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Analysing capacity challenges in the Multi-Airport System of Mexico City

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Abstract

The relentless growth in Mexico City's aviation traffic has inevitably strained capacity development of its airport, raising the dilemma between the possible solutions. In the present study, Mexico's Multi-Airport System is subjected to analysis by means of multi-model simulation, focusing on the capacity-demand problem of the system. The methodology combines phases of modelling, data collection, simulation, experimental design, and analysis. Drawing a distinction from previous works involving two-airport systems. It also explores the challenges raised by the Covid-19 pandemic in Mexico City airport operations, with a discrete-event simulation model of a multi-airport system composed by three airports (MEX, TLC, and the new airport NLU). The study is including the latest data of flights, infrastructures, and layout collected in 2021. Therefore, the paper aims to answer to the question of whether the system will be able to cope with the expected demand in a short-, medium-, and long-term by simulating three future scenarios based on aviation forecasts. The study reveals potential limitations of the system as time evolves and the feasibility of a joint operation to absorb the demand in such a big region like Mexico City.

Keywords: Multi-Airport System; simulation; airfield capacity; traffic congestion.

1. Introduction

Mexico City airport has become the busiest airport in the country, leading to capacity problems that arose the dilemma between building a new airport or expanding the existing one; unfortunately, due to the limitations of the current one, the expansion solution is not feasible anymore. For that reason, the Mexican government constructed a new one from scratch. Airport Felipe Angeles (NLU) has been opened on 21 March of 2022 to alleviate the congestion problems in the airport of Mexico City (MEX).

Furthermore, with the new one, the govern of Mexico is aiming at developing a proper multi-airport system composed by the new airport (NLU) and the two old ones within the metropolitan region of Mexico City, Toluca (TLC) and the airport of Mexico City (MEX).

This paper presents a study that investigates the practical limitations and performance indicators of the capacity of the multi-airport system of Mexico City. The approach developed a simulation framework composed by the three airports formed by MEX, TLC and NLU. For that purpose, different scenarios are designed according to the expected commercial and cargo flight traffic, airline business models, and aircraft equipment. We proposed different potential scenarios of development to evaluate what the limitations will be and where are opportunities for alleviate the congestion at MEX.

Three future scenarios are proposed, modifying the model accordingly to the NLU project phase development. The 2021 scenario is taken as a baseline, where the current capacity and demand problem is evaluated. Then a 2025 Scenario is considered followed by a final one at year 2035.

A review of flight demand forecasts - before COVID-19 - is also considered, giving a global view of the expected growth before the pandemic.

Some publications from agencies (ICAO, 2018) estimate that global passenger traffic is expected to grow at 4.2% annually from 2018 to 2038. Nevertheless, due to Covid-19 the estimation has dropped. An analysis published by ICAO (2021) - considering factors like economic recession, potential resilience, or speed of recovery of the countries - conclude that full recovery to return to 2019 levels is not expected until 2024.

In this study a scenario design was developed considering actual forecasts of annual growth rate of flight demand, both in Mexico and at a global scale, to calculate the number of additional flights when the demand is evolving.

Simulation was selected as the appropriate tool for the study. Firstly, because the operations performed by the aviation sector are based on schedule and secondly, because the inherent variability of the system makes simulation an ideal approach.

Flight information is provided in tables with the corresponding arriving and outgoing connections, including information about the airline, aircraft type, arrival time and destination. Specific data of aircrafts and airports is employed to design in an accurate model logic, and the airline data is taken into consideration for statistical purposes. This way, flights are generated in the model according to the arrival time to the airport, triggering the events that characterize the simulation.

The paper continues as follows, section 2 presents the state of the art with regards to multi-airport systems, section 3 introduces the methodology; section 4 presents the experimental design and results the experimental design and section 5 concludes and give future lines of research.

2. State of the art

Works on Multi-Airport Systems are relatively novel. The seminal paper of De Neufville and Odoni (1995) introduced and defined the concept of multi-airport system (MAS) as: "the set of significant airports that serve commercial transport in a metropolitan region, without regard to ownership or political control of the individual airports". MAS constitute a sizable segment of the airport industry, around 80% of the worldwide traffic and can be found in the busiest metropolitan areas of the globe.

According to De Neufville et al., (2013) the main difficulties in developing a MAS include "insufficient traffic at a new airport and in the overall system, difficulty in closing an old airport, the volatility of traffic at the secondary airports and the changing nature of customers". The paper of Martin and Voltes-Dorta (2011) provides some caution for the development and use of MAS. They suggest, considering a financial approach, that some MAS worldwide are operating inefficiently and that the consolidation of air traffic of the whole MAS into one airport could provide a better performance regarding operating costs. Furthermore, De Luca. (2012) and Yang et al. (2016) suggested that the viability of a MAS is intertwined with the development of other transport infrastructure, such as, railways, roads, and bus services, so that customers of the MAS could have accessible options to use any of the airports in the system and change their initial preference regarding the principal airport. Regarding the issue of airport selection, the subject of the main factors involved influencing selection among customers has been extensively studied using statistical methods (Hess and Polak, 2005; Loo, 2008; Ishii et al., 2009; Marcucci and Gatta, 2011; de Luca, 2012; Fuellhart et al., 2013; Nesset and Helgesen, 2014). These papers found that air fare, access time, flight frequency, the number of airlines and the availability of airport–airline combinations were statistically significant factors in customer choice of airport. Interestingly, airport access time was found to be more important for business travellers than for leisure travellers. In contrast, leisure travellers were found to be more sensitive to price changes than business travellers. The specific issue of multi-airport capacity has been studied before by Ramanujam and Balakrishnan (2009). The study of them focuses on the definition of capacity envelopes for the MAS of NYC, based on Gilbo (1993) proposal. Using quantile regression and historical data, they modelled the relation between arrival and departure rates at singular airports considering the arrival rate as the independent variable, as arrivals are given priority over departures at singular airports. In this paper, special attention is paid to the traffic evolution, since Mexico City is the busiest airport in the country and the effect of COVID-19 pandemic on flight demand is wreaking havoc.

For the analysis of multi-airport planning and design, the authors have had previous efforts where they consider only a bi-airport system (NLU-MEX), and they validated the feasibility of the operation at Mexico City (Mujica, 2018) and also Mujica et al. (2019). On this regard, the current study goes one step beyond by considering the current demand and including TLC airport in the model to have a more accurate view of the potential of the multi-airport system of Mexico City.

3. Methodology

The methodology followed in this study, is the one devised by Mujica et al. (2018), illustrated with an example of two models for an expansion project in The Netherlands. In this case, the concept of the multi-model framework is translated by using a combination of models using SIMIO program. Figure 1 illustrates the general methodology developed for the current study.

Once the objective was identified, a level of abstraction for the three airports forming the system was specified. This stage was followed by the data collection. Flight information was collected from FlightRadar24 (2021a & 2021b) and the airports' official webpages. In this case several layers of models were developed; one consisted of a low-level model of MEX that considers in high detail the runway system operation and the complete airside of the airport. Another layer is composed by a high-level model of NLU considering the capacity estimated for the different stages of development, particularly the runway system capacity and the gate capacity. The last one is the model of TLC which similarly to NLU is a high-level model that considers the current gate capacity and runway capacity to evaluate its limitations.

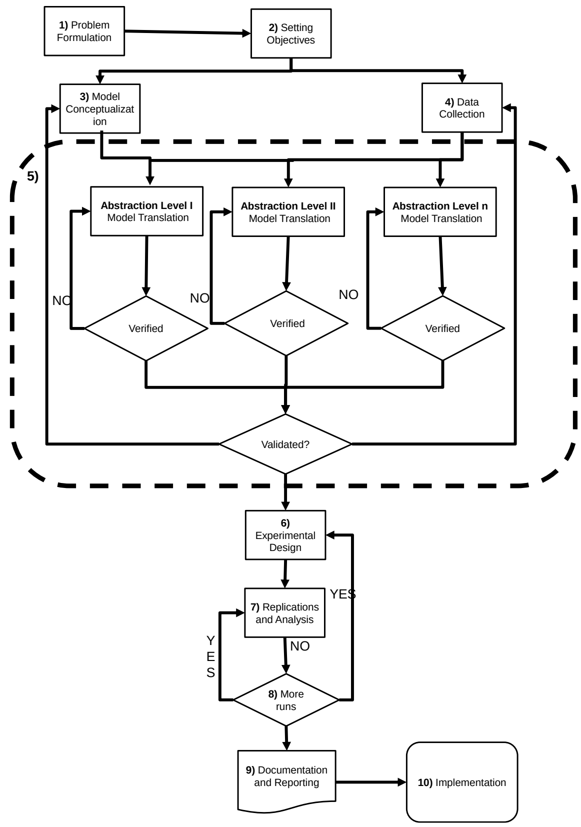

Figure 1. Methodology of the n-model virtual cycle approach for airport capacity

3.1. Simulation model: multi-Airport system layout

The Metropolitan Area of Mexico City is the area served currently by Mexico City International Airport (MEX) and the surrounding airports of Toluca (TLC) and now Felipe Angeles Airport (NLU). Figure 2 illustrates the metropolitan area of Mexico City with the MAS for the region.

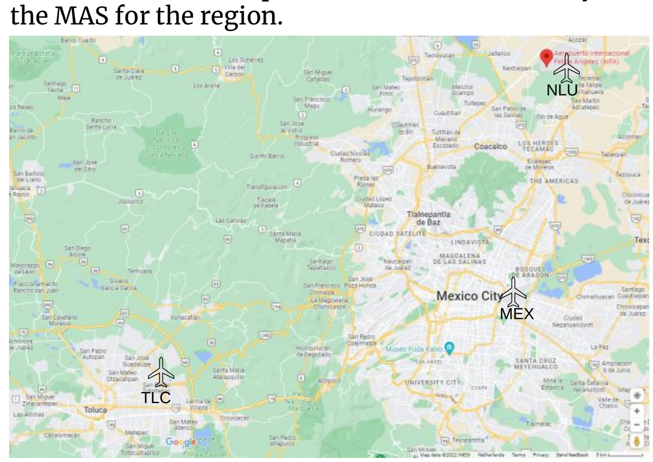

Figure 2. Multi-airport system of Mexico City

With the use of the methodology presented, a framework composed of three sub-models (NLU-TLC_MEX) was developed. The models were verified and validated and in turn we developed an experimental design to get insight related to the capacity of the system for three different time horizons.

3.1.1. Mexico City International Airport (MEX) model

MEX is composed by Terminal 1 (with 33 contact and 17 remote positions) and Terminal 2 (23 contact and 18 remote positions), operating with domestic and international commercial carriers and handling aircrafts ranging from A320s to A380. Two Code E runways of 3900 m (05R/23L) and 3952 m (05L/23L) enable the maximum theoretical capacity of the system to be of 61 ATM/h.

The model of MEX implemented is a detailed low-level model, where the elements that conform the airport are represented as a network of nodes and edges where the properties are configured to simulate their behaviour in the system. For instance, each of the 96 gates are represented as a server in which the processing time and aircraft capacity is specified, or runways and taxiways are represented with nodes and edges also.

Figure 3. Airside model of Mexico City airport

3.1.2. International Airport of Toluca (TLC)

The existing secondary airport of the MAS (TLC) has a single runway of 4310 m, the largest in Mexico so far, and a single L shaped terminal with 12 gates. When it comes to cargo, the airports cargo area is mainly controlled by FedEx, and it is located at the southern side of the runway. This airport was modelled as a network of capacitated nodes connected by weighted edges representing the different elements of the system. The gate capacity of the airport is considered as 12 units (Aircraft).

3.1.3. Felipe Angeles International Airport (NLU)

The third airport NLU, which was opened to operation on 21st March of 2022. It is being implemented in three stages from 2022 to 2035 and finally to 2052, periodically increasing the airport's operation capacity from 44 to 107 gates and in its last stage to 178 gates.

The model is a high-level one which is represented with a unique server bringing together all the gates by specifying the capacity of the server (44,107 or 178 for NLU during the three stages of development).

It is important to note that the gates in each airport terminal are distributed accordingly to the flight category distinguishing international and domestic flights for cargo, Low-Cost Carrier, and Full-Service Carrier.

4. Experiments results and analysis

In this section we present the results of the experimental design.

4.1. Data analysis

One of the main challenges of this study was to analyse both commercial and cargo flight demand in the Metropolitan Region of Mexico City, paying special attention to the operating airlines and equipment type.

Data collection was performed extracting information from both Flight Radar24 (Flight Radar, 2021) and the webpages of both MEX (MEX, 2021) and TLC (AIT, 2021) airports, NLU was not operational at the time of the study. Flight schedules in real time were collected during the week between April 7th, 2021, and April 14th, 2021, gathering information about the following fields for the arrival flights to MEX and TLC:

- Origin
- Destination
- Arriving time (date and hour)
- Flight code
- Airline
- Equipment (aircraft model)

It is important to mention that since no data of the passenger capacity was available, full design capacity of each aircraft is assumed.

4.1.1. Traffic distribution of the MAS

The estimation of the traffic share expected was based on the total passenger demand of the Multi-Airport System proposed in the Master Plan (GACM, 2020). It is expected that the current congestion in MEX is lowered by increasing the operations in TLC and NLU progressively, according to the development stages of the NLU project. Figure 4 illustrates the demand distribution considered in the study.

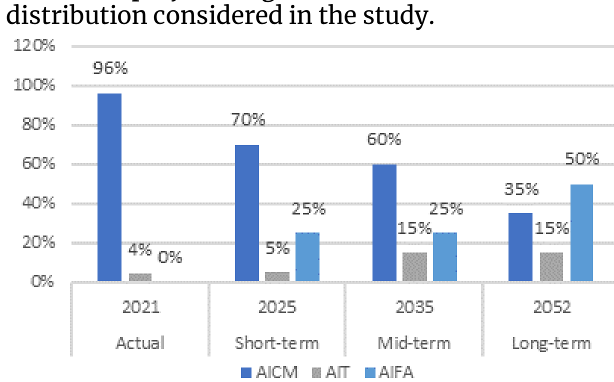

Figure 4. MAS traffic share in the simulation scenarios

For the initial scenario, the flight demand growth rate considered on this paper is not the one presented in the Plan Maestro, since the forecasted figures are believed to be overrated contemplating the current depression situation after COVID-19. Instead, short-term goals proposed by the airport operator are considered: the annual growth for the 2021-2025 period will go from 51% decline in 2020, to 41% increase in 2021, 15% in 2022, 18% in 2023 and finally, to 12% in 2024 (year when full recovery is assumed).

After full recovery, growth rates estimated for 2019 situation were applied, assuming a constant annual percent rate growth: In the second stage of NLU project, LCC flights are expected to increase in a higher rate than FSC, growing +4% annually, compared to +3% growth for FSC. In the last stage, the growth is assumed to be equal and +3% for both carrier types.

Regarding cargo demand, annual growth rate of cargo operations is 5% between 2025 and 2035 and 7% between 2035 and 2052. It is important to note that cargo business has been the only revenue for many airlines during the pandemic, since passenger flights that were responsible for delivering 60% of the cargo in their bellies ceased, leading as a result an increase in cargo freighters yield.

4.1.2. Airline review: Probability distributions related to turnaround time of flights

Turnaround time (TAT) plays a key role in the correct representation of the operations of the airports, since it is the time interval that considers the time required to unload an airplane after its arrival at a gate and the time to prepare the aircraft for the next departure.

Due to the random nature of this property, probability distributions associated to aircrafts TAT were constructed, performing a data collection and analysis for different equipment-airline pairs that arrive both to MEX and TLC. Since it was considered unfeasible timewise to extract data for all the airlines and equipment that operate in the MAS, airlines were selected regarding the flight operation days on a weekly basis, selecting the most operative airline with the highest frequency equipment associated to it.

Following the work of Mujica & Flores (2019), probability distribution fitting was performed with the data by grouping TATs in pairs of Arline-Equipment, so that the effect of the business model in the turnaround time is also considered. Figure 5 illustrates the types of adjustment done for the pairs.

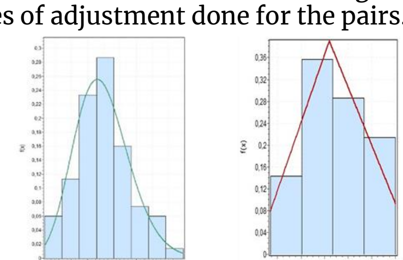

Figure 5 Fitted TAT distributions for Aeromar AT72 and AA B738

The results obtained employing EasyFit (2021) software are subjected to chi-squared goodness of fit test to measure the compatibility of the random data sample introduced and the theoretical probability distribution generated. Table 1 presents the complete TAT used for the pairs in the model.

Table 1. Aircraft-airline pair turnaround time probability.

Airline	Aircraft	TAT probability
AEROMAR	AT72	Random.Beta(17.22, 118.7)
AEROMEXICO	E190	Random.LogNormal(4.3276, 0.28628)
AEROMEXICO	B738	Random.PearsonVI(46.76, 16.209, 30.084)
AEROMEXICO	B789	Random.Beta(1.201, 0.92347)
AIR FRANCE	B77W	Random.LogLogistic(8.4552, 168.57)
DELTA	B752	Random.Weibull(4.4576, 99.895)
VIVA AEROBUS	A320	Random.Weibull(3.4719, 67.18)
VOLARIS	A320	Random.LogNormal(4.316, 0.23414)
UNITED AIRLINES	A320	Random.Beta(0.55208, 0.38001)
AMERICAN AIRLINES	B738	Random.Triangular(60.759, 92, 128.6)
TAR AEROLINEAS	E145	Random.Weibull(3.312, 30.736)
VIVA AEROBUS	A320	Random.Beta(0.45607, 0.67419)
VIVA AEROBUS	A20N	Random.Weibull(1.3226, 19.894)
FEDEX	B763	Random.Weibull(1.8384, 27.519)

4.1.3. Gate allocation

Since gate information is not publicly available, we allocated them following thumb rules based on experience. We followed the following allocation avoiding overlapping of flights in the system:

- When two consecutive flights arrive at the same hour and at the same gate, the gate randomly allocated must be changed by either the upper or lower bound gate of the hall of the terminal.
- When two flights arrive at the same gate at different times, overlapping caused by TAT must be checked. If the time between flights is shorter than the TAT corresponding to the first flight, the gate of the second one must be reallocated.

4.2. Boundary conditions and analysis criteria

The analysis was performed under the following considerations:

- Daily operation flight schedules are considered, in such a way that all simulations carried out consist of 24-hour long run.
- The traffic mix for the MAS depends on NLU

Project development phase.

- The parking positions in each airport conforming the MAS are modified according to the NLU Project development phases.
- 30 replications are made for each experiment.
- It is assumed that the PAX/aircraft correspond to the maximum capacity of the aircrafts selected for simulation applying a passenger load factor of 100% according to the scenario.

4.3. Simulated Scenarios

The current situation in 2021 is taken as a baseline for the scenarios, where the capacity and demand are evaluated.

4.3.1. *Scenario 0*

The Current Mexico City Metropolitan Region traffic values are used in the models, following the flight schedules of MEX and TLC airports on a week basis.

The model includes:

- MEX including 05R-23L and 05L-23R runways, terminal 1 and terminal 2 and 103 contact positions for the aircrafts operating.
- TLC airport including a unique runway, the commercial terminal with 12 contact positions and the cargo terminal.
- Traffic mix based on the forecasts, including LCC, FSC and Cargo carriers.

Since NLU is not operative at the time of the study, the traffic is shared between MEX and TLC. In this case, the principal airport holds 96% of the total demand of the system.

When it comes to TLC, it is noticeable that the current flight schedule is a clear representation of the effects of the pandemic. According to collected data from FlightRadar24, the mean of daily scheduled flights cancelled during March 2021 is 50%, being the number of weekly departures of around 20 flights.

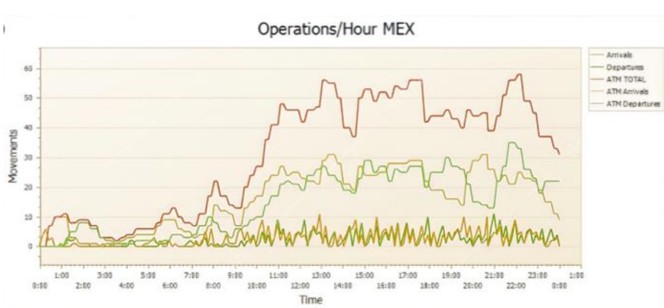

Figure 6. ATM evolution during a day in MEX, Scenario 0

As it can be seen in Figure 7 the results reflect the current situation of the pandemic. The demand has dropped compared to the increasing tendency exhibited in the last decades and this can be appreciated in the 3 ATM/hr, a negligible value compared to its stated limit of 36 ATM/hr.

As it can be seen in Figure 7, the operation frequency in TLC is almost marginal compared to the one in MEX, which explains the imbalance of the traffic share in the Multi-Airport System at the present time (96% of the traffic is absorbed by MEX and 4% by TLC). The maximum passenger value in the system -at the time of study - is of 25.3 MPAX, which is almost half of the expected value in the forecasts before COVID-19.

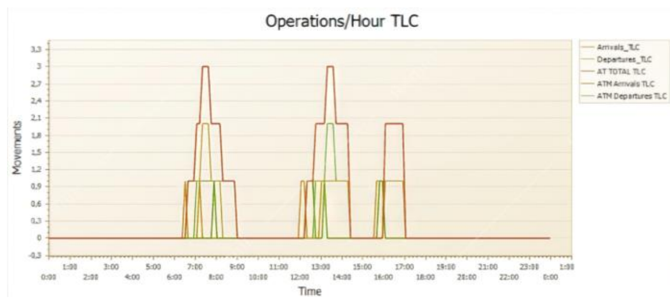

Figure 7. ATM evolution during a day in TLC, Scenario 0

Table 2 complements the results for this scenario.

Table 2. Performance indicators of MEX, TLC & NLU in Scenario 0.

	MEX		TLC		NLU	
	Avg	Max	Avg	Max	Avg	Max
ATM_hr	31.3	59.9	0.4	3	-	-
Aircraft Waiting Gate	0	0	0	0	-	-
Aircraft Waiting Runway	0.7	5.3	0	0	-	-
Gate Occupancy	20%	48%	1%	10%	-	-

4.3.2. *Scenario 1*

This scenario represents the first phase of NLU in 2025 (that will be finished by 2022), when two commercial runways will be operational. It is important to mark that their 1.6 km distance between them enables simultaneous landing and take-off operations. It is assumed that most LCC carriers will move to NLU, releasing the congestion from MEX.

This assumption will be maintained for subsequent scenarios in which the volume of traffic will increase and the share of passengers among the system's airports will be redistributed.

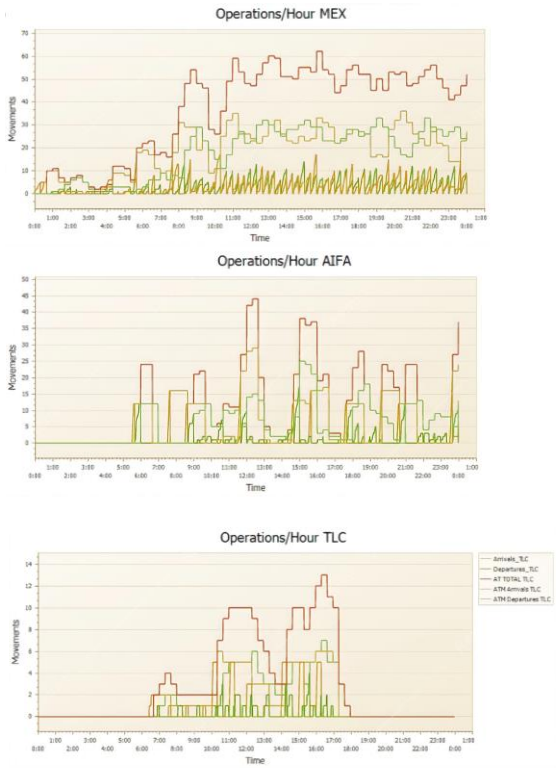

Figure 8. ATM evolution during a day in MEX, NLU and TLC in Scenario 1

According to forecasts, this scenario represents the recovery scenario from the COVID-19 pandemic effects. Therefore, the simulation is conducted with values of flight schedules before the pandemic. As it was in the situation pre-pandemic, the system presents the first signs of congestion, reaching a maximum of 63.5 ATM/hr in MEX and 41.5 ATM/hr in NLU. Nevertheless, it must be noted that the average values obtained in the three airports are 37.2 ATM/hr in MEX, 2.9 ATM/hr in TLC and 12.6 ATM/hr in NLU, revealing that the problems are focused during peak hour – as it happens in most airports in the globe -.

When it comes to gate occupancy, early signs of oversized infrastructure of the NLU terminal appear looking at the figures obtained, as only 20% of the available gates appear to be in use. In this case it can be noticed that the bottleneck in MEX is the runway, as it has always been declared by the government for years. This conclusion is drawn from the fact that the number of aircrafts waiting in queue, being almost 1 on average and 6 at most. It is important to realize that 6 is the maximum value, but this does not mean that there will always be 6 aircrafts waiting. Table 3 complements the results of Scenario 1.

Table 3. Performance indicators of MEX, TLC & NLU in Scenario 1.

	MEX		TLC		NLU	
	Avg	Max	Avg	Max	Avg	Max
ATM_hr	37.2	63.5	2.9	15.9	12.6	41.5
Aircraft Waiting Gate	0.02	0.03	0	0	0	0
Aircraft Waiting Runway	0.8	5.9	0	1	0	0
Gate Occupancy	31%	57%	4%	49%	20%	57%

4.3.3. Scenario 2

This is the mid-term scenario of the evolution of traffic in the multi-airport system, representing the situation of the capacity and demand in 2035, where Phase 2 of NLU project would have been reached. This means that from that moment on, the airport will be able to accommodate around 43.2 MPAX annually and 107 aircraft positions will be operative.

This expected capacity expansion, that doubles the number of available gates, together with maintaining the same traffic share of Scenario 1 (25% of the total MAS traffic), reflects a situation where the operational level of the airports is decongested, reaching a maximum of 62.7 ATM/hr at MEX during peak hour.

When it comes to the maximum expected passenger inflow of the system, it is expected that the airports altogether will be able to absorb 106.5 MPAX annually (allocating 60.6 MPAX, 16.3 MPAX and 29.6 MPAX, in MEX, TLC and NLU, respectively).

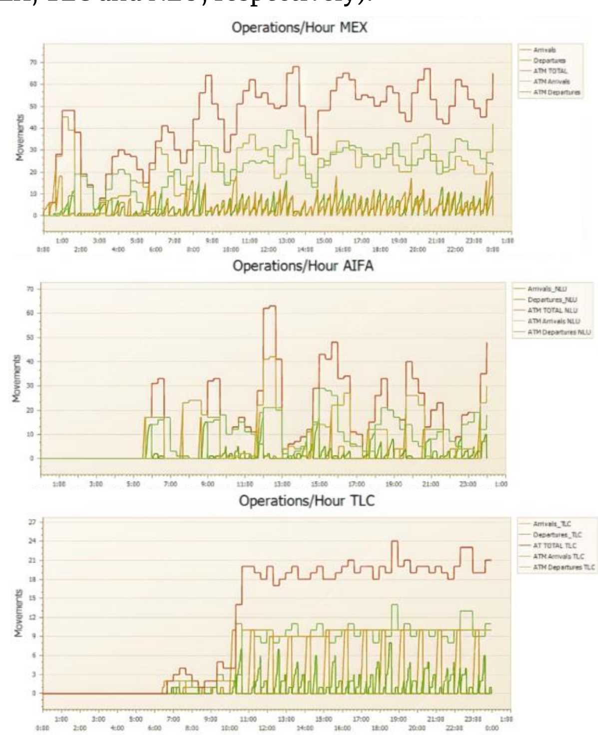

Figure 9. ATM evolution during a day in MEX, NLU and TLC in Scenario 2

Following the tendency of previous scenarios, gate occupancy does not represent a problem in any of the three airports, despite the high 89% maximum value obtained in TLC (see Table 4).

The runways at MEX are the bottleneck as it can be noticed that at least one aircraft is waiting for the runway on average. Similarly, in this case the limitation of Runway usage appears for the first time in NLU during peak hour; however, not representing a problem.

Table 4. Performance indicators of MEX, TLC & NLU in Scenario 2.

	MEX		TLC		NLU	
	Avg	Max	Avg	Max	Avg	Max
ATM_hr	32.7	62.7	10.9	23.6	5.2	30.7
Aircraft Waiting Gate	0.9146	1.6333	0	0	0	0
Aircraft Waiting Runway	1.1	9.4	0	1	0	4
Gate Occupancy	39%	66%	16%	89%	12%	31%

4.3.4. *Scenario 3*

This scenario represents the expected demand for 2052, where the last phase of NLU and therefore full-operation capacity of the system would have been reached. Table 5 presents the statistics for this scenario illustrating the expected values of the multi-airport system in 2052.

Table 5. Performance indicators of MEX, TLC & NLU in Scenario 3.

	MEX		TLC		NLU	
	Avg	Max	Avg	Max	Avg	Max
ATM_hr	42.5	73.4	19.2	34	60.5	167.9
Aircraft Waiting Gate	8.6	15.4	0	0	0	0
Aircraft Waiting Runway	0.9	5.7	0	2	0	7
Gate Occupancy	47%	75%	19%	88%	19%	48%

In such case, it is expected that the MAS will be able to allocate 160 MPAX every year, being NLU the busiest airport with 84.9 MPAX, followed by MEX with around 50 MPAX. Figure 10 illustrates the evolution during the day.

In the last scenario the biggest flight demand is used as input for the simulation. In fact, this is the first time where saturation limit is surpassed in TLC – revealing the necessity of expansion of infrastructures- with a maximum of 34 ATM/hr (compared to the theoretical 32 ATM/hr capacity)

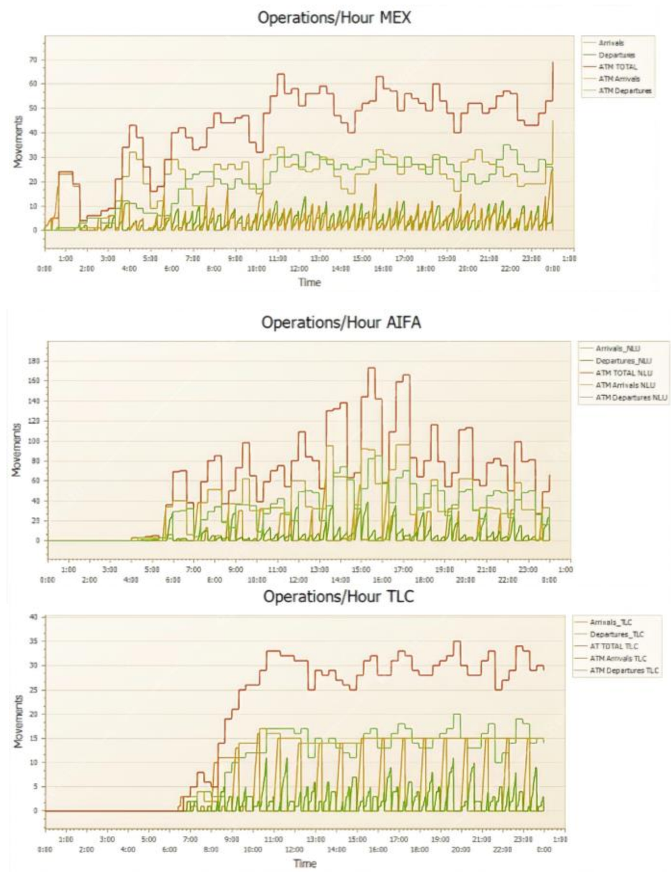

Figure 10. ATM evolution during a day in MEX, NLU and TLC in Scenario 3

The runway limitations are revealed in MEX and NLU. Regardless of the implementation of a third runway in NLU, even if the average is less than a flight, 7 aircrafts need to wait for the runway during peak hour. Once again, the low value of gate occupancy reflects the oversized capacity of the terminal infrastructure – with 2 terminal buildings-.

The 60.5 ATM/hr operation average obtained in NLU can be considered a consequence of the distribution in the daily flight schedule, as it can be appreciated in Figure 10. In our assumption, NLU is operating from 4:00 to 24:00, which is a disadvantage compared to the 24 hour-operation of MEX.

5. Conclusions

The study presents the study done for analysing for the first time the multi-airport system of the metropolitan region of Mexico City. This approach can be replicated in other systems as it is a general methodology based on a multi-model approach.

The study analyses the system under diverse assumptions like the LCC will leave MEX and operate at TLC and NLU or that international flights will not operate in TLC.

Results show that with the opening of the new NLU airport, the Multi-Airport System formed by MEX, NLU and TLC would be able to cope with the expected demand in a short-term and long-term. For the case of MEX, the runway system is a delicate element in the system that limits the growth as it has happened during the last decades.

When it comes to the secondary airports, TLC and NLU, results reveal the infrastructure of NLU is sufficient to absorb the demand diverted from MEX to NLU and the gate capacity is more than enough for the expected demand; for the case of TLC, it has enough spare capacity to absorb traffic and the current number of gates are also sufficient or even underutilized.

With regards to passenger capacity of the system, it is important to note that the flight schedules of Scenario 0 simulate the effects of the pandemic, as 25.3 million PAX are absorbed by the whole MAS compared to the 72 MPAX estimated for 2022. After recovery, in Scenario 1, it can be noted that the pandemic gave time to the government to have NLU operational for the shifting of traffic to NLU from MEX on a timely basis as it can be seen in the results obtained.

The main limitation of the system in the long run will be the capacity of the runways as waiting Aircraft appear in MEX and NLU and in TLC when the scenarios of biggest demand are analysed.

In general, the methodology proposed for the study of the multi-airport system seemed the right one to analyse for the first time a complex system such as the one present in Mexico City. For that reason, the authors strongly suggest the use of simulation as a tool to evaluate and identify the turning points when new infrastructure is required with the increase of demand in the system.

5.1. Future work and limitations

As mentioned, the multi-model approach is composed by one low-level and 2 high-level models for the airports of MEX, NLU and TLC. This might be a limitation as the operation of multiple runways might not be properly simulated but the approach gives us a good initial estimate of the expected performance. In the future, the authors will work on developing different simulation models for the complete system to get a better understanding of all the emergent dynamics present in such a complex one. In addition, the land connection and accessibility to the three airports will be added to the framework to estimate travel times between airports and identify quality KPIs such as travel times and connecting times within Mexico City which are also of great importance to understand the potential of such a system.

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