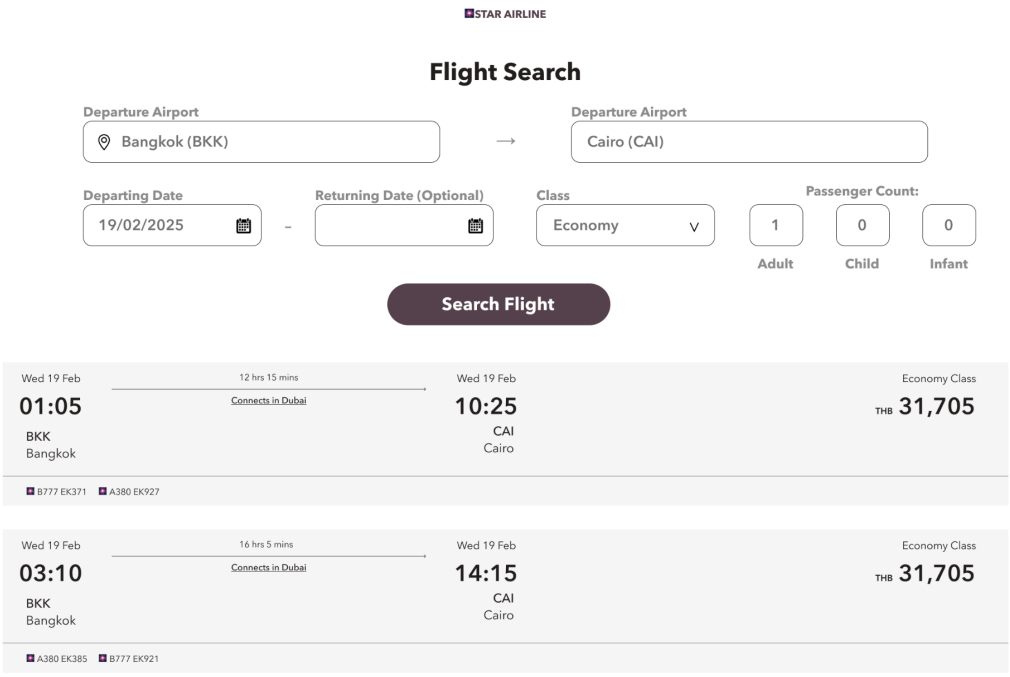
User Registration Form



Current Issue:
The form collects only basic information and lacks integration with passenger profiles, travel history, preferences, and frequent flyer status, limiting personalization.

Data Input:
Full Name: Passenger's first and last name.
Date of Birth: Required for verifying age-based services (e.g., child fares).
Nationality: Passenger's country of citizenship for immigration and travel purposes.
Email Address: Passenger's email for booking confirmations.
Phone Number: Contact number for notifications and support.
Password: Secure password for account login and access.
Confirm Password: To ensure accuracy and prevent login issues.

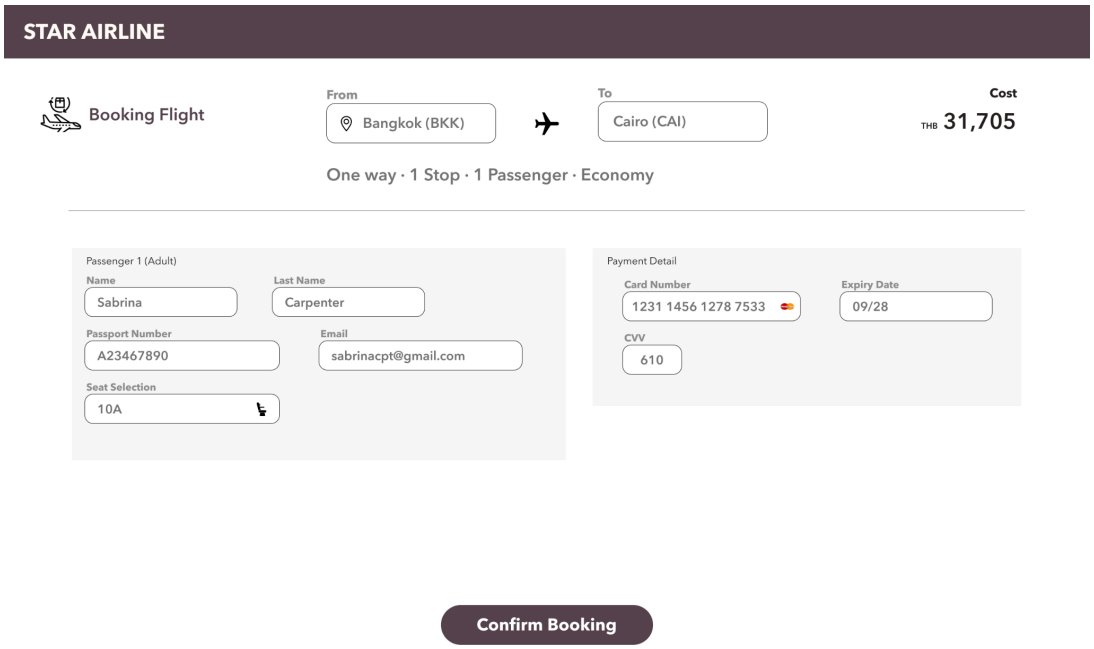
Passengers Booking Form (Search Flight)



Current Issue:
Personalized flight recommendations and advantages like loyalty points or preferred seating are limited because the form only collects basic flight search information and does not connect the passenger's profile, travel history, or preferences.

Data Input:
Departure Airport: The airport from which the passenger will depart (e.g., City or Airport Code).
Destination Airport: The airport where the passenger will arrive (e.g., City or Airport Code).
Departure Date: The date of the flight's departure.
Return Date (Optional): The date of the return flight.
Travel Class: Preferred class of travel (e.g., Economy, Premium Economy, Business, First Class).
Number of Passengers: Total number of passengers, including adults, children, and infants.

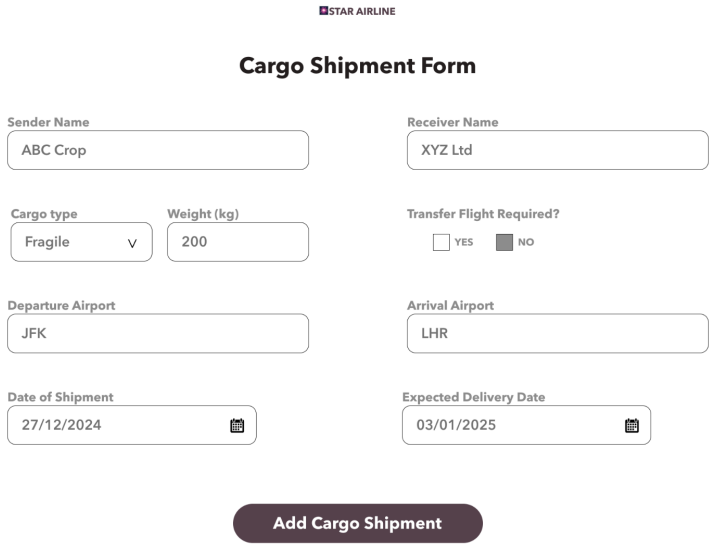
Passengers Booking Form (Booking Flight)



Current Issue:
Passengers can buy flights using the form, but it does not integrate with their profiles, travel history, or preferences. As a result, they are unable to take advantage of specific booking choices like loyalty benefits, special discounts, or seat selections.

Data Input:
Full Name: Passenger's first and last name for the booking.
Email Address: Passenger's email for flight confirmation and updates.
Departure Airport: The airport from which the passenger will depart (e.g., City or Airport Code).
Destination Airport: The airport where the passenger will arrive (e.g., City or Airport Code).
Number of Passengers: Total number of passengers, including adults, children, and infants.
Travel Class: Preferred travel class (e.g., Economy, Premium Economy, Business, First Class).
Payment Method: Payment details (credit card, PayPal, etc.) for booking confirmation.

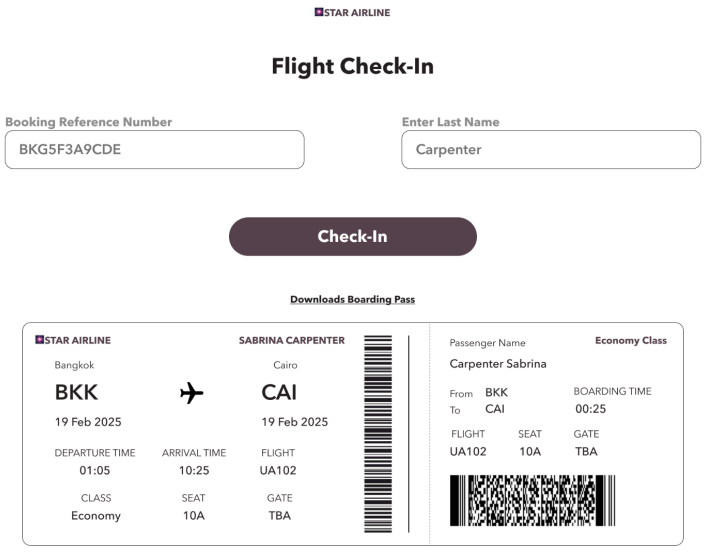
Cargo Shipment Form



Current Issue:
Personalized services like preferred delivery methods, discounts, or automated updates are limited because the form simply collects basic shipment information and does not connect to customer profiles or shipment history.

Data Input:
Sender Name: The name of the individual or company sending the cargo.
Receiver Name: The name of the individual or company receiving the cargo.
Cargo Type: Type of cargo being shipped (e.g., perishable goods, electronics, fragile items, etc.).
Weight and Dimensions: The weight and dimensions (length, width, height) of the shipment.
Departure Airport: The airport from which the cargo will depart.
Arrival Airport: The airport where the cargo will arrive.
Date of Shipment: The date when the cargo will be shipped.
Expected Delivery Port: The port where the shipment is expected to arrive for unloading.

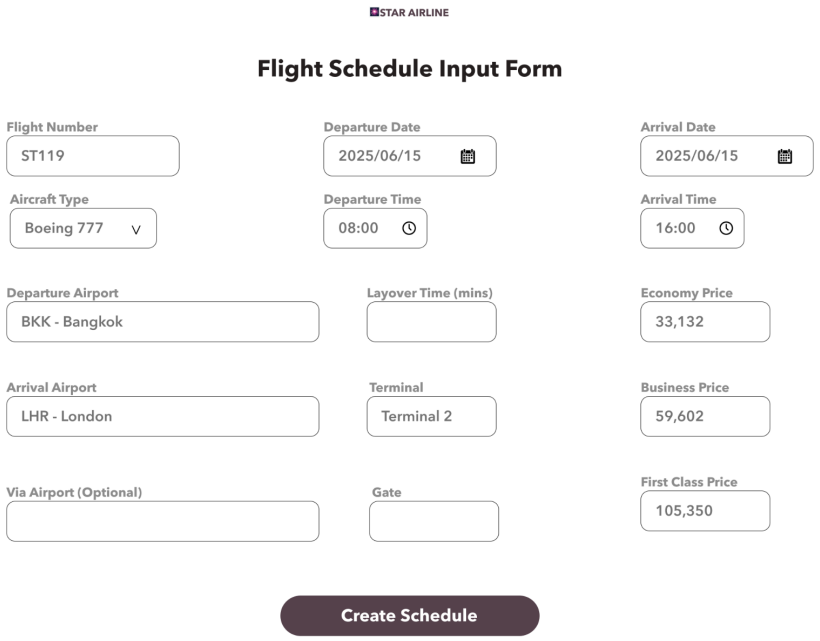
Flight Check-In Form



Current Issue:
Basic check-in information is captured by the form, but it does not connect to customer profiles, travel histories, or preferences. As a result, customization possibilities like automatic baggage check-in, frequent flyer benefits, and seat selection are limited.

Data Input:
Booking Reference Number: The unique booking ID for your flight reservation.
Passenger Name: Passenger's first and last name as per the booking.
Flight Number: The flight number of the booking.
Departure Airport: The airport from which the passenger will depart.
Destination Airport: The airport where the passenger will arrive.
Departure Date: The date of the flight's departure.
Submit Check-In: Button to complete the check-in process.

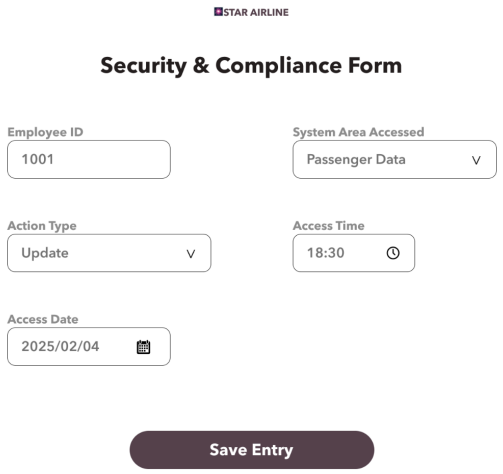
Flight Schedule Input Form



Current Issue:
The form records the necessary travel schedule information, but it does not interface with passenger profiles or airline systems, making it difficult to optimize scheduling, provide customized route options, or manage frequent flyer preferences.

Data Input:
Flight Number: Unique identifier for the flight.
Departure Airport: The airport from which the flight will depart.
Arrival Airport: The airport where the flight will arrive.
Departure Date and Time: The scheduled date and time for departure.
Arrival Date and Time: The scheduled date and time for arrival.
Aircraft Type: The type of aircraft used for the flight.
Layovers: If the flight includes layovers, list the locations, duration, and time between flights.
Ticket Price: The base price or ticket pricing range for the flight.

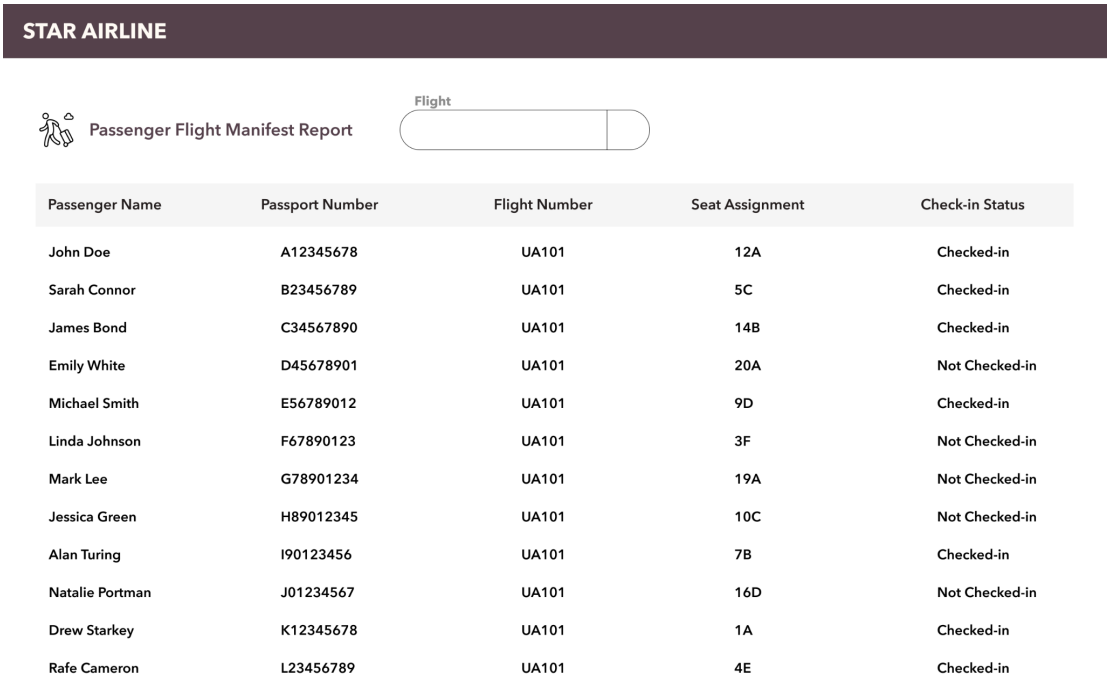
Security & Compliance Form



Current Issue:
Only basic security and compliance information is captured by the form; it does not integrate with passenger or shipment profiles, which restricts the ability to apply compliance exemptions based on prior records, enhance verification, or customize security procedures.

Data Input:
Employee ID: The individual employee ID as per legal documentation.
Action Type: Type of action performed (e.g., update, data entry, data retrieval, file access).
Access Time: The time at which the access took place.
Access Date: Date on which the access occurred.

Passenger Flight Manifest Report



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Passenger Flight Manifest Report

Flight

Passenger Name	Passport Number	Flight Number	Seat Assignment	Check-in Status
John Doe	A12345678	UA101	12A	Checked-in
Sarah Connor	B23456789	UA101	5C	Checked-in
James Bond	C34567890	UA101	14B	Checked-in
Emily White	D45678901	UA101	20A	Not Checked-in
Michael Smith	E56789012	UA101	9D	Checked-in
Linda Johnson	F67890123	UA101	3F	Not Checked-in
Mark Lee	G78901234	UA101	19A	Not Checked-in
Jessica Green	H89012345	UA101	10C	Not Checked-in
Alan Turing	I90123456	UA101	7B	Checked-in
Natalie Portman	J01234567	UA101	16D	Not Checked-in
Drew Starkey	K12345678	UA101	1A	Checked-in
Rafe Cameron	L23456789	UA101	4E	Checked-in

Current Issue:
Although the report gathers basic passenger information, it does not incorporate travel history, passenger profiles, or loyalty programs. As a result, it is not possible to track frequent flyer status, provide individualized services, or optimize seating arrangements.

Data Output:
Passenger Full Name: Passenger's full name as per booking.

Passport Number: Passport number for international travel verification.

Flight Number: Unique identifier for the flight.

Seat Number: Assigned seat number for the passenger on the flight.

Check-in Status: Indicates passenger check-in status (e.g., checked-in, Not checked-in)

Cargo Shipment Status Report

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Cargo Shipment Status Report

Cargo ID	Sender & Receiver Details	Shipment Status	Current Location	Date
C001	ABC Crop → XYZ Ltd	In Transit	New York, USA	2025/01/01
C002	DEF Crop → ABC Ltd	Delivered	London, UK	2025/01/06
C003	GDH Industries → SM Enterprises	Pending	Osaka, Japan	2025/01/25
C004	JKLInc →MNO Ltd	Delivered	Los Angeles,USA	2025/02/09
C005	CK Industries → YG Enterprises	In Transit	Frankfurt, Germany	2025/02/14
C006	CP Group → JT Co	In Transit	Dubai, UAE	2025/02/28
C007	CH Co → LN Group	Delivered	Melbourne, Australia	2025/03/07
C008	GU Ltd → DP Co	Delivered	Amsterdam, Netherland	2025/03/19
C009	YO Group → PT Enterprises	Pending	Paris, France	2025/03/30
C010	SOHO Co → LV Ltd	Pending	Toronto, Canada	2025/04/05
C011	GQ Crop → HM Ltd	Delivered	Miami, USA	2025/04/26
C012	YG Ltd → QA Enterprises	Delivered	Sydney, Australia	2025/04/27

Current Issue:
Personalized tracking, priority handling, and shipping suggestions are limited because the report only records the most basic shipment information and does not link with customer profiles, order histories, or cargo preferences.

Data Output:
Cargo ID: Unique identifier for the shipment.

Current Location: Latest recorded position of the shipment (Airport).

Date: The date on the shipment status.

Shipment Status: Provides real-time updates on the progress of a cargo shipment from origin to destination.

Cargo Shipment History Report

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Cargo Shipment History Report

Cargo ID	Sender & Receiver Details	Status Update Time	Status Description	Departure Airport	Arrival Airport
C001	ABC Crop → XYZ Ltd	2025/01/02 10:00	Shipment → Pick Up	JFK	ICN
C002	DEF Crop → ABC Ltd	2025/01/07 11:00	Shipment → Delivered	LHR	HKG
C003	GDH Industries → SM Enterprises	2025/01/26 10:30	Shipment → Delivered	ITM	PEK
C004	JKLInc →MNO Ltd	2025/02/11 01:00	Shipment → Delivered	LAX	DOH
C005	CK Industries → YG Enterprises	2025/02/14 02:30	Shipment → Pick Up	FRA	MEX
C006	CP Group → JT Co	2025/03/01 03:00	Shipment → Pick Up	DXB	MAD
C007	CH Co → LN Group	2025/03/09 09:00	Shipment → Delivered	MEL	BCN
C008	GU Ltd → DP Co	2025/03/21 08:00	shipment → Pick Up	AMS	FCO
C009	YO Group → PT Enterprises	2025/03/31 09:30	Shipment → Pick up	CDG	VIE
C010	SOHO Co → LV Ltd	2025/04/08 05:00	Shipment → Delivered	YYZ	ZRH
C011	GQ Crop → HM Ltd	2025/04/29 08:30	Shipment → Delivered	MIA	GVA
C012	YG Ltd → QA Enterprises	2025/04/29 11:30	Shipment → Delivered	SYD	ARN

Current Issue:

Customer profiles are not connected to previous shipping history, preferences, or recurring orders; the report just records the most basic shipment information. This restricts the availability of individualized services, effective tracking, and advancements in predictive logistics.

Data Output:

Cargo ID: Unique identifier for the shipment.
Departure Airport: Origin of shipment.
Arrival Airport: Final destination of shipment.
Shipment Status History: Sequential log of shipment progress (e.g., Shipment → Pick Up)

Flight Occupancy Report

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Flight Occupancy Report

Flight Number	Total Seats	Booked Seats	Available Seats
UA101	180	160	20
UA102	150	140	10
BA202	220	180	40
BA203	200	195	5
LH304	250	230	20
LH305	190	160	30
AA404	210	190	20
AA406	170	130	40
NH502	160	120	40
CX609	180	160	20
TK707	300	280	20
DL808	220	200	20

Current Issue:
Only basic passenger counts are provided in the report; frequent flyer data, seat preferences, and historical occupancy patterns are not integrated. This restricts the capacity to improve passenger experience, modify pricing tactics, and allocate seats as efficiently as possible.

Data Output:
Flight Number: Unique identifier for the flight.
Total Booked Seats: Number of seats booked for the flight.
Total Available Seats: Maximum seating capacity of the aircraft.

Revenue Report by Flight Report

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Revenue Report by Flight

Flight Number	Total Ticket Revenue	Cargo Revenue	Total Revenue
UA101	110,000	75,000	185,000
UA102	100,000	70,000	170,000
BA202	98,000	60,000	158,000
BA203	180,000	80,000	260,000
LH304	200,000	90,000	290,000
LH305	170,000	85,000	255,000
AA404	150,000	75,000	225,000
AA406	185,000	110,000	295,000
NH502	80,000	50,000	130,000
CX609	100,000	70,000	170,000
TK707	140,000	89,000	229,000
DL808	150,000	95,000	245,000

Current Issue:
The report's capacity to predict future revenues and optimize pricing strategies is limited because it just records basic revenue data and does not incorporate previous patterns, consumer preferences, or dynamic pricing models.

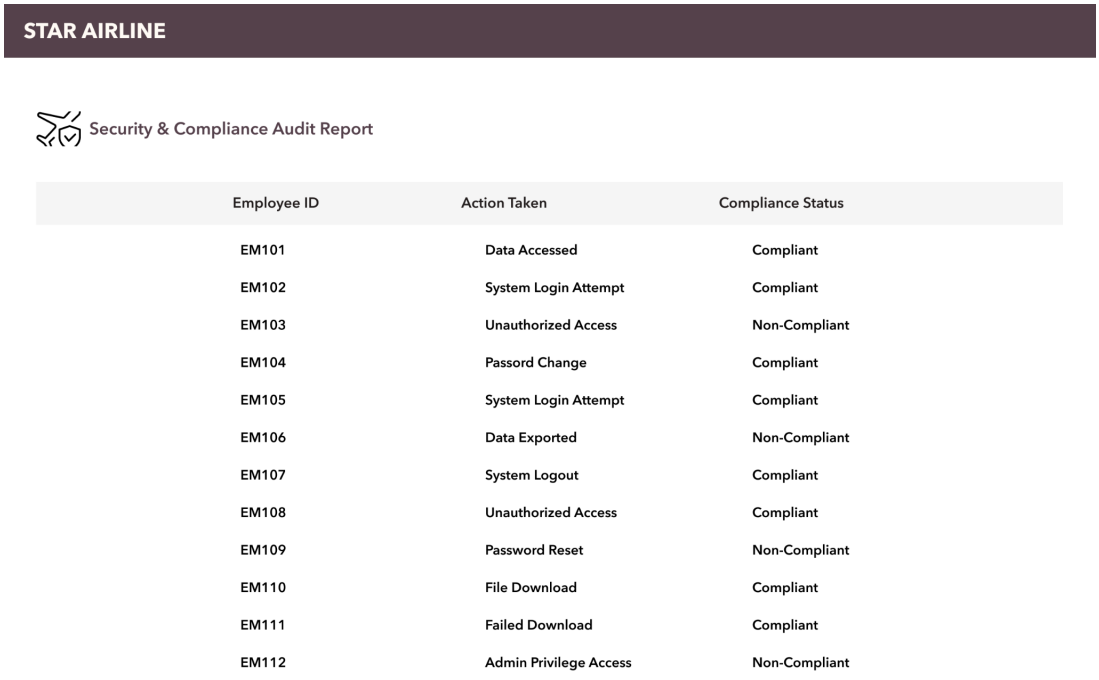
Data Output:
Flight Number: Unique identifier for the flight.

Total Ticket Revenue: Total ticket revenue from passengers.

Cargo Revenue: Cargo revenue from passengers.

Total Revenue: Total revenue from all passengers.

Security & Compliance Audit Report



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Security & Compliance Audit Report

Employee ID	Action Taken	Compliance Status
EM101	Data Accessed	Compliant
EM102	System Login Attempt	Compliant
EM103	Unauthorized Access	Non-Compliant
EM104	Passord Change	Compliant
EM105	System Login Attempt	Compliant
EM106	Data Exported	Non-Compliant
EM107	System Logout	Compliant
EM108	Unauthorized Access	Compliant
EM109	Password Reset	Non-Compliant
EM110	File Download	Compliant
EM111	Failed Download	Compliant
EM112	Admin Privilege Access	Non-Compliant

Current Issue:
Basic information about employee conduct is included in the audit report, but it lacks links to comprehensive security procedures, past compliance trends, or employee behavior patterns that could improve security monitoring and guarantee ongoing adherence to legal requirements.

Data Output:
Employee ID: Unique identification number of the employee involved in the action.
Action Taken: Description of the action performed by the employee (e.g., data access, system login).
Compliance Status: The action taken by the employee (e.g., compliance, non-compliance)

Mission Statement

Developing a centralized airline database system that enables effective passenger and cargo management while providing real-time tracking, improved security, and complete regulatory compliance is the goal of this project. Utilizing modern technology like RFID, GPS, and IoT, the system will enhance passenger satisfaction, reduce delays, and streamline operations. The airline can make effective decisions due to the useful, data-driven insights it will offer into important areas like revenue management, flight occupancy, and security. The system will also comply with important airline laws, such as the PDPA, GDPR, ICAO, and IATA, protecting private data and encouraging client confidence. The ultimate objective is maintaining operational excellence across all airline functions, enhancing service quality, and streamlining processes.

Mission Objectives

Our objectives aim to ensure that Airways not only delivers its mission statement but also provides all passengers with an excellent, effortless, effective, and focused customer travel experience.

1. **Improving Passenger Booking and Check-In Processes:** Emphasizes utilizing automation, smartphone check-ins, and self-service kiosks to increase process efficiency. Cutting down on wait times and improving passenger experience, improves to prevent delays and raises customer satisfaction.
2. **Ensuring Accurate Cargo Tracking and Managing Transfer Shipments:** This involves tracking shipments in real-time using technologies like RFID, GPS, and Internet of Things devices. This increases overall logistics efficiency by preventing delays, preventing lost cargo, and ensuring that shipments being moved between planes are precisely tracked.
3. **Meeting Aviation and Data Security Regulations:** Regulations including the PDPA, GDPR, ICAO, and IATA ensure the security of passenger and cargo data while adhering to crucial industry standards. Respecting these rules lowers the possibility of legal issues, protects sensitive data, and enhances consumer trust.
4. **Providing Real-Time Reports for Revenue, Security, and Flight Occupancy:** Provides current data to support airlines in creating better decisions. Better flight planning, enhanced security, and improved resource management are all made achievable by this, and they all lead to more profitable and effective operations.

Scope and Boundary

The airline database system encompasses a broad range of functionalities designed to streamline operations, enhance security, and improve passenger and cargo management. The system's scope defines the core features included, while boundaries clarify what is outside the system's capabilities.

Scope (Included Features):

- **Passenger Booking & Check-in Management:** Passengers can book tickets, select seats, and check in via the system, reducing wait times and improving the boarding process.

- **Cargo Tracking, Including Multi-leg Shipments:** Enables real-time monitoring of cargo movements across different flights, ensuring accurate tracking for shipments requiring transfer flights.

- **Security Compliance Monitoring:** Implements access controls and logs system usage to track employee interactions and ensure adherence to industry regulations.

- **Automated Revenue and Audit Reporting:** Provides financial summaries of flight earnings, cargo revenue, and compliance audits, supporting airline decision-making and regulatory reporting.

Boundary (Excluded Features):

- **Aircraft Maintenance Tracking:** The system does not handle aircraft repair logs, engine diagnostics, or part replacements, as separate aviation maintenance systems manage these.

- **In-flight Services Management:** Catering, entertainment, and customer service provided during flights fall outside the system's scope, as they are typically managed by separate service modules.

- **Air Traffic Control (ATC) Coordination:** The system does not manage communications with ATC, as that is handled by specialized aviation traffic control software.

- **Third-party Travel Agency Integrations:** While passengers can book flights directly through the airline's system, the integration with external travel agencies or booking platforms is beyond this system's scope.

By defining clear boundaries, the system remains focused, efficient, and manageable, ensuring that core airline functions are streamlined without unnecessary complexity.

Mappings of Major user views and operations

- Based on the scope, we can divide the user group into the following categories.
- Passengers, Cargo Operators, Airline Staff, Security Officers, and Finance and Audit teams.
- The picture below shows the overview picture of the relationship between user groups and data. Each user group is compartmentalized to access data that are needed for their operation and transaction only.

Data/Users	Passengers	Airline Personnel	Security Officers	Finance and Audit team	Cargo Operators
Passengers Data	Read, write, modify, delete	Read, write, modify, delete	Read	No access	No access
Flight Data	Read (Limited)	Read, write, modify	Read	No access	Read
Reservation Data	Read, modify, delete	Read, write, modify, delete	Read, modify	Read (Limited)	No access
Aircraft Data	Read (limited)	Read, write, modify	Read	No access	Read
Cargo Data	No access	Read, write, modify, delete	Read, modify	Read (Audit only)	Read, write, modify, delete
Security Logs	No access	Read (Limited)	Read, write, modify, delete	No access	Read
Financial Data	No access	No access	No access	Read, write, modify, delete (Confidential)	No access

Users' Requirements Specification

Currently based on the previous section, we have identified users to be passengers, airline personnel, security officers, the Finance and Audit team, and Cargo Operators as a different group of users.

Data Requirements

The data requirements are different for each group of users because airlines have multiple users for different database access.

Passengers

Passenger name, gender, passport number, passport expiry date, date of birth, address, phone number, contact person, emergency contact, payment details, meal preference, seat preference, loyalty status, flight history, frequent flyer number, check-in status, baggage allowance.

Airline Personnel, Security Officers, Finance and Audit team, and Cargo Operators do share the common data in the following

Employee ID, Employee name, Employee nickname, Date of birth, Position, Department, Employment Status, Contact Number, email address, emergency contact, and access level.

But Security Officers, Finance and Audit team, and Cargo Operators have extension data in the following:

- **Security Officers**
  - shift schedule certification.
- **Finance and Audit team**
  - certification.
- **Cargo Operators**
  - shift schedule certification.

Transaction Requirements

The database must be able to handle basic operations such as insert, delete, update, and handle the look-up/search queries as well

Data Insertion or Data Entry

The insertion of data can be done in various ways,

- **Passengers**
  Passengers can insert their information into the passenger's database.
- **Airline Personnel**
  Airline personnel generally have most of the privilege to insert in most of the databases that exist, except the ones that are compartmentalized (Financial Data and Security Logs).
- **Security Officers**
  Security officers can only write in Security logs.
- **Finance and Audit team**
  The Finance and Audit team can only write into the Financial database.
- **Cargo Operators**
  Cargo operators can only write into the cargo database.

Data Deletion/Update

- **Passengers**
  Passengers can access delete and modify their information from the passenger's database, reservation database.
- **Airline Personnel**
  Airline Personnel can delete and modify data from the passenger database, Flight database, reservation database, and cargo database.
- **Security Officers**
  Security officers can delete and modify data from Security logs and can modify from the reservations database and cargo database.
- **Finance and Audit team**
  The Finance and Audit team can only delete and modify data from the finance database only.
- **Cargo Operators**
  Cargo operators can only delete and modify data from the cargo database.

Data Queries

To retrieve data and information from databases.

This picture shows an example of queries that typical airlines usually do.

Query Type	Example
Basic Lookup	Find all upcoming flights, passengers, and cargo
Aggregate Query	Count total passengers on a specific flight
Reporting Query	Monthly revenue from cargo shipments
Real-Time Query	Fetch current flight delays

Systems Requirements Specification

A lot of information in this section is referenced in the conversation with ChatGPT throughout several prompts. https://chatgpt.com/share/67a0687e-b80c-8000-a923-0e2f07e6beeb

Initial database size and Database growth

The typical number of passengers for Star Airlines each year is around 32 million based on this there are a lot of components in the database that the airline has to store.
This is an example estimation of database size that considers each component.

Component	Records per year	Avg. Record Size	Yearly Growth
Passenger Data	32 Million	5 KB	5-10%
Flight Data	200K	10 KB	3-5%
Cargo Data	2 Million shipments	15 KB	6-8%
Booking&Ticketing	30 Million bookings	8 KB	5-10%
Operational Data	1 Million entries	20 KB	5-8%
Crew & Employee Data	50K employee	10 KB	2-3%
Loyalty Program Data	10 Million members	7 KB	7-10%
Security & Compliance logs	500 Million bags	50 KB	8-15%

Based on ChatGPT's estimation:

- **Passenger Data:** 32M×5KB=160GB32M×5KB=160GB
- **Flight Data:** 200K×10KB=2GB200K×10KB=2GB
- **Cargo Data:** 2M×15KB=30GB2M×15KB=30GB
- **Booking & Ticketing:** 30M×8KB=240GB30M×8KB=240GB
- **Operational Data:** 1M×20KB=20GB1M×20KB=20GB
- **Crew & Employee Data:** 50K×10KB=0.5GB50K×10KB=0.5GB
- **Loyalty Program:** 10M×7KB=70GB10M×7KB=70GB
- **Security Logs:** 500M×50KB=25TB500M×50KB=25TB

Result in a total initial database size of 25.5 TB for the first year.
We agree with ChatGPT that at least in each year growth should be around 5-10%, so let's say that growth rate is 10% annually.
The size after 1 year would be 28 TB and the Size after 5 years would be around 41-45 TB.

Types and average number of records searches

Normal databases have two types of access: Online Transaction Processing (OLTP) for frequent, real-time operations and Online Analytical Processing (OLAP) for batch processing such as reporting and analytics. Typical Airlines do have both types because when talking about airlines, there are a lot of operations on a daily basis, so the amount of queries per day is a lot because flights are happening every hour somewhere around the world.

These are some typical access types.

Access Type	Examples	Frequency	Performance Needs
Read Operations	Flight status lookup, booking details retrieval	Very High (Millions/day)	Low Latency (<1s)
Write Operations	New bookings, passenger check-ins, flight logs	High (Thousands/sec)	High consistency
Update Operations	Passenger profile changes, seat upgrades	Medium (Millions/day)	Medium latency (1-3s)
Delete Operations	Ticket cancellations, GDPR data deletions	Low (Thousands/day)	Medium latency (3-5s)
Batch Processing	Revenue reports, loyalty program analytics	Low (Daily/Weekly)	High Throughput
Security & Compliance Logs	Login records, access logs, fraud detection	High (Millions/day)	High retention

Estimation of day-to-day operations

Operation Type	Estimated Queries per day
Passenger Bookings & Modifications	32 Million
Flight Lookups & Status Checks	~ 20 - 30 Million
Cargo Shipment Processing	~ 1 - 2 Million
Check-in & Boarding Pass Generation	10 Million booking
Loyalty Program Transactions	1 Million
Customer Support Requests	500 k
Flight Crew Schedules & Management	1 Million
Security Logs & Fraud Detection	50 Million

Networking and shared access requirements

The database is shared across multiple users and also integrated with different systems: The table below shows Stakeholders who are accessible to the database.

User group	Access Type	Access Method	Data Sensitivity
Passenger Data	Booking, Check-in	Web/Mobile, apps, kiosks	High (PII & payment)
Airline Staff	Scheduling, flight logs, duty hours	Secure VPNs, airline portals	Medium
Airport Authorities & Immigration	Passenger records, visa checks	API integrations, direct DB links	High
Partner Airlines	Shared ticketing, baggage handling	API integrations	Medium
Travel Agent	Flight availability, ticket bookings	B2B APIs	Medium
Cargo Handlers & customs	Shipment tracking, manifest data	Secure portals, EDI (Electronic Data Interchange)	High
Regulatory Bodies (ICAO, IATA, FAA)	Compliance audits, security logs	Secure data transfers	High

The network is also an important system because Star Airways does have multiple regions and offices, but databases must be able to share and sync across regions and offices.
The below table is an example of a hybrid model(multi-region cloud and on-prem) that ChatGPT has suggested.

Region	**Primary Data Center**	**Failover Site**	**Latency Considerations**
North America	AWS US-East	Google Cloud US-Central	Under 100ms
Europe	Azure Germany	AWS UK	Under 50ms
Middle East	Azure UAE	AWS Bahrain	Under 50 ms
Asia-Pacific	Google Cloud Singapore	Azure India	Under 80ms
Latin America	AWS Brazil	Azure Chile	Under 120ms

Performance

The database must have high availability (99.999%), handle the high volume of concurrent requests, handle multiple-point/region access, and have the ability to load balancing during peak hours.

ChatGPT suggested that to gain higher efficiency, the administrator who oversees the server should use hybrid database architecture, implement caching (Redis) for frequently accessed data, and use asynchronous processing for batch operations.

Security

Security involves compliance with data protection laws and regulations such as PDPA (Thailand) and GDPR (Europe) to ensure the confidentiality of personal information of customers and employees. Also, another important side is access control. Databases have to be accessed by people who have been granted access only which introduces us to role-based access models that are widely used in this similar situation and the database should be protected by password and two-authentications.

Backup

The backup schedule should mainly be divided into two parts: daily backup and whole system backup.
Daily backup is for traditional day-to-day operations.
The whole system backup is in case of a ransomware attack, cybersecurity attack, and system-wide outage.

Recovery

There are multiple recovery strategies (Nayak, 2023), but the strategies that are suitable for the airline industry the most are parallel recovery and Point-in-Time Recovery because these two strategies are capable of handling events such as deletion of data accidentally and it does have the ability to recover fast.

Legal issues

Of course, when we talk about data, companies must follow laws such as PDPA (Thailand) and GDPR (Europe).

Here's the difference between GDPR and PDPA.

Aspect	**GDPR(EU)**	**PDPA (Thailand)**
Applied To	Any company processing EU citizens' data	Any company processing Thai citizens' data
Consent standard	Explicit, opt-in for sensitive data	Explicit, opt-in for all data
Right to Erasure	Customers can request full deletion	Customers can request deletion, but exceptions exist
Data Breach Notification	72-hour reporting deadline	72-hour reporting deadline
Penalties	Up to 4% of global revenue	Up to THB 5M (~$150K) + possible jail time
International Transfers	Strict Standard Contractual Clauses (SCCs) needed	Must comply with PDPC guidelines

Another important regulation is from ICAO, IATA, FAA, and CAA, these authorities are regulators of Civil Aviation around the world.
The following pictures are results from ChatGPT when prompted with “another regulator, from the aviation side, what are there? that is not just data control” by the GPT-4o on February 3rd.

This picture represents well-known organizations that regulate civil aviation.

Regulators	**Jurisdiction**	**Key Responsibilities**
ICAO (International Civil Aviation Organization)	Global(un agency)	Sets global aviation safety and security standards (Chicago Convention).
IATA (International Air Transport Association)	Global (airline industry)	Supports commercial airline operations, ticketing, and cargo management.
FAA (Federal Aviation Administration)	USA	Regulates flight safety, aircraft certification, and pilot licensing.
EASA (European Union Aviation Safety Agency)	EU	Aircraft certification, maintenance regulations, and airworthiness standards.
CAAT (The Civil Aviation Authority of Thailand	Thailand	Manages airspace safety and airline operations in Thailand.
GCAA (General Civil Aviation Authority)	UAE	Regulates airlines in the UAE.

References

Nayak, S. (2023, May 3). *Database backup and recovery techniques*. Medium. Retrieved February 3, 2025, from https://medium.com/@shruti.nayak20/database-backup-and-recovery-techniques-c541faf3444a

ChatGPT. (GPT-4). OpenAI. Database design project February 2, 2025, from https://chatgpt.com/share/67a3655c-14f4-8001-9e95-df5d22da5594