# Table of Contents

[Problem and Solution 1](#_Toc102810378)

[Problem 1](#_Toc102810379)

[Problem statement 1](#_Toc102810380)

[Solution 2](#_Toc102810381)

[Solution strategy 2](#_Toc102810382)

# Problem and Solution

## Problem

### Problem statement

People find boarding a flight annoying because they must wait in long queues to manually verify their identity. What if we could make the process more organic and seamless? And with no lines.

(**What**) The objective is to create a contactless kiosk system that automatically validates passengers for a specific flight. People just walk to their gate and board.

Business Considerations (**Why**) Automation will make boarding easy, fast, and hassle-free. This would contribute to a more pleasant flying experience.

Technical Requirements (**How**)

* Passenger ID (e.g., passport) identification to establish identity
* Facial recognition to identify the passenger to enable a virtual profile
* Object identification system to identify if passengers have prohibited items in luggage
* Digital asset management to manage all data generation, collection, and storage
* Managing the entrance and exit of the secured area of the airport
* Managing social distancing protocol during covid pandemic
* Handling passenger data privacy & security and ensuring Responsible AI

## Solution

### Solution strategy

Currently, verification is a manual process. Passengers must stand in long queues. Our solution is a contactless system that automatically verifies if someone can board a flight. The automated boarding kiosk uses several Azure Cognitive Services, including Computer Vision, Face, Video Analyzer/Indexer and Form Recognizer to complete identity validation.

#### Solution Strategy Walkthrough

The goal of this solution is to make the passenger’s experiences as hassle-free, easy, fast as possible. The process beings once a passengers crosses the security gate into the passenger and staff only zones.

##### Some basic information

* Passengers can begin their boarding verification at any point, once they are in the secured zone.
* Camaras around the entrance of the secured zone take images of passengers.
  + Use Azure Computer Vision to analyze video from airport entrance cameras in real time to set up the passenger’s current profile. This information is fed into the Passenger Schema in a key-value semi-structured storage system.
    - The profile is valid only while passengers are within the secured zone.
      * Ethical and Responsible AI considerations: As soon as they leave this zone (either by boarding a plane or exiting to an unsecured part of the airport) their profile is disabled. If they return, they must begin the process again.
  + Video Analyzer/Indexer creates thumbnails of the passenger’s face which goes into the Face Schema.
  + With asynchronous programming, use Azure Computer Vision’s Image understanding to generate image descriptions of a passenger’s basic appearance e.g., color of clothing, glasses, masks and other visual assets and objects to help identify the passenger. Azure Video Analyzer can help to extract information about brand of clothing, luggage, etc. to add to the passenger’s profile. They may provide speech information for language identification.
* For boarding verification to begin, passengers need a minimum of two items: A government issued ID (e.g., a passport) and a boarding pass (physical or virtual e.g., in the form of a QR code). Optional items like a booking reference can be helpful if validation fails.
* After security has cleared the passengers to enter the flying zone, they can scan their IDs on any LCD screen in the secured zone.
  + We use the Face API to analyse the face in the ID. The information is fed into a Face Schema.
  + Face recognition technology establishes their identity
    - Once identity is established, more information is added into the Passenger schemas.
* Now, the validation process can begin. Note: the passenger are also informed that they can keep moving while data is being process (because they can access updated information at any other LCD panel).
  + Information from the Passenger schema is used to find the passenger in a Carrier’s Boarding schema and to continue the multi-step verification processes.
  + If validation passes (i.e., the passenger’s profile is successfully mapped to a boarding schema:
    - Now, passengers can get both general information about their flight and specific information like class and seat number.
      * Use text extraction to extract passenger’s boarding information from the airport’s boarding schema based on profile details and display on the screen.
      * This information is processed only once and saved for future use (while the passenger’s profile is active).
  + If the system fails to find boarding details for the passenger:
    - A message will invite the passenger to re-scan a boarding pass or enter a booking reference (if the passenger doesn’t have a physical boarding pass).
    - Use text extraction to get information about passengers (from their booking information).
    - Re-establish the link between the passenger’s profile and boarding information.
    - Now, the information can be displayed on any LCD screen the passenger stops in front of.
  + If validation is still unsuccessful, a message will direct the passenger to a live agent.
* As validated passengers move through the secured zone:
  + LCD screens along the way will provide information about a passenger’s current location relative to gate destination, and offer suggestions on the quickest, least congested routes. Passengers will see up-to-date boarding information such as if/when physically boarding will start for their section of the plane and if/when the entrance way is free (or uncongested). Passengers can see how much time they have left to board.
  + Scanning strips along the floors will scan passengers and their luggage for prohibited items
* The goal is that passengers arrive at their gate ready to fly:
  + The facial recognition system will re-identify the passenger once again.
  + Sensors at the passenger’s gate will disable to allow that passenger to board. The boarding Kiosk at the plane entrance will show their seat number and a warm message, to have a safe and pleasant flight.
* If unvalidated passengers enter the boarding area or approach the plane’s entrance, red LED lights in the proximity will flash to warn them.
* While passengers are inside the airport, cameras use live-video feedback to continuously collect customer sentiment and experience information.

#### Entities, Data and Schemas

##### Entities

List of entities: Passenger, Airport, Plane, Luggage

Attributes: Name, Booking reference created when a person books a flight, flying class, luggage details (count, size, weight), flying experience represented by the passenger's sentiment rating while in the airport.

**Some relationships between among the entities:**

* The airport will have planes. Planes will have passenger seats.
* The passenger face validates their identity and links them to a flight booking.
* The passenger will have a virtual boarding pass. The boarding pass will have a gate for the flight and a seat number for the passenger.

##### Data-specific considerations

**Data Input sources**

* Airport Cameras. There will be cameras at the airport entrance to collect face identity data.
* LCD screens. There will be screen all over the airport. They could collect extra face information. Passengers can scan their IDs and boarding passes or enter their unique booking reference. The screens could collect sentiment data every time a passenger stopped to interact the screen e.g., to get information about their flight time, gate number, etc.
* Object sensors. The airport floors will have sensors to weigh and scan luggage for prohibited items.

Some ideas about how data flows:

* Passenger flight booking: Passengers pay for a flight with a carrier. The carrier collects their personal information, facial identity information, payment information, contact details, etc and generates a booking reference (key-value pair) to the flight.
* Airport setup: The airport has boarding areas and gates for various carriers and their airplanes. There is shopping, restaurants and lounges to entertain travellers.
* Passenger boarding: Passengers will arrive at the airport and board their plane at a specific gate.
* Passenger flying experience: LCD screens will collect and add experience data as passengers located their gate and board their planes.

##### Schema

The schema shows how entities e.g., passengers, various airports, different planes, etc. are connected.

Face schema.

Passenger schema. With unstructured data stored in Azure Blog Storage using key-value pair, where a booking reference can serve as the unique key and various passenger information collected in the value set.

Boarding schema. the structured flight details and validation information stored in Azure SQL Database

#### Other consideration:

Data outputs facilities would help to display information to passengers, e.g., LCD panels all over the airport, intercom announcement system, visual flashes to notify passengers when they enter the wrong zone, offline notification through email/SMS, mobile app updates if they sign up for the airport app.

Data Validation: The information filled out by passengers for their booking is compared against the information on their ID. For performance metrics and threshold, we expect a precision of at least 75% to the prohibited Object Identification

How to verify if a passenger can board the flight e.g., The first and last name extracted from the boarding pass and ID card must match with the name in the Boarding schema.