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**Publication date**

2017

**Document Version**

Author accepted manuscript (AAM)

[Link to publication](#)

**Citation for published version (APA):**

Scala, P. M., & Mujica Mota, M. A. (2017). *Model-Based Remote Runway Solution for a Congested Airport: Mexico City Airport Case*.

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# MODEL-BASED REMOTE RUNWAY SOLUTION FOR A CONGESTED AIRPORT: MEXICO CITY AIRPORT CASE

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## ABSTRACT

The airport of Mexico City is suffering from congestion problems during part of the day. For that reason the government announced the construction of a complete new one which is supposed to be operative in 2020 in its first phase. However the economic downturn in the country jeopardize the complete project besides other technical issues; for that reason it is important to have intelligent alternatives that allow to invest in a progressive fashion so that the investments are not lost or end up in useless infrastructure. The current work explores the option of using a remote runway in the location of the new airport so in case the original project is delayed or even cancelled the objective of absorbing more traffic is still achieved. The results indicate that the proposed infrastructure allows the growth of the airport while the operational indicators are not in bad shape as taxi times are similar to those in airports with remote runways such as Schiphol in The Netherlands.

Keywords: simulation, airport, congestion, taxi time, airport failure, downturn, over dimension, NAICM

## 1. INTRODUCTION

Mexico City Airport (ICAO:MMMX) is the main airport of the metropolitan region. It is an airport that has been evolving since the early 20<sup>th</sup> century. Due to the economic evolution of the country and the main city (Mexico City), the airport has been evolving in parallel. Its evolution at the beginning was due to the local carriers mainly Mexicana and Aeromexico, some international mainly from the US have been also part of the traffic flying from and to Mexico. Mexico has no Open skies policy however recently Mexico signed an agreement with the US that allows American airlines to fly from anyplace in the US to any airport in Mexico (Transportation 2014). Due to this and the expectancy of a trend towards Open skies, the demand is expected to grow in the coming years (around +5% in aircraft movement and +12.2% in number of passengers).

In 2015, the airport network of Mexico as a country transported more than 73 million passengers and about 655 500 tons of cargo. The 63% were domestic passengers and 37% internationals. Mexico City International Airport moved 38.43 million passengers,

more than a third of the total traffic of the country (SCT, 2015), which makes it the major airport in Mexico and one of the most important airports in Latin America. The domestic general aviation sector accounted for the 8.5% of the total movements. For the coming years, 41 million passengers have been forecasted by 2020.

### 1.1. The Situation of Mexico City Airport

Mexico City Airport is considered key for the development of the metropolitan region in Mexico and also for the development of the country. The development of the new airport in Mexico City is under progress however due to different causes the project has suffered delays and it is at risk of not being on time (De Jung 2017). The airport once finished will have a final capacity of 120 mill pax/yr. However this airport will not be operative until 2020 (only the first phase). As expected, Mexico City as a destination is still growing and the country has also gained importance as a tourist and business destination.

According to OCDE, the MMMX's slot allocation process is one of the major hurdle for airline competition, the claim by the government is that airport is fully used and thus competition by new entrants is restricted. In 2013, the Ministry of Communications and Transportation (SCT) issued a new Saturation Declaratory for the Airport (DOF, 2013). According to Mexican authorities, the maximum capacity is limited to 61 operations per hour (with hard restriction of 40 landings per hour) under optimal conditions. However, during adverse weather conditions the limit will drop to 30 or even 20 landings per hour.

There are several consequences of MMMX being constrained:

- Traffic at regional airports bound for AICM suffers delays (ground delays) due to ATC problems at MMMX.
- The result is increasing delays in the domestic aviation system and underutilization of aircraft by the airlines.
- Different queues appear at different locations in the airport making the ATC a real challenge for the controllers

- ATC apparently gives priority to intercontinental flights hence domestic flights will suffer the most the lack of slots.

On the other hand, low cost carriers and international airlines put pressure on the airport to let them enter to operate in the airport. In consequence with the agreement with the US, recently JetBlue, SouthWest started operations from the US to Mexico City Airport putting more competition to the Low Cost Carriers currently operating at the airport, so the expectation of continued growth will be maintained. Fig. 1 illustrates the growth trend of recent years in which the impact of the LCC is revealed.

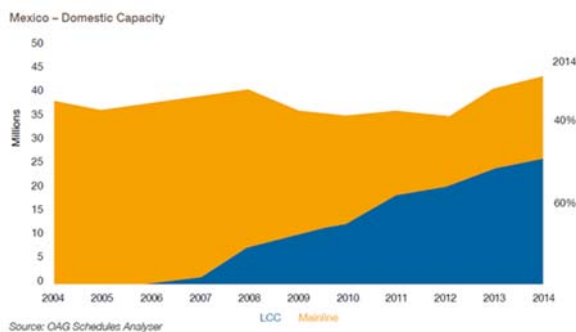


Figure 1. The growth trends in MEXX

Besides that not only the narrow body aircrafts want to operate in the airport, also the biggest commercial aircraft have claimed their right to operate there. Last year AirFrance started with the operation of the A380 three times a week to Mexico City and Lufthansa and Emirates have stated that they have intentions to start operating with the A380 from Frankfurt and Dubai to Mexico City respectively (CAPA 2014).

For all these reasons and with the risk of severe delays in the delivery of the new airport that will absorb all the expected growth, it is critical to evaluate the current and alternative solutions to the airport saturation. The required tool needs to be able to incorporate the different key elements that determine the capacity such as infrastructure configuration, taxiways, runways, restrictions, airlines business models, weather, and the uncertainty inherent to those elements for understanding the emergent dynamics that appear once all the elements are put together in place.

Due to the level of investment of the project (between US\$3.7bn to US\$ 10.3bn), the risk involved in the project is quite high, on the one hand the current airport is under congestion levels that hinder its growth hence it will be necessary to come with a solution such as the construction of a new airport; on the other hand if the levels of demand that justify such a huge investment are not fulfilled then the risk of having a half-empty system is also high. For this reason it is necessary that these types of investments are made in such a flexible way that the previous risks are minimized as much as possible. It has been mentioned that there are diverse factors whose

uncertainty might have an adverse effect on the original plans such as economic downturns, strikes, government change, technical problems, among others. For this reasons the authors have emphasized in previous works (Mujica et al. 2017) that the inclusion of simulation in several planning steps are the only way for evaluating the effect of uncertainty in these types of investments. In particular for this type of project, it is proposed intermediate states of the project in which for each of them the risk is inherently minimized. Figure 2 shows the approach proposed.

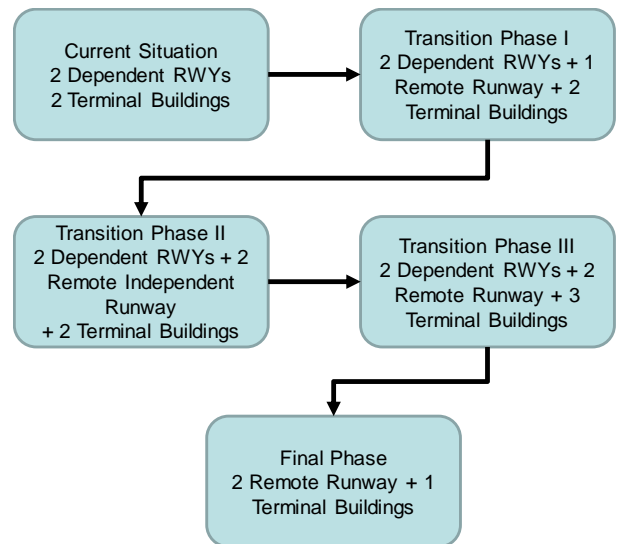


Figure 2. The flexible approach for the implementation of a new airport in Mexico

As it can be appreciated from the figure, the development is progressive and at each phase it is possible to evaluate the risk of failure or anomalous conditions which were not in line with the original plan, and theoretically wise it would be possible to stop the development in each phase if it identified that the original assumptions (demand, operational conditions etc.) are not valid in reality.

In this article we present the analysis of an alternative operational option (Transition Phase I) which is a remote runway in the location of the future airport. The option has been demonstrated as feasible in other important airports in the world. The most familiar one is Schiphol Airport in Amsterdam which has a runway that is almost 6 km away from the passenger terminal building. The developed model allows to evaluate the feasibility of the operation and the identification of potential operative problems as well as the future performance indicators that the new system might have. This configuration can be used as a transition between the current airport to the new one or as a hybrid model if due to unexpected reasons the new airport cannot be finished.

## 2. SIMULATION MODELS

MMMX runway system consists of two runways with dimensions of 3963x45m and 3985x45m, respectively. Runways operate in a segregated mode which means that one is used for arrivals and the other one for departures. According to Herrera (2012), the arrivals are performed on the runway 05R/23L and departure on runway 05L/23R. The current airport facilities have a total surface area of 790 ha. It has two passenger terminals, Terminal 1 (T1) and Terminal 2 (T2), it includes 96 parking positions, 36 direct boarding gates in T1 and 34 in T2, and a total of 74 operative gates. T1 is used for both national and international flights, whereas T2 is used mainly operated by Aeromexico. Figure 3 depicts an aerial view of the airport and the location of the assigned for the new airport.

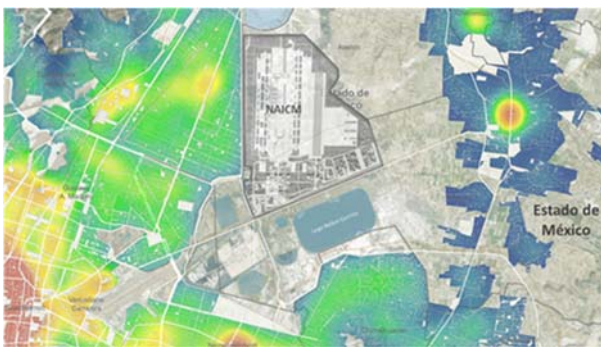


Figure 3. The future location of the new airport of Mexico City

In this work, we used a validated model of the current Airport of Mexico City as the base case and then we implemented the remote runway taking into consideration the logistical challenges of the new system.

### 2.1. Current System Description

The validated model is the simulation model of the current airport; Fig. 4 illustrates the base model.

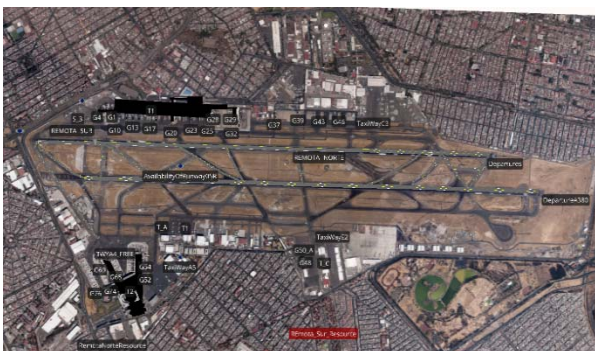


Figure 4. Base Case: Current Model of Mexico City Airport

For the current system, the following table presents the values of the different elements in the system.

Table 2. Current Airport Model Description

Element	Value	Comment
Terminal 1 Gates	36	Direct boarding gates
Terminal 2 Gates	34	Direct boarding gates
Turnaround Times	-	Based on different probability distributions
Taxiing speeds (Km/h)	9.26 - 18.5 - 27.7 - 37	Depending on which part of the taxiway A/C are crossing
Runway Occupancy Time Arrival (sec.)	39	Time consumed by the A/C in order to cross the runway at landings
Runway Occupancy Time Departure (sec.)	46	Time consumed by the A/C in order to cross the runway at departures

### 2.2. Remote Runway System Description

The proposed configuration is presented in Fig.5 where it can be seen the location of the new airport of Mexico city (NAICM). This will be the base for making the model of the proposed configuration.



Figure 5. Remote Runway Model of Mexico City Airport

Table 3 describes the main characteristics of the remote runway model.

One of the main disadvantages of the use of a remote runway is the taxi time from terminals to the runway, however the objective of evaluating this configuration is also for verifying if the impact of taxi time degrades the performance of the system as a whole.

Table 3. Remote Runway Airport Model Description

Element	Value	Comment
Runway Length (m)	3,985	It can accommodate all different types of aircraft
Runway Occupancy Time Arrival (sec.)	39	Time consumed by the A/C in order to cross the runway at landings
Speed runway exit (Km/h)	50	Speed of the aircraft after a landing at the runway exit
Speed Taxiing (Km/h)	9.26 - 18.5 - 27.7 - 37	Depending on which part of the taxiway A/C are crossing
Distance to Terminal 1 (m)	13,000	Approx. distance from the remotest runway exit to Terminal 1 area
Distance to Terminal 2 (m)	12,655	Approx. distance from the runway exit to Terminal 1 area

### 3. EXPERIMENTAL DESIGN

For evaluating the future performance of the airport there were some assumptions taken:

- It is possible to construct a taxiway system that connects the current airport with the new runway
- The analysis of the airspace topology has been taken out of the study
- The effect of the wind direction has been neglected
- The traffic mix is kept similar
- The increase of traffic is only in the available slots (morning and night)

The experimental design takes the current model as the base case and then a second scenario with the increase of 30% is evaluated. Then it will be compared to the operation of the scenario with the remote runway, keeping some variables controlled. Table 1 presents the characteristics of the four Scenarios.

Table 1. Scenario definition

Base Scenario	Scenario 1	Scenario 2	Scenario 3
Current Traffic	+ 30% traffic	Current Traffic	+ 30% Traffic
2 Dependent Runways	2 Dependent Runways	Remote Runway	Remote Runway

With the development of these scenarios we established the feasibility and potential of the proposed solution. The first two scenarios (base case + Scenario1) put focus on

what is the impact of the increase of traffic in the current system. As it has been presented by previous studies (Mujica et al. 2016) the limiting element of the airport is the runway system, in the first scenario we present the performance indicators of the operation and the ones if we increase the traffic by 30%. In the following two scenarios we implement the remote runway under the current situation and then the increase of traffic in 30% so that we are able to identify the potential and performance indicators of the future airport with the remote runway.

### 4. RESULTS

After running the scenarios with the proposed variations, it was identified what the current parameters were and with those values we were able to determine the difference and potential for improvement of the current system. Table 4 presents the main performance indicators of the four scenarios evaluated.

Table 4. Performance Indicators of the Different Scenarios

	Base scenario	Scenario 1	Scenario 2	Scenario 3
ATMs	941	1175	939	1181
Max hourly ATMs	61	62	70	73
Avg time in queue before departing (min.)	22.84	24.06	3.3	3.24
Max A/C in queue from T1	10	12	3	3
Max hourly A/C in queue from T1	5	5	3	3
A/C in queue from T2	28	33	4	4
Max hourly A/C in queue from T2	9	9	4	4
Taxi time from runway to gate (min.)	1.87	1.73	25.81	25.73

As it can be appreciated in the base case, the queues of A/C are high while with the new scenario not only the number of ATMs are increased drastically but also the queues are reduced dramatically. In addition, it is noticeable that in the new configuration if the A/C make the taxi from the remote runway to the terminal building



at approximately 37 km/hr it might take approximately 25 minutes time to get to the Terminals, however, the taxi speed can be increased which might reduce the time to get to the terminals. Hourly ATMs are showed in figure 6 and 7 for the Base scenario and Scenario 2, respectively. In these two graphs it is possible to see how the hourly ATMs evolve during the day and the difference between the two scenarios in terms of number of hourly movements. The figures reveal the level of improvement that can be achieved with the new implementation which is in line with the objective of the NAICM.

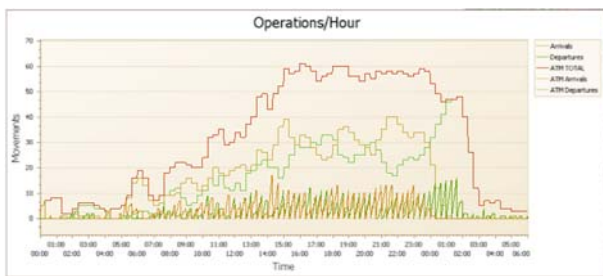


Figure 6: Hourly ATMs Base scenario

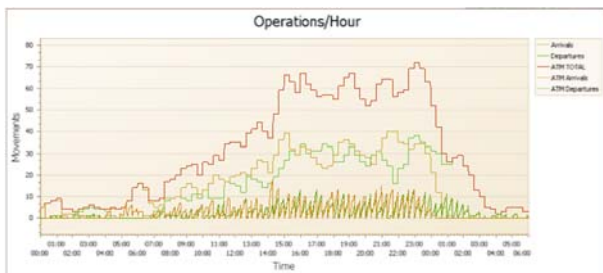


Figure 7: Hourly ATMs Scenario 2 (with remote runway)

## 5. CONCLUSIONS

It has been presented a simulation model of a proposed operational configuration of a runway which will be part of the new airport of Mexico City. The proposed model is used to investigate the performance indicators that the airport with a remote runway might have in case it is implemented as a transition to the future airport of Mexico City. This approach will enable the decision-makers to reduce the risk of an economic catastrophe if the assumptions regarding demand and operational capacity are not fulfilled. The concept of a remote runway was inspired by Schiphol which is one of the most important hub airports in Europe and has a runway which is approximately 7 km away from the terminal building. The results confirm that the operational values are satisfactory and that with the implementation of the remote runway it is possible to absorb approximately 470,000 ATM movements per year assuming an operation of 17 hrs/day, while reducing highly the levels of congestion. In other words it is expected that with this configuration the airport is able to transport 60-70 mill passengers per year which is approximately the double of the current values. This approach structured in an

intelligent way will enable governments and decision makers reduce the risk of failed investments by a very high degree. For this reason the authors foster the use of simulation as a tool for addressing the inherent uncertainty that these systems show. As future work other types of scenarios will be studied such as the ones in which the impact of new aircraft like A380s, B787 or A350 might have in the capacity or how a smart allocation based on the business model of the airlines might improve the efficiency of the operation of the airport.

## Acknowledgments

The authors would like to thank the Aviation Academy of the University of Applied Sciences for supporting this study and the Dutch Benelux Simulation Society ([www.dutchbss.org](http://www.dutchbss.org)) and EUROSIM for the dissemination of the findings of this study.

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