Unveiling Airport Potential: A Simulation-Based Study of Felipe Angeles Airport's Capacity in Mexico City

Author(s)
Mota, Miguel; Di Bernardi, Alejandro; Orozco, Angel

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Introduction

The Felipe Ángeles International Airport (NLU) opened on March 21, 2022, to alleviate congestion at Mexico City's Benito Juárez International Airport (MEX), which has been declared saturated [8] by the local government[. Additionally, the Mexican government aims to develop a comprehensive multi-airport system [6][7], within the metropolitan region of Mexico City. This system includes the new NLU airport, as well as the existing Toluca International Airport (TLC) and Benito Juárez International Airport (MEX).

This paper presents a study that investigates the practical limitations and evaluates the performance indicators of the capacity [10] of the Felipe Ángeles Airport terminal. The facility has been designed for progressive expansion according to demand. Currently, the system appears to be over-dimensioned; however, it is beneficial for all stakeholders to identify potential future problems. Therefore, the authors used simulation models to generate synthetic data and evaluate the turning points when the system reaches its limits. This approach provides timely warnings for airport operators, helping to avoid problems for passengers and stakeholders.

The approach consists of a simulation framework [9] composed of different layers of knowledge that together create a realistic model to assess the current situation and predict future scenarios accurately.

We considered different scenarios, using the 2024 scenario as a baseline to evaluate the current capacity and demand issues. Based on expected growth, we generated new scenarios for each subsequent year until 2028 to identify the turning point of capacity limitations.

Current Situation of 2024

NLU features three runways: two runways, each 4,500 meters long, designated for commercial use, and one runway, 3,500 meters long, designated for military use [3] . This runway configuration allows NLU to perform simultaneous operations for commercial traffic. Figure 1 illustrates the airside of the airport.

Figure 1 – Aerial view of NLU

Passengers of the commercial operations are directed to the terminal building, as illustrated in Figure 2. This building represents the first of four planned expansion phases outlined in the airport's Master Plan. The terminal is designed to expand in response to increasing demand, ensuring that capacity aligns with passenger needs. Currently, the terminal handles approximately 56 departures per day, accommodating around 5.2 million passengers annually. Future development plans aim for the terminal to support over 100 million passengers per year. Once this capacity is reached, a mirror-image terminal will be constructed on the opposite side of the current one to further increase capacity.

Figure 2 – Aerial view of NLU’s Terminal Building

The characteristics of the current terminal are summarized in Table 1.

Table 1-Airport Felipe Angeles Characteristics (May 2024)

	Totals
Total Area	5410 SQM
Passenger entrance	4
CheckIn Islands	12
Check In Desks	330 (estimated)
Security Points (Operational)	14
Operation	Domestic & international
Number Gates	34
Departing Flights (17 May 2024)	56

The data presented in Table 1 is a combination of official information and original research conducted by the authors. These values, specifically considered for May 17, 2024, were used to model the terminal building. It is important to note that passenger flow is segregated between domestic and international travelers. Currently, most passengers are processed in the domestic area, utilizing only 7 out of the 14 available security checkpoints and a portion of the total check-in desks available in the terminal.

Methodology

The methodology employed in this study is based on the framework devised by Mujica et al. [4]. This approach integrates various knowledge layers to construct the final model. For the study of NLU, we combined a layer containing information about the distances and locations of the infrastructure. On top of this, we incorporated a logistic model that includes the logic and sequence of processes, as well as the flow of passengers within the terminal. The input for this framework is the demand, or the number of expected passengers, for the year under study. We made certain assumptions based on experience to simulate passenger processing times, walking speeds, and processing times at check-in and security. Figure 3 illustrates the general methodology developed for the current study.

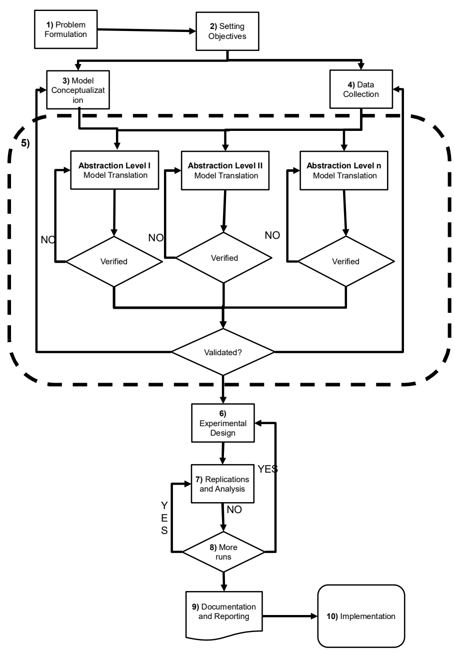

Figure 3 – Aerial view of NLU's Terminal Building

For the model translation we used a propietiary library coded in SIMIO [11]; and flight information was collected from FlightRadar24 [2] and the airports' official webpages to identify what type of equipment was the most used in the operation and which airlines are currently operations . The following section presents the assumptions used for the framework.

Terminal Building Model

As previously mentioned, the Terminal building model was developed following the aforementioned framework. We utilized terminal charts to ascertain the physical characteristics and locations of various facilities. Atop this layer, we integrated a network model to simulate the sequential processes within the terminal, spanning from the curbside to the gates. Several assumptions were made in this process, detailed in Table 2.

Table 2-Airport Felipe Angeles Model Assumptions

Item	Value used
Passenger entrance	4
CheckIn Islands Active	2
Check In Desks	21
Security Points (Operational)	7
Operation	Domestic
Number Gates	12
Departing Flights (17 May 2024)	56
CheckIn Processing Time (AVG)	45 sec
Sec Screening (AVG)	55 sec
Frequency of Departing Flights	1 hr
Pax Speed	Range (0.6 – 1.1) m/s
Logic	Dom Sequential Process: Entrance-Hall – CheckIn –Dwell Time – Security – Departing Gate
Companions	1
Dwell Time	15 min before goto Gate

Using the provided values, we constructed the model. Figure 4 depicts the resulting model.

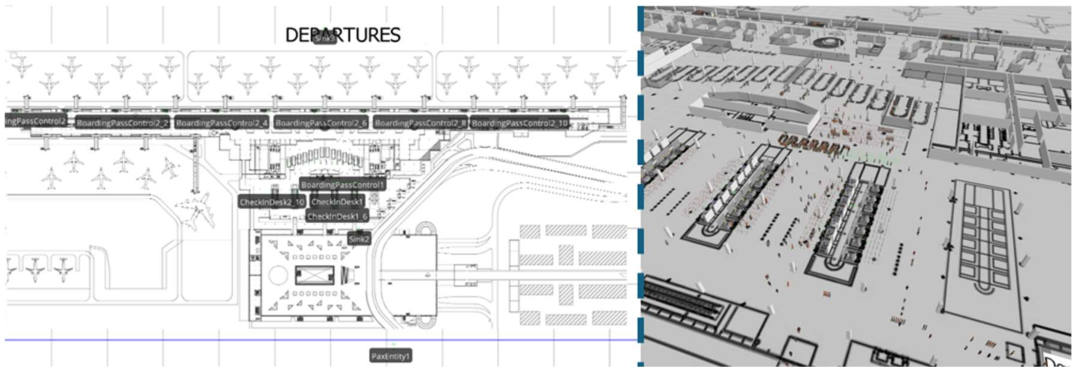

Figure 4 – NLU Simulation Model

Experiment Results and Analysis

We conducted an initial experimental design, taking into account an annual growth increment of 50%, which represents the yearly growth of the airport. The primary assumption is that AIFA will grow at a rate of 50% over the next five years. Notably, in January 2024, the growth surged by 82% compared to January 2022 [5]. To maintain a conservative approach, the authors opted for a 50% growth rate estimate for the next five years, and the model was executed based on this value.

As previously stated, a key assumption underlying our study is that the airport operator maintains the current configuration of the terminal, including the number of security lines and the segregation of passengers into domestic and international areas. Figure 5 depicts the evolution of the level of service in the check-in area, identified as one of the potential hotspots within the terminal.

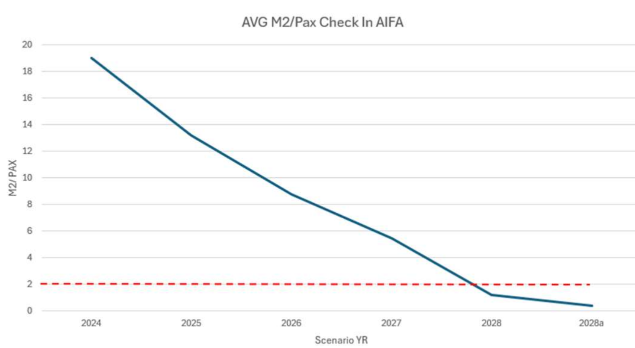

Figure 5 – Evolution of Level of Service at CheckIn

The red line in the graph represents the threshold considered as a good level of service according to IATA standards. It serves as a benchmark to identify the turning point when the system may require expansion or intervention to alleviate congestion. Notably, concerning the check-in area, it has been observed that ample space is available, making it relatively easy to alleviate congestion by opening more check-in counters for processing additional passengers.

However, a more challenging situation may arise in the case of security. Figure 6 illustrates the evolution of the level of service in the security lines. It is pertinent to note that by 2028, the level of service has deteriorated to a critical level.

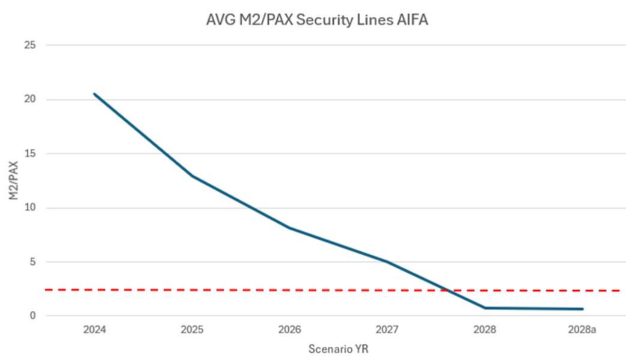

Figure 6 – Evolution of Level of Service at Security

Between 2027 and 2028, congestion issues may arise in the security areas due to insufficient security lines. This observation is significant, as evidenced by the graphs illustrating the results of the analysis. It is important to note that currently, AIFA has ample capacity. However, with the growth rate considered in the study, the years from 2024 to 2027 present no major problems in processing passengers under the current operational assumptions.

Nevertheless, by 2028, significant challenges emerge as the level of service deteriorates markedly. An additional simulation conducted for the second quarter of 2028 reveals that, under existing conditions, operational collapse is a real possibility.

Conclusions

This study presents a simulation-based analysis of the terminal building capacity at Felipe Angeles International Airport, located in Mexico City. This airport was established to alleviate congestion at the old Mexico City Airport (AICM). Given that the airport is not currently operating at full capacity, the objective of this study was to stress-test the system to determine when it might encounter operational difficulties under existing conditions, signaling the need for infrastructure expansion to accommodate growing demand and ensure the smooth functioning of the airport for passengers and stakeholders.

The results indicate that the airport has sufficient capacity to accommodate up to 9 million passengers until the year 2027. However, by 2028, when an influx of 13 million passengers is expected, proactive measures will be necessary to advance to the next stage of infrastructure expansion, as per the airport's progressive design, to manage the increased demand effectively and prevent disruptions for passengers and stakeholders

It is important to note that this study assumes static operational conditions, including a fixed number of check-in lines, security procedures, and processing times. While the findings serve as a foundation for identifying potential limitations, the dynamic nature of airports allows for adjustments to be made before problems arise. Future research will involve field studies to calibrate model parameters and incorporate variables such as a higher percentage of passengers using self-check-in, which may impact system performance.

The methodology presented in this study can serve as a valuable tool for establishing baseline criteria for action in the event that the airport system is not managed dynamically. The authors strongly advocate for its use in assessing the impact of new technologies or expansions to anticipate system behavior and performance effectively.

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