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

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IX Iberoamerican Air Transportation Research Society International Congress

"The Resilience and Sustainability of Air Transportation."

IX Congresso Internacional da Sociedade Ibero-americana de Pesquisa em Transporte Aéreo

"A Resiliência e a Sustentabilidade do Transporte Aéreo".

IX Congreso Internacional de la Red Iberoamericana de Investigación en Transporte Aéreo.

"La resiliencia y la sostenibilidad del transporte aéreo"

RIDITA 2024

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Lisboa (Portugal), June 27-29, 2024

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¬ PREAMBULE

Pasión es la palabra que reúne a los que conformamos la Red Iberoamericana de Investigación en Transporte Aéreo. Quizás sea por nuestro origen latino y por este entrañable lazo que la península ibérica ha tendido con el continente americano o viceversa. El transporte aéreo es de las actividades más complejas y fascinantes con las que aún hoy cuenta la humanidad. Y eso se debe al imponente avance tecnológico, de servicio, de seguridad y de mejora en la calidad de vida. Se debe también a buscar la tan deseada sostenibilidad junto a recursos humanos altamente calificados.

Cómo investigadores, siempre debemos preguntarnos ¿Qué nos duele? Porque el dolor despierta la reacción y los deseos de superación. El mayor aporte que un investigador puede hacer a la sociedad es hacerla reflexionar. Y las hipótesis deben estar a la altura de la importancia del transporte aéreo.

La RIDITA es una sociedad de conocimiento madura que busca nuevos horizontes. Somos el mejor agente de cambio para que los sectores público y privado puedan diseñar sus estrategias, cada cual con sus propios intereses, pero a la vez articularlas por el bien común. Debemos asegurar el rigor científico para que los cambios siempre necesarios repercutan positivamente en la sociedad en general, en la sociedad en su conjunto.

Fundada en el año 2007, la RIDITA hoy cuenta con casi 300 socios en más de 25 países. En lo personal estoy orgulloso por lo conseguido y expectante por lo que vendrá, Lisboa sin duda es el lugar elegido para un nuevo protagonismo de esta Red en el escenario mundial de la aviación.

Este libro de actas contiene valiosos artículos, de gran aporte. Mis sinceras felicitaciones a cada uno de los autores por su entrega, por su pasión. Invito a todos a leer estos trabajos y que estos aportes sean adoptados para tender nuevas redes y lograr cambios.

Bienvenidos al IX Congreso.
Bienvenidos a una nueva RIDITA.

Daniel Montero Ferreiro
Presidente de la RIDITA 2019 - 2024

We are delighted to extend our warmest welcome to all participants of the IX Iberoamerican Air Transportation Research Society International Congress, jointly organized by ISEC Lisboa, UBI, and IST. This esteemed gathering, dedicated to exploring "The Resilience and Sustainability of Air Transportation," promises to be an enriching and thought-provoking event.

From June 27th to 29th, 2024, esteemed researchers, academics, and industry professionals from around the globe will converge in the vibrant city of Lisbon to engage in discussions, share insights, and foster collaborations aimed at advancing our understanding of the challenges and opportunities facing the air transportation industry.

At the heart of this congress lies a crucial theme: The Resilience and Sustainability of Air Transportation. In an era marked by unprecedented global challenges, it is imperative that we examine the resilience of air transport systems and explore strategies to ensure their long-term sustainability in the face of evolving environmental, economic, and societal factors.

Through a series of keynote speeches, panel discussions, paper presentations, and workshops, this congress seeks to facilitate meaningful dialogue and knowledge exchange on a wide range of topics, including but not limited to aviation safety, infrastructure development, regulatory frameworks, emerging technologies, and the societal impacts of air transportation.

We extend our deepest gratitude to all participants, sponsors, and partners whose contributions have made this congress possible. Together, let us embark on a journey of discovery, innovation, and collaboration as we strive to shape the future of air transportation for the benefit of society.

We look forward to welcoming you to Lisbon for what promises to be an inspiring and transformative congress.

Sincerely,

Maria Emília da Silva Baltazar
Jorge Miguel dos Reis Silva
Vasco Reis

IX Iberoamerican Air Transportation Research Society International Congress
Organizing Committee

¬ INTRODUCTION

The congress endeavours to foster the advancement and diffusion of air transport research within the Ibero-American region, encompassing its scientific, academic, technological, applied, and informative dimensions. It seeks to cultivate connections among members through scientific sessions, digital platforms, and analogous gatherings. Special emphasis is placed on nurturing cultural appreciation for air transport research and enhancing its educational aspects, thereby serving as a hub for information exchange and dissemination among stakeholders.

¬ CONGRESS TOPICS

A. Aircrafts
   - A.1. Aerospace and Aeronautical Engineering
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   - A.3. Others

B. Air Industry
   - B.1. Air Transportation and Management Engineering
   - B.2. Sustainable Aviation
   - B.3. Others

C. Airports
   - C.1. Airports Operation and Management
   - C.2. Emerging Technologies
   - C.3. Others

D. Air Space
   - D.1. Aerial Mobility & Autonomous Flight Systems
   - D.2. Navigation, Guidance and Control
   - D.3. Others

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

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Abstract/Resumo/Resumen

The capacity of the newly inaugurated airport terminal in Mexico City, opened in 2022, has sparked debates regarding its adequacy to accommodate future demand. To address this critical question, our study employs simulation-based analysis to assess the terminal's true potential. By simulating various scenarios, we aim to provide insights into its capacity to handle increasing passenger loads over the coming years and decades. Furthermore, our analysis identifies potential challenges and issues that may arise with the terminal's growth. This research seeks to offer valuable perspectives for stakeholders involved in the airport's planning and management, contributing to informed decision-making in ensuring efficient and sustainable aviation infrastructure.

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

1. 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.

2. 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.

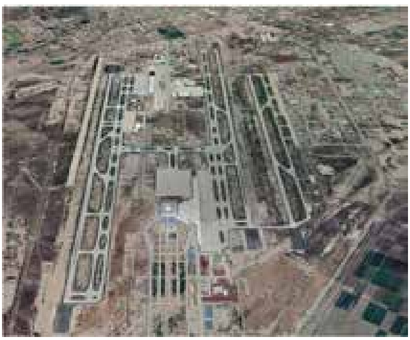

Figure 1 – Aerial view of NLU

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.

3. 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.

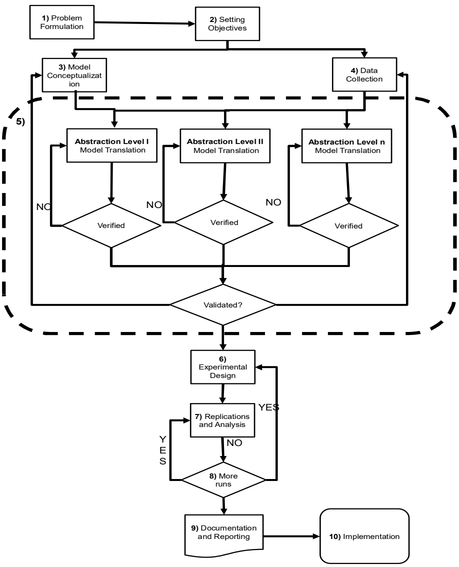

Figure 3 – Aerial view of NLU's Terminal Building

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.

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3.1. 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.

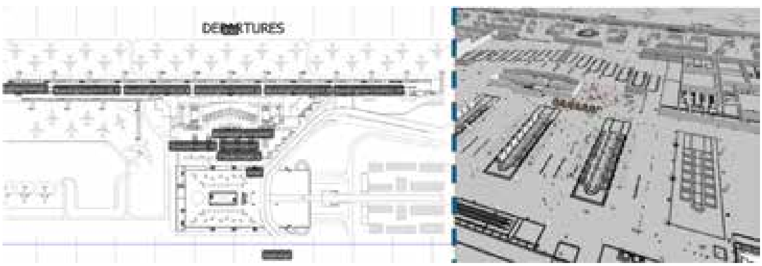

Figure 4 – NLU Simulation Model

4. 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.

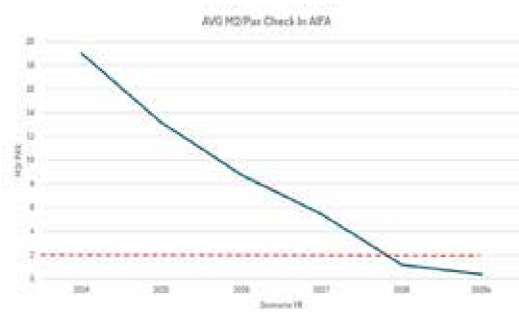

Figure 5 – Evolution of Level of Service at CheckIn

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.

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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.

5. 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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