Connecting the megalopolis

Corridors for integrated air and public transport networks in the megalopolis of Mexico

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Extáticos ante el nopal del águila y de la serpiente —compendio feliz de nuestro campo— oyeron la voz del ave agorera que les prometía seguro asilo sobre aquellos lagos hospitalarios...

Más tarde, de aquel palafito había brotado una ciudad...

Más tarde, la ciudad se había dilatado en imperio...

Alfonso Reyes
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To Irma and Rafael, that even from kilometers of distance make me feel their support and love.
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Airport infrastructure faces important challenges in the context of the megalopolis of Mexico. The airport of Mexico City was rapidly surrounded by urban settlements making it difficult its expansion and operation.

Two decades after the first international terminal was inaugurated (1952) the government was already exploring options for either expanding the existing airport or building a new one for handling a growing air transport demand. The vast space needs that this large mobility infrastructure requires faced in the mexican capital a explosive urban expansion driven by squats and irregular settlements.

The urban expansion the region experienced at that time soon made some of the options not feasible anymore. The more the urbanization was growing the farther the location of a possible new airport was becoming.

The discussion about building a new airport has always been a highly politicized issue confronting several actors including federal ministries, state governments, local municipalities and different social, economic and political groups. The confronting interests have generally lead to a third constant, the continuing adjustment and efficiency improving of the existing airport were large amount of money have been invested through time in order to maintain the terminal operative. That situation has configured a very land use efficient airport.

However, the environmental standards especially in term in noise control might not fulfilling international standards. Moreover, the process of ever making more and more intensive and efficient use of the airport has also limits. If the demand for air travel keeps growing it is very likely that the airport alone will not be able to cope with future demand. In this regard, the urban pressure this large infrastructure is posing over its dense and complex urban surroundings is rising more and more environmental and social concerns.

In that dynamic, there have been always two constant positions by the government about the construction a new airport in the metropolitan area: building a new airport in the remains of Lake Texcoco (the nearest location) or building a new airport in the plains north of the Valley of Mexico (the farthest location).While the first model could be related with a concentration one (an airport hub), the second one suggest a more decentralized system (a multi-airport network) as that airport could

**INTRODUCTION**
In 2001, the government announced the construction of a new airport in the Texcoco area. After months of demonstrations, the government finally decided to step back and cancel the project. At the same time, the decision taken was again to extend the life cycle of the terminal increasing its capacity but adding a network element: the airports of the neighboring cities should from then on complement and attract part of the operations of the airport. This started up a trend for the consolidation of the alternative airport infrastructure that have acquire more relevance in the recent years, even tough the airport of Mexico City is still dominant.

Ten years after the cancellation of the project in Texcoco and even after the expansion works, the airport of Mexico City is facing again saturation, therefore the airport issue is taking again a relevant role on the national infrastructural agenda. In these years, the conditions in the megapolis have changed. New regional infrastructure has been built, low budget airlines have started operating in the Mexican market and the airport of Toluca has become now the de facto alternate airport for Mexico City.

At the same time, increased environmental consciousness in the society and increased awareness of the need for restoring part of the nature infrastructures in the region have promoted the development of different proposals for restoring the wetland systems in the area of Texcoco as part of social and nature regeneration programs supported by several actors. An example is the project “Parque Ecológico Texcoco”.

However, in spite of these efforts, still some actors support the idea of building there an airport based mainly in a transport accessibility perspective point of view, supported by an idea of an ever growing demand that would require huge airport facilities in it. Their main arguments are the proximity to the city center and the possibility for simultaneous operation of several runways. On the other hand, the state governments try to promote the development of the alternate airports in which investments have been made.

The lack of definition about where a new airport would be built or how a multi-airport system would operate has acted as an element that prevented a faster development of a metropolitan ecological and water management park in Texcoco or the consolidation of the airport network of the region. In this sense, the consequences of the development of airport infrastructure in the region represents a key aspect that will profoundly influence the future evolution of the megalopolis of Mexico.

On April 2013 the air transport authority issued a declaration of saturation for the International Airport of Mexico City.

The air space of the airport is already saturated from 6 to 10 AM and from 4 to 8 PM.

Source: La Jornada, April 18th, 2013.
PROBLEM STATEMENT

The paradox of global connection and local disconnection.

Since air transport was available, cities worldwide have increased their demand for air transport services and long distance connections. Nowadays, sometimes it is easier to reach a destination hundreds of kilometres away by plane than arriving to a point in the same region or even in the same city by public transport.

The access to different types of mobility also implies an economic cost, the faster you travel the more expensive it becomes. In contexts like the Mexican, air transport is still being predominantly used by higher income groups in the society. In contrast, public transport is predominantly used by lower income groups. However, cheaper flights and improved public transport services attractive for different levles of the society might be blurring this situation. Moreover, the integration of air transport and public transport rises both as a necessity for improving the working conditions and the efficiency of the airport system as well as an opportunity for reducing between who and where to have access to the mobility system:

Both long distance and local connections are important and need to be attended, as Jane Jacobs (1970: 35) stated: “No creative local economy—which is to say, no city economy—seems to have grown in isolation from other cities”. National and international flows are facilitated by new types of mobility now available. However, as authors like Graham and Marvin (2008) have shown, the priority of the development of contemporary infrastructures has been assigned to facilitating the connecting of specific groups in society, while the modern paradigm of evenly distributed access to infrastructure has been eroded. In that context, it is likely that contemporary societies are producing a group of super connected people able to reach other continents in terms of hours while important sectors in society need to spend daily several hours in inefficient and uncomfortable public transport.

Could there be a way to integrate both mobility needs and generate a win-win situation?

RELEVANCE

The saturation problem in the airport of Mexico City presents different environmental and economic threats on the city. It increases air transport risks in a densely inhabited urban area as well as increased air pollutants emissions. Additionally, the saturation problem can potentially affect different sectors of economy with delays and high air transport prices.

At the same time, the public transport in the megalopolis of Mexico is inefficient and fragmented. Currently some inhabitants of the megalopolis are spending more than 3.5 hours per day in commuting. Moreover, Mexico City was ranked in the last position of the Commuter Pain Survey in 2010 (Medina, S.; 2012).

RESEARCH QUESTIONS

What if the megalopolis of Mexico had a multi-airport network and the region was fully integrated with public transports?

What if inter-metropolitan mobility corridors would be used as tools for improving accessibility to public transport and urban development?

What if the integration of different types of mobility at a local scale could be used as tool for enhancing the quality of public space?
This project explores the hypothesis of taking advantage of the existing airport network instead of building a new one in the area of Texcoco assuming six principles:

The problematic of the airport is not just a problem of Mexico City, is an issue that concerns the surrounding region. Currently the centralized airport infrastructure is a clear sign of the regional dependency on Mexico City.

Time distance is more relevant that distance. If adequate infrastructure is developed, distant options could be feasible.

The area of Texcoco wetlands should be used as a metropolitan ecological reserve due to the relevance it might acquire in the coming decades in terms of its potential water management, environmental and social role.

The development alternate airports can be used as a tool for improving the competitiveness of the economy of the medium cities of the megalopolis.

Uncertainty surrounds the long term of air industry, different types of air transport might appear especially in relation with dependence on fossil fuel, and in that sense other means of transport may acquire more relevance in the future due to the running out of fossil fuels, important uncertainty surrounds the long term of air industry.

OBJECTIVES

Produce a multi-scalar strategy (megapolitan, intermetropolitan and local) for integrating airport and public transport infrastructures in the megalopolis of Mexico.

Show the spatial effects of the integration of new types of public transport mobility in the megalopolis of Mexico.

METHODOLOGY

This research has been developed simultaneously analysing the region and doing thematic bibliographic research adjusting the scope according with the evolution of the work.

The theoretical framework has been developed reading different books and papers related to mobility infrastructure and its effects on cities and territories. The literature review included works from authors like Graham and Marvin (2008), Guller and Guller (2002), Schaafsma et al. (2008), Freestone and Baker (2011) and De Neufville (1995, 2005) among others. In the literature review I have paid special emphasis on the role of airport in relation with urban development for understanding its positive and negative externalities as well the different economic, environmental and social / governance factors that influence its operation. As a result, from that theoretical framework, I defined a set of relevant indicators for understanding different dimensions of airport infrastructure as well as for identifying some trends about air industry operation in the coming years.

As one of the characteristics of airport problematic in the megalopolis of Mexico is the indefiniteness of the construction of a new airport and since a big part of the public debate is related on where build a new alternate airport for the Valley of Mexico, I devoted part of the research for understanding the different implications of five of the locations currently being studied by the government, mainly for developing a critical stance on the subject. For helping developing a personal opinion I used the SWOT analysis technique and the method of Dan and Nishry.

For analysing the specific conditions of the megalopolis, I did an overview of different texts (books,
online publications) mainly oriented towards understanding the problematic of its airport and public transport infrastructure. The purpose of this research was to identify three main aspects: First, recent trends in the megalopolis urban development, second, projects and proposals for airports and public transport lines and third the identification of drivers of change that will shape the region in the coming decades. For spatializing the information, I used representation tools like hand sketching and GIS mapping.

Simultaneously with the research part I started developing a spatial strategy, constantly understanding the implications and reflecting on the outcomes in different scales. In the final week of the project, the development of the proposal took a more relevant role, obtaining out of them different reflections and developing criticism about my own work.

For evaluating the hypotheses proposed and visualizing the implications of the strategy, the design became a qualitative tool of assessment. As a result, the design presents a vision for megalopolitan scale and different zooms in relevant sites showing the local outcomes. As conclusions I do a critic reflection on the research, its limitations and its future possibilities.
CHAPTER 1: Outlining the megalopolis of Mexico.
INTRODUCING THE MEGALOPOLIS

Defining what a city is represents a complex issue. Defining what is Mexico City is a risky one. Defining what the megalopolis of Mexico is, is even a more dangerous adventure.

According to Jacobs (1970:262) a metropolitan area politically means a city that has politically expanded beyond its formal boundaries, in the process engulfing former towns and, in some instances, coalescing with other, formerly separate, cities”.

Generally the mere size of Mexico City metropolitan area makes think about it as megalopolis, an probably it is. In regard to the megalopolis of Mexico, several authors have launched different, even opposing definitions. There is not a consensus on its definition.

However, its already large number of inhabitants (20 million) usually eclipses the also large number of inhabitants living in the neighbouring cities that sum up a total of 8 more million inhabitants. For this research, I understand the megalopolis of Mexico as a summing up of the metropolitan areas of Mexico (that includes the Federal District and part of the states of Mexico and Hidalgo), Cuernavaca, Cuautla, Puebla – Tlaxcala, Tlaxcala – Apizaco, Tula and Toluca.

Together, they represent a megalopolitan area of more than 28 million inhabitants with important historical links and interdependencies.
Fig. 6 The megalopolis of Mexico.

A. Metropolitan area of the Valley of Mexico (MAVM).
B. Metropolitan area of Toluca.
C. Metropolitan area of Cuernavaca.
D. Metropolitan area of Cuautla.
E. Metropolitan area of Puebla - Tlaxcala.
F. Metropolitan area of Tlaxcala - Apizaco.
G. Metropolitan area of Tulancingo.
H. Metropolitan area of Pachuca.
I. Metropolitan area of Tula.

Fig. 7. Inhabitants per geographic unit (ageb) in the megalopolis of Mexico.

174,179 average daily users of highways connecting the MAVM and the neighbouring metropolitan areas.

Source: Ministry of Transport
Fig. 8. Forests and natural areas in the megalopolis of Mexico.

Fig. 9. The fragmented political mosaic of the megalopolis.

6 states:
Federal District
State of Mexico
Hidalgo
Puebla
Tlaxcala
Morelos

3 government levels:
Federal
State
Municipal
Fig. 10. Example of the new dwelling complexes developed during the last decade in the peripheral areas.

Fig. 11. Highway construction and urban expansion in the last 10 years.

Fig. 12 Highway construction and urban expansion in the last 10 years.

Fig. 13. The new suburban train.

Expansion of public transport

Fig. 14. New public transport lines built in the last 10 years.

Suburban train.

Metro.

BRT.
By 2030 the population living in the neighbouring metropolitan areas of the megalopolis of Mexico will represent one third of the total.

84% of air pollution in the ZMVM is generated by vehicles, however only 16% of total travels are done using private vehicles.
Fig. 16. GDP size per metropolitan area areas of the megalopolis of Mexico.

Fig. 17. GDP per activity of each of the metropolitan areas of the megalopolis of Mexico.

Fig. 18. Population per metropolitan area in the megalopolis of Mexico.

Fig. 19. Passengers vs population in the airports of the megalopolis of Mexico.
CHAPTER 2:
Theoretical framework: Air and land mobility infrastructures and their role in urban development and planning.
Societies and their production specialize in specific activities and rely on the material flows coming from the exterior. However, the dependency on those remote flows also increases with their specialization. Infrastructures like highways or trainways build continuity throughout space, a continuity that links in chain, a set of exist of stops that are articulated with more local networks. The location of exits and stops is generally predefined and fixed, hierarchising the location attractiveness of a region according to its proximity to one of these infrastructure exchanges.

Differently from them, airports operate like platforms, punctual elements that allow the landing and take-off of aircrafts. In that sense, connections between remote spaces are supported by the existence of another platform in other location. These platforms are by definition highly standardized elements that operate in similar ways worldwide for servicing the technical requirements of the aircrafts. Even tough airport platforms do not have and spatial continuity across vast areas of the territory, they require a vast network of supporting infrastructure for functioning.

While the very essence of transport is to establish connections to other places, the radical difference between air transport and other means of transport is the travel time. By reducing journeys that used to take weeks in the past, only to few hours now, air transport represents an authentic time collapsor that has changed drastically the world movement of people and goods. Airports are one of the key elements to understand the dynamics of the contemporary city and regions. Without air transport and the impact it has in increasing and fastening the flows of people and goods worldwide it could not be understood phenomena like the development of touristic towns, the operation of high-technology industry clusters and some forms of export oriented agriculture, among others, located both in developed and emergent economies.

Airports are the ultimate interface between the local and the global. These spaces operate as articulators and filters between global and local flows of goods and persons. In most of the contemporary cities, the airport has become a gateway that directly links the region with a potentially infinite series of destinations national and worldwide.

The mobility infrastructure and the time travel it enables is reshaping the world geographies, establishing new hierarchical nodes defined by its access to world transport networks. This aspect is also questioning and changing the notion of the regional and the local. Paradoxically in some areas it is faster to get to another country that arriving in a location in the same region. In others, depending...
of the type of transport links available it can take the same time to move to another part in the same country than moving to another continent.

Air industry operation

In the past, the governments guaranteed the air connection of specific regions supporting the national air carriers. Airports used to be conceived only as transport infrastructures. After the privatization of national air carriers and airports in most countries during the last decades, the business model of airports is based now on the renting of airport slots and the provision of supplies to airlines. Guller (2003: 87) notes that “the core sectors of the airport business are airline handling, passenger transport, freight transport and related commercial activities.”

The prices are fixed by a bargaining between the airport and the airlines. The more attractive a location is for an airline, the more the airport can ask for renting a position in the terminal.

For reducing costs, international air networks are organized in a system of hub and spoke. A hub airport articulates national and international connections usually with other hub airports. For operating a hub should be able to articulate several feeding flights arriving at precise time for fulfilling the offer of an intercontinental flight. The spokes need a hub in order to access to reach a destination with not frequent passenger demand.

Usually big markets like those located in big metropolitan areas are also hubs, nevertheless, some of the most transited airport hubs are nowadays located in smaller cities if compared with the big metropolises. Moreover, according to Schipper, Y. et al (2001) quoting Friedham et al. (1999): “World cities seem to have a quality issue with the airport infrastructure at two levels: the major airport themselves are congested and they are part of ineffective multi airport systems”.

As a side effect of that model, some airports became unattractive for big airline carriers and gave place to the emergence of the low cost companies that are connected in a point to point scheme. Schaafsma et al (2008) suggest that the hub scheme still appears to be especially advantageous for long haul flights while the point to point scheme seems to be more efficient in flights covering smaller distances. In the future, as they comment “Growth in air transport may further change the balance between hub-and-spoke networks and point-to-point networks in favour of the latter” (2008: 26).

Airport negative externalities

The negative impacts caused by airports operation can be classified in two groups strongly interrelated: environmental and social.

According to Schipper, Y. et al (2001) the environmental externalities of air transport markets can be classified into three groups: external direct, external indirect and external effects associated with the presence of infrastructure. A summary table with the listing of the possible externalities they present is shown below.

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External direct effects depending on output in airline markets.

- Local air pollution.
- Global atmospheric pollution.
- Soil pollution.
- Noise pollution.
- Accident risk.
- Congestion.

External indirect effects, upstream or downstream.

- Pollution associated with aircraft or kerosene production.
- Disposal of scrapped aircraft.
- Costs associated with over exploitation of carbon-based fuels.
- Airport waste and environmentally harmful materials used in aircraft servicing and maintenance.

External effects associated with presence of infrastructure.

- Modification of river courses and field drainage.
- Deterioration in ecosystem through airport construction.
- Water and soil pollution through airport waste water leakage from storage tanks.
- Impacts on flora and fauna around airport.

In this classification it is possible to see how the negative externalities are not affecting only the surroundings of the airport but they are related also with the supporting infrastructure that serves it and with the environmental impacts caused for the production of the material required for the operation of this type of transport.

In relation with the pollution generated directly by airplanes it is important to note that nowadays air transport is one of the most polluting means of transport increasingly contributing to already with 3% to 5% of world CO2 emissions (Kivits et al: 2010).

Some other environmental externalities that could be caused by air industry include the introduction of external biologic agents like seeds and animals that could become into plagues, as well as the introduction of biological hazards such as viruses that in extreme cases could spread diseases worldwide.

As we can see, these negative environmental externalities could have also a strong health impact on the people living not just in the airport area but also in locations farther away from the terminal.

There are however, other types of negative social externalities that are more related with the way the presence of airport infrastructure impacts the adjacent communities and the urban development of a region. Three frequent social negative externalities can be identified. First, the risk of expropriation people living in the area could face because of the need for expanding the airport or its supporting infrastructure. Second, the speculation processes that could arise around the airport area, and thirdly, the different level of easiness of access to the airport in a regional scale that could contribute to increase spatial un-evenness.

Because of the above mentioned is clear to understand why the development or expansion of new airports could become a highly controversial issue that generally faces rejection from environmental groups and local communities.

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Because of the above mentioned is clear to understand why the development or expansion of new airports could become a highly controversial issue that generally faces rejection from environmental groups and local communities.
Contrasting with its negative environmental consequences, airports can produce widespread benefits for the regional economy enabling the flow of persons and goods, opening opportunities for business and employment in direct and indirect ways.

In some regions, the influence of an airport can be so relevant that it can be considered an economic engine as stated by Schaafsma, et al. (2008). According to them, in our time, the airport plays a role in city regions in three aspects: “the accessibility of a region, as a factor in location choices of international companies and to generate economic activity and diversify the economy” (2008: 34). According to their point of view, airports should be considered places of “value creation” putting forward five developments that are related to it. “Supply chain management and global shift, the formation of economic clusters, the growth of airport-related business and knowledge districts, airports as poles of interaction and innovation, airports and airport regions as destinations for tourism, leisure and entertainment” (2008:35). For smaller city regions “the airport can be an even bigger pull factor. Potentially it can boost the regional economy and become a pole of economic development itself” (2008: 56).

In a direct way, the operation of an airport generate jobs in a wide range of activities that can be classified into two groups: landside activities and airside activities: Airside activities involve all the companies and services that are directly related to the air platform operations including air security, aircraft maintenance, customs, logistics, among others. Landside activities involve the supporting services for the users and workers of the terminal like retail, offices, transport and maintenance services. The amount and functioning of those activities relates closely with the size of the terminal and the amount of passengers it handles. It seems to exist a proportional relation. The bigger the amount of passengers an airport handles, the more jobs in the terminal area are created. A minimum critical mass seems to be necessary for fully developing the job creation potential of an air terminal according to GullerGuller “Airports that grow beyond 20 million passengers become major regional work centres with long work cycles (often 24-hour service economies) (2002: 77)”. However, the amount of jobs generated in the airport also depends on the specific operation of the air terminal, as they same show. According to them, 500 workplaces in Barcelona Airport were generating 500 workplaces per million passengers per annum, while Amsterdam was generating 1400 workplaces per million passengers per annum (2002: 72).

In an indirect way, the airport influence extends to a wide range of activities that expand far beyond...
from the airport area establishing bold and thin links with different aspects of life in the region. From people meeting their family, to tourists, business men, artists, or performers visiting the region, among other activities.

Being an indispensable supporting infrastructure for activities such as tourism, the conventions and business sector or entertainment activities, air travel also enables face to face human interaction that tenuously impact in the personal life, the transmission of ideas and culture exchange. In the case of goods that this type of transport enables to move, the influence is also multiplied in almost any economic sector one can imagine. From the fashion designer or the wine exporter that can sell their products abroad to the laboratories or industries that import items for their business activity.
Airports establish a complex interaction with the region in which they are located. Originally conceived only as transport infrastructure elements, today airports and its surroundings have evolved into economically strategic and conflictive areas.

Nowadays, “International airports are one of the most important hot-spots in metropolitan regions” (De Jong, et al.: 2008). In that sense, the planning of these areas acquires a relevant role for reducing the impacts of the negative externalities this type of infrastructure produce and at the same time maximise the benefits it can bring to the region.

In their review on airport planning literature, Freestone and Baker (2011) identify six models of Airport-Driven Urban Development: Airfront, Decoplex, Airport city, Aerotropolis and Area. A synthesis of the six models they have identified is presented in Fig. 24.

For highlighting some of the strategic tools of each of the six models a self elaborated diagram based on Schlaack (2010) and Freestone and Baker (2011) is presented below.

In most of these planning models, the proximity and the accessibility to the airport platforms appears as a strategic and advantaged location where some high added value programs are implemented. Additionally, the attractiveness as a development location of the airport involves the integration of the airport terminal with local and regional transport network according to authors like Guller (2003: 131) for whom the “Airport interchange is the airport railway station's function as node in landside traffic networks: it not only serves air traffic passengers and airport employees, but is also the interchange between regional and national public transport networks "rail-rail, rail-subway, rail-bus, bus-bus, etc.). It can often provide faster connections to different parts of the region than a central station. Airport interchange requires the convenient interconnection of all modes of transport.”

In that way, the public transport connectivity with locations like the central business district and specific intermediate locations in a transit-oriented-development (TOD) is the base of models like the “airport corridor”.

Most of these urban planning models (decoplex, airport city, airport corridor and aerotropolis) are airport centered planning models promoted by entrepreneurs and airport operators. Its promoters center their focus on the economic benefits these types of developments could bring to the area but mainly from the airport business perspective. Models like the aerotropolis one, appear frankly as

Fig. 24. Models of airport driven urban development. Based on Schlaack (2010) and Freestone and Baker (2011).
real estate mega-developments in which the interaction with specific site conditions appear elusive. However, some of the models outline a more flexible approach that could allow for more integration with other aspects of regional planning like the “airport corridor” one. Other approaches like the Airea one, achieve to approach in a more complex way some of the interactions among airport and city uses, even though the practical application of the model (specially the strategic planning and design implications) remain vague.

Contrasting a too optimistic approach underlying most of the models is the uncertainty and fragility that surrounds air industry. Due to the nature of airport infrastructure, investments made are very high and involve long periods of investment return. Shifts in economy, airlines problems or change in strategy can drastically modify the flight patterns and the number of a passenger an airport receive potentially harming the airport related activities this type of urban planning models try to promote. Another source of uncertainty that challenges the sustainability of these models of urban planning is related with the dependence of air industry on oil supplies and the increasing contribution of air travel to global warming. While the transition to cleaner sources of energy supply for aircraft seems to be developing, the possible technological changes they would require could strongly modify air industry and its spatial requirements in the future as presented by Kivits et al. (2010). This aspect introduces a relevant source of uncertainty for the long term that should be taken into consideration for planning policies.

Chapter conclusions

As could be seen through this literature revision, infrastructure and air transport have given rise to new sorts of interdependencies and linkages between the local and the global. The scale of the regional collapses in favour of the global. The time travel implosion is related also to an energy consumption explosion that would potentially harm future human sustainability. The reduction in travel time is proportionally related with price. The faster you travel the more expensive the ticket is. In this sense, sharp reduction in time travelling is available for those who can afford the price of it. Thus infrastructure and technological change become elements that potentially could promote spatial unevenness in relation with the dependence of the less interconnected nodes on the most connected ones and social unevenness in relation with the high prices that the access to faster means of transport imply. In that sense, matter of social interest that societies and governments should promote will be that of creating mechanisms for achieving more equity in relation with the access to different types of infrastructure and means of transport. The phrase put forward by Graham and Marvin (2001) “One’s persons infrastructure is another’s difficulty” clearly depicts the complex relation between airports and regions. Because of its double

Fig. 25 Uncertain future trends for air industry in regard to fossil fuel dependence.
faced nature as source of strong positive and negative externalities, specially air travel and transport poses strong planning and design challenges.

From my perspective, the four sustainability pillars (economic, environmental, social and governance) put forward by Freestone and Baker (2011) can be the basis for a more comprehensive understanding for analyzing the implications of airports in cities. As they point out (2011:265) “systemic treatments of airports in a metropolitan context and with reference to broader urban and planning constructs still remain elusive”. While private entrepreneurship can be a fertile soil to develop added value in relation to airport activities, the urban planning approach in relation to those areas should be part of general regional planning strategies that use airports and airport related developments and its direct and indirect implications as tools for the common good.

Airport planning need to build on the specific potential of a city and region as Soja (2000) quoting Jane Jacobs says: “all propulsive forces for economic growth and development…emerge from the particular socio-spatial milieu of cities, from that extraordinary but too often overlooked condition of human life that can be described as the spatial specificity of urbanism”.

"all propulsive forces for economic growth and development...emerge from the particular socio-spatial milieu of cities, from that extraordinary but too often overlooked condition of human life that can be described as the spatial specificity of urbanism".
CHAPTER 3:
The airports of the megalopolis of Mexico and their challenges.
Air industry started in Mexico as in other countries as air exhibitions. In the case of Mexico City, the grasslands located between the center of the city and the Lake of Texcoco were the site when in 8th January 1910, took off the first airplane in the country’s history. However, it was until 1952 that the first international terminal of the airport of Mexico City was inaugurated.

For Dominguez-Virgen (2009) the limitation of the operational capacity of the airport was first identified during the presidential periods of Gustavo Díaz Ordaz (1964-1970) and Luis Echeverria Alvarez. According to him, the relevance of the issue in the political agenda has fluctuated because of two factors that temporarily reduced the saturation problem: First, the economic crises (that affected air travel demand) and second, some minor adjustments in the infrastructure that have made it possible to increment in a marginal way airport capacity.

During the government of Luis Echeverria was first considered the necessity for attending the airport capacity issue. Two options were studied. The first one involved moving all operations of Mexico City Airport to the municipality of Zumpango. The second one, implied building a new runway using the existing airport and in the meantime starting the expansion process in the area of Zumpango for later building a new airport. Because of economic and political conjunctural problems only minor modifications were made to the terminal for expanding its capacity. Years later, the lands that were expropriated in Zumpango were squatted and the option for building the airport there was discarded. (Dominguez-Virgen: 2009). The lack of definition of a long term strategy for the airport and the explosive urban growth of the Metropolitan Area of the Valley of Mexico City during the second half of the 20th century gave as a result that the options nearer to the city center for expanding the airport capacity were discarded time after time.

By the end of the 20th century the stronger candidates sites for developing a new airport in the Metropolitan Area of Mexico City were an option in Texcoco (State of Mexico) and option in Tizayuca (State of Hidalgo). From the aeronautic point of view, the option in Tizayuca was suboptimal compared with the option in Texcoco where three parallel runways that could allow for simultaneous landing could be constructed. However, from the environmental perspective, it was the weakest option. Dominguez-Virgen also identified two coalitions that lobbied for supporting them.

In 2001, the federal government announced the construction of the new airport of Mexico City in Texcoco. However, due to strong political opposition the project was cancelled and on August 1st 2002.

As an alternative for the failed project for building a new airport in Texcoco, the federal government announced in 2003 the creation of a metropolitan airport network, in Spanish “Sistema Metropolitano de Aeropuertos” (SMA) for attending the airport capacity needs.

Of the complementary airports of the network, the one in Toluca was the one that received more relevance due to its proximity to Mexico City. In that sense, the airport in Toluca attracted some of the first low-budget airlines that operated in the country and became the second airport of Mexico City. Moreover, in 2009 the airport of Toluca handled more than 2 million passengers ranking among the five busiest in the country. However, the airport saw a drastic diminution in the number of travellers after 2011 when the low budget airlines were allowed to fly from the airport of Mexico City.
Fig. 27. Airports of the megalopolis of Mexico.

A. Mexico City airport (MEX)
B. Toluca Airport (TLC)
C. Puebla Airport (PUE)
D. Cuernavaca Airport (CUE)

Fig. 28. Table. Airports of the megalopolis of Mexico (includes Queretaro airport)

| Airport          | Passengers (2012) | Cargo (2008) | Airport capacity (passengers) | Dominant airline | Dominant alliance | Low-Cost Carriers | Airport Manager | Distance from city center | Distance from Mexico City Center | Distance from Toluca Center | Distance from Puebla Center | Distance from Cuernavaca Center | Distance from Queretaro Center | Area of the airport (ha) | Airport status | Capacity / Passengers ratio | Passengers / Area ratio |
|------------------|-------------------|--------------|--------------------------------|------------------|------------------|-------------------|-----------------|---------------------------|-------------------------------|-----------------------------|---------------------------|---------------------------------|---------------------------|-----------------------------|--------------------------|--------------------------|
| Mexico City Airport (MEX) | 29,491,553 | 360,746 | 32,000,000 | Aeromexico | SkyTeam | Interjet, Viva Aerobus, Volaris | AICM | 8 km | 62 km | 102 km | 58 km | 187 km | 750 | International Airport | 1.085056457 | 39322.07067 |
| Toluca Airport (TLC) | 972,414 | 25132 | 8,000,000 | Aeromexico | NA | Interjet, Viva Aerobus, Volaris | AMAIT | 10 km | 44 km | 62 km | 54 km | 163 km | 683 | International Airport | 8.226048804 | 1468.687783 |
| Puebla Airport (PUE) | 264,211 | 1,022 | 4,000,000 | Aeromexico Connect | NA | American Eagle, United Express, Interjet, Volaris | ASA | 23 km | 87 km | 135 km | 93 km | 263 km | 396 | International Airport | 1.513941509 | 667.1994949 |
| Cuernavaca Airport (CUE) | 50,874 | 254.7 | 110,000 | Viva Aerobus | NA | Viva Aerobus | Aeropuerto de Cuernavaca S.A. De C.V. | 65 km | 65 km | 114 km | 10 km | 227 km | 110 | International Airport | 2.163204662 | 462.4909091 |
| Queretaro (QRO) | 226,908 | 2943.7 | 110,000 | Aeromexico connect | NA | American Eagle, Volaris | Aeropuerto Internacional de Queretaro S.A. De C.V. | 170 km | 157 km | 272 km | 214 km | 21 km | 688 | International Airport | 1.10178117 | 329.8081395 |
Fig. 29. Mexico City International Airport.

Fig. 30. Toluca International Airport.

Fig. 31. Puebla International Airport.

Fig. 32. Cuernavaca International Airport.

Fig. 33. Queretaro International Airport.
Chapter conclusions

Nowadays, the airport of Mexico City concentrates the largest number of passengers of the region. Followed distantly by the Airport of Toluca, and even more distantly by the very few number of passengers currently using the airports of Puebla and Cuernavaca.

These facts result logic considering the hub status of the International Airport of Mexico City, which actually is used by passengers coming from the other cities in the region.

In terms of cargo, the airport of Mexico City also plays the most important role in the region, however, there has been an important growth in the amount of cargo that is moved in other airports of the network, highlighting specially the airport of Queretaro that increased its cargo operation. According to Galindez and Nava Figueroa (2009) the implementation of the airport network has proved to be successful. Even though, according to them, the fact that the government has not completely enforced policies for promoting air traffic in the alternate airports, has caused that the airport of Mexico City ended competing with the rest of the airports after finishing its expansion.

In 2012, the airport of Mexico City handled more than 29,000,000 million passengers reaching again levels of saturation. In that regard, the public discussion on how to face airport saturation is moving again at the center of the public agenda.

The ratio between the number of inhabitants in relation with the number of passengers that traveled to and from Mexico City is very low if compared with other metropolises. Taking the 20 largest urban economies of the world in terms of gdp and number of passengers, is interesting to note that Mexico City ranks well below the rest, even if compared with other big Latin American cities like Sao Paulo and Buenos Aires. That fact could also show the need for more airport capacity.
On April 2013, the General Direction of Civil Aeronautics “Dirección General de Aeronáutica Civil (DGAC)” issued a notice of saturation for the airport of Mexico City. According to it, the airport is facing saturation 8 hours a day. Quoting Dominguez Virgen (2009: 69) in case the number of flights keep growing and airport capacity won’t be incremented, “the cost would be transferred to the users (and the economy in general) through delays, higher air rates and increased air security risks”.

Four options are now being considered for solving the saturation problem: building a new airport in Texcoco, building a new airport in Tizayuca, building an airport at Santa Lucia Military base or expanding the capacity of Toluca Airport.

Fig. 36 Airport passenger capacity vs airport travellers per year in the megalopolis of Mexico (2012). With data from the ministry of Transport.
Analysing five airport site locations.

As a highly politicized issue it is, a complex set of interests, supporters and opponents can be identified. A table that summarizes some of the most evident for each case are shown in Appendix 1.

As a way for identifying the different characteristics of the airport options that are being evaluated, I did a qualitative SWOT analysis and a qualitative weighted analysis based on the method of Dan and Nishry. For carrying out this analysis, I defined 18 indicators that can be group into three major areas related to the three pillars of sustainability (Economic, Environmental and Social/Governance). These indicators are based on the theoretical framework about airport externalities and models of airport driven urban development presented before, as well as some issues relevant in the regional context of the center of Mexico. I do not intend this analysis to show a thoroughly scientific truth, I used it as a way for grasping a new subject for me, for helping me in defining my personal position on the subject and for making more transparent and systematic my research.

The indicators I took into consideration are:

Economic

- Initial investment. How much financial resources would be needed for putting into operation the airport?
- Space for future expansion. Is there availability of land in the area so the airport can have space for accommodating more air operations in the future if needed?
- Real Estate development. Is there attractive space for real estate developments in the area surrounding the airport?
- Railway access. How easy would it be to connect the airport to existing rail roads?
- Highway access. How easy would it be to connect the airport to existing highway infrastructure?
- Strategic regional position. How the position of the airport in relation with urban settlements and infrastructures in the region would facilitate its accessibility?

Environmental

- Recycling of existing infrastructures. Is it possible to take advantage of existing airport infrastructure?
- Presence of birds in the area. Is the site located next to water bodies with birds that could put a threat on airport operations?
- Weather conditions. Is it common the presence of frequent mists or volcanic ashes in the area?
- Water availability. How the water is supplied to the airport?

Fig. 37. Proposed locations for a new airport in the megalopolis of Mexico.
A. Texcoco. B. Santa Lucia Military Base. C. Tizayuca.
• Conditions of the subsoil. Can the characteristics of the subsoil represent extra costs in the construction and management of facilities and runways or in pollution management?
• Noise affect on population. What type of urban environments could be directly affected by aircraft noise?
• Energy supply. Are there already gas ducts for providing jet fuel to the airport?

Social / Governance
• Interference with other airports. The operation of the airport would imply the closing of other airport or impose difficulties for existing ones?
• External Support. Are there signs that political, economical actors or user would support the project?
• Community support. Are there signs that local groups would support the project?
• Site Antecedents. What’s the history of the site?
• Land ownership. Who owns the land? Would there be need for expropriations?

In the following pages I present a short description of each one of the airport sites commenting them in relation with the 18 indicators that I have proposed.

PART A. Brief indicator description for each site and SWOT analysis.

PART B. Weighted evaluation.

PART C. Limitations and discussion.
Option 0. Extending the life cycle of the AICM.

Economic indicators

- **Initial investment.** The airport may require investments for adapting it to new type of airplanes like the A380 involving modifications in the runways. Noise mitigation measures like acoustic windows will be required in noise affected areas.

- **Space for future expansion.** Since the airport is completely surrounded by urbanization, it is not possible to build an additional runway. Possible measures for expanding the capacity could include some adjustments in the terminals, and the moving of some of the flight operations to other airports.

- **Real Estate development.** In the area surrounding the airport can be found several companies related to the operation of the terminal including hotels, restaurants, warehouses, and small and medium scale industries.

- **Railway access.** The airport has no link to passenger trains but the tracks and rights of way of the old train system can be found north of the airport.

- **Highway access.** The airport is directly linked to the inner ring road of Mexico City, Ignacio Zaragoza, Vlahor and Mexico - Texcoco highways.

- **Strategic regional position.** The airport is located in the middle of the metropolitan area just 7 kilometers to the Historic Center of Mexico City. It serves the Federal District, the State of Mexico, the State of Puebla, the State of Morelos and the State of Hidalgo.

Environmental indicators

- **Recycling of existing infrastructures.** Since it was created the airport has experienced several renovations and adaptation in order to increase its capacity and to adapt it to air travel trends.

- **Presence of birds in the area.** The airport could be affected by migratory birds that hibernate in the neighboring lacustrine areas.
Weather conditions. The airport needs to suspend its activities several times each year because of mist. Occasionally, the runways are closed because of floods. Popocatepetl volcano is located 64 km from the terminal.

Water availability. Water is provided by water wells and pipes. The consumption of the airport is about 810,000 liters of water per day.

Conditions of the subsoil. The soil of the area is lacustrine, as a consequence of that and because of the height of the construction and the extraction of underground water it presents important soil subsidence.

Noise effect on population. The acoustic footprint of the aircrafts getting to airport affects highly inhabited areas of Mexico City. Not specific mechanisms for counter it have been announced yet.

Energy supply. The jet fuel is provided to the airport through a gas duct. The airport is connected to the electric grid.

Social / Governance

Social / Governance indicators

Interference with other airports. The terminal operates together with the airport network of the center of Mexico.

External Support. Users of the airport would find uncomfortable to move the operation to other site, especially if it implies longer time of displacement to a possible new location.

Community support. Workers and owners of companies operating in the proximities of the terminal would be interested in maintaining the operation of the terminal.

Site Antecedents. In the past the area was covered by the waters of Texcoco Lake. Once the Lake was dried, it became grassland between the center of Mexico City to the west and the remains of Texcoco Lake to the east.

Land ownership. The land of the airport is managed by the company AICM which is also part of ASA, a decentralized organ of the ministry of Transport and Communications of Mexico.

SWOT ANALYSIS

STRENGTHS. The main strengths of the current airport are in social and governance aspects since the terminal has been operating in the area since decades ago. Other strengths are related with some aspects as the recycle of existing infrastructure since important investments have been made in the area through the years for increasing the capacity of the airport. Additionally, the airport is quite well integrated to highway and public transports infrastructures representing an important transport node at the east of the metropolitan area of Mexico City.

WEAKNESSES. The main weaknesses of the airport of Mexico City are related to environmental and economic aspects. Located almost in the middle of the megalopolis of Mexico as it is surrounded by highly inhabited areas. In that sense, the terminal contributes negatively to air pollution in the valley of Mexico and is affecting with noise highly inhabited areas of the center of Mexico City. Additionally, due to this same condition, the airport cannot be expanded, affecting its future perspectives, especially if different aircraft technologies would require more space in runways as is happening recently with the introduction of the A380.
OPPORTUNITIES. While the airport is connected to public transport network (one metro station and one metrobus stop) in the future the right of way of the railroad’s might be used for connecting the airport with this type of mobility system. Moreover, Pantitlan Station, one of the most connected transport hubs of Mexico City is located in a very close location to Terminal 2. One interesting possibility for the future could be to find the way to integrate directly terminal 2 and this transport hub situation that could facilitate accessibility by public transport.

THREATS. The most important threats that the airport would face are related with environmental issues. Tighter aircraft noise regulations in the future may affect the operation of the airport. In recent years there have been some protests against aircraft noise in the area. Additionally, the airport is located in a lacustrine soil that presents subsidence, increasing operative costs.

As other parts of Mexico City, the airport has not enough water for its maintenance and sometimes is being supplied by water pipes.

Fig. 40 Entrance to terminal 2 of the International Airport of Mexico City.

Economic indicators

• Initial investment. The place requires investments for avoiding the risk of soil subsidence as well as the development of energy infrastructure and public transport.
• Space for future expansion. In the area could be built up to 3 parallel runways for simultaneous landing ensuring the highest capacity of the proposed options.
• Real estate development. The existing terminal could use for real estate development once the airport is close after a new one begins its operations.
• Railway access. No train tracks are crossing the area. Some of the old tracks located in the periphery of the federal zone.
• Highway access. Through the area passes the Mexico-Texcoco highway.
• Strategic regional position. This place is located between the cities of Texcoco and the center of Mexico City.

Environmental indicators

• Recycling of existing infrastructures. The construction of the airport in this site involves the closing of the existing airport.
• Presence of birds in the area. The airport is located in a lacustrine zone that hosts more than 300 000 migratory birds each year. Risk of interference with these animals is high.
• Weather conditions. Mists in the area are frequent and the place present high risk of floods. The airport is located 65 km from the Popocatepetl volcano and could be affected in case of ash eruption.
• Water availability. Water could be provided by the lakes in the area or by connecting the...
SWOT ANALYSIS

STRENGTHS. The main strengths of this option are related with economic aspects. The airport in Texcoco is the closest location to the city center and is located at the center of the megalopolis of Mexico as the current airport also is. Moreover, the urban development factor could be very high taking into consideration the locational aspect. From the point of view of external support, it is been backed by several organizations and it might represent a reasonable option for the current users of Mexico City airport. Of the proposed options is the one that has the biggest space for expansion.

WEAKNESSES. The weakest points are related with environmental and social / governance issues. The construction of an airport in the terrains of Texcoco has been contested by (CONAGUA) since it would seriously affect the works for restoring part of the lacustrine environments in the area since decades ago.

SOCIAL / GOVERNANCE INDICATORS

• Interference with other airports. The terminal requires the closing up of the existing airport of Mexico City.
• External Support. The project has faced strong opposition by environmentalist groups in the past. Some of the current users of the airport may support the project because it offers the closest location to the existing terminal.
• Community support. The National Water Commission has strongly opposed to the construction of the airport project. There were important political problems with the surrounding communities opposing to the project 10 years ago.
• Site Antecedents. After the drying out of the lake, the area suffered desertification. Since the 1960s, the federal government bought 10,000 ha in the zone for developing a project for protecting the metropolitan area from floods and improving its ecological conditions.
• Land ownership. The land is owned by the federal government and is directly managed by the National Water Commission (CONAGUA).
OPPORTUNITIES. The most relevant urban opportunities for building the airport in this area are related with the use that the existing terminal could have, representing a huge surface of land almost in the middle of the site that would be set for construction and real estate development.

THREATS. The main threats are related with the adverse environment the construction of the airport in this location could face. The political conflicts that arose in 2002 and that ended with the cancelation of the project might reappear. An important threat could be those of the migratory birds that use the lakes.

Fig. 42 Aerial view of Texcoco wetland area.
Option 2. An airport in Santa Lucia Military Base.

Economic indicators

- **Initial investment.** The initial investments would require the adaptation and development of train infrastructure for making accessible the site, as well as the construction of the civil terminal and water and energy supply supporting networks.
- **Space for future expansion.** In the area could be built up to 2 parallel runways, and a third one for exclusive use of the army.
- **Real Estate development.** Part of the terrain could be used for real estate development, especially for warehouse and airport related industries.
- **Railway access.** The military base is located next to the intersection of two railways. One connecting Mexico City with Pachuca and another that connects to the east of the State of Mexico. Both are underused but can be recycled.

Environmental indicators

- **Recycling of existing infrastructures.** The construction of the airport in this site could take advantage of part of the infrastructure that has been developed for the military base.
- **Presence of birds in the area.** The airbase is located 14 kilometers from Zumpango Lake. Interference with them could happen.
- **Weather conditions.** Mists in the area are not uncommon. The airport is located 90 km from the Popocatepetl volcano. The risks in case of volcanic ash eruption are low.
- **Water availability.** Water could be provided by the lake of Zumpango or by connecting the terminal to the Cutzamala System.
- **Conditions of the subsoil.** This site is located in an ex-lacustrine area. Additional costs for avoiding soil subsidence could appear.
- **Energy supply.** There are some gas ducts in the surrounding area that could be used for bringing oil from the Tula Refinery.
SWOT ANALYSIS

STRENGTHS. The main strengths are related with the fact that the land is already own by the government so there won't be special need for expropriations. Additionally, the location of the military base is not as far as others. Additionally, the site already has a runway that could be used as part of the new airport reducing the initial required investment.

WEAKNESSES. The possibilities for expansion are not as big as other options. Agreements with the military would be required for a joint operation in the area. The option is not well known as the other options.

OPPORTUNITIES. The terminal is located in a railroad crossing what would give the opportunity to connect them to Mexico City using the rights of way of the old rail roads.

THREATS. The surrounding areas have presented important urbanization in the last years, reducing the space that could be required for noise and safety buffers.

Social / Governance

• Interference with other airports. The air base has operated together with Mexico City airport since it opened. With some redefinition of routes and proper management both terminals could operate together.
• External Support. The users coming from Mexico City may prefer this option in comparison with the one of Tizayuca. There has not been too much open public on regard of this option.
• Community support. A political party has proposed the site for a new airport. There is no record of local support to this proposal. The army may oppose to this project or they can operate in a joint way the airport.
• Site Antecedents. Centuries ago the area was covered by the Lake Xaltocan. It remains a swampy area after the works of drying out of the lake.
• In 1958 the terrains in the area were expropriated by the government in order to build a Military Base.
• Land ownership. The land is owned by the Mexican army. Part of it is being occupied by a military housing complex.

Fig. 45 Landscape at the surroundings of Santa Lucia Military Base.

Economic indicators

- **Initial investment.** Initial investment would imply the construction of train infrastructure and supporting energy and water supply networks.
- **Space for future expansion.** In the area could be built up to 2 parallel runways for simultaneous landing.
- **Real Estate development.** The place has high availability of land that could be used for real estate development especially for logistic activities.
- **Railway access.** Next to the proposed site for the new terminal crosses the Mexico-Pachuca train line. That line has the potential to be used for cargo and also for passengers.
- **Strategic regional position.** This place is located 23 km from the center of the city of Pachuca and 65 km from the center of Mexico City. The place is located in a mid position between the cities of Queretaro (178 km) and Puebla (125 km).

Environmental

- **Recycling of existing infrastructures.** There is no current construction on site that could be recycled. The main element to recycle would be the train tracks.
- **Presence of birds in the area.** The closest water body to the site is located about 13 km. The risk of bird interference is low.
- **Weather conditions.** The weather in the area is dry and mists are not frequent. The airport is located 104 km from the Popocatepetl volcano. The volcanic ash hazard is low.
- **Water availability.** Water could be provided by some of the dams located in the region.
- **Conditions of the subsoil.** This site is located in a plain with low yield agriculture soils and no lacustrine origin.
- **Energy supply.** A gas duct may be built connecting Tula Refinery with the site.

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**Fig. 46.** Tizayuca airport option conflict and opportunities map.

**Fig. 47.** Location of Tizayuca airport option in relation with the megalopolis of Mexico.
SWOT ANALYSIS

STRENGTHS. In this case, the strengths are related with the accessibility to infrastructure since the site is located in the crossing of the Mexico City – Highway and the Arco Norte bypass and next to the rail road connecting Mexico with Pachuca. Additionally, the lands have been already bought and expropriated by the government.

WEAKNESSES. The location of this site is the farthest of the options from the center of Mexico City.

OPPORTUNITIES. The construction of the airport in this area could represent an economic opportunity for the city of Pachuca especially in relation with logistics.

THREATS. Land speculation in the surrounding areas as well as some conflicts with the people that was expropriated in the area may generate conflicts in the future.
Option 4. Expanding Toluca Airport.

Economic indicators

- **Initial investment.** Investments are required to expand the airport to its maximum capacity involving possible buy of neighboring lands as well as an investment related by the accessibility by train.
- **Space for future expansion.** The airport has started to be surrounded by urbanization. The current infrastructure can handle up to 8 million passengers but if its capacity is increased it could handle up to 25 million passengers. The expansion plans may require land expropriations.
- **Real Estate development.** The area has an industry and warehouse cluster in its surroundings. There is still available land around the airport area and in the airside of the airport.
- **Railway access.** The airport has no link to passenger trains. A link could be built using the existing tracks and right-of-way of the old Mexico-Toluca train line.
- **Strategic regional position.** The airport is located between the cities of Toluca and the metropolitan area of Mexico City.

Environmental indicators

- **Recycling of existing infrastructures.** The infrastructure of the airport has been recently upgraded to service a higher demand of passengers.
- **Presence of birds in the area.** The airport is located 7 km from the nearest wetland and in radius of 20 km from the place there are other lakes. The terminal could be slightly affected by migratory birds.
- **Weather conditions.** The airport needs to suspend its activities several times each year because of mist. The airport is located at more than 100 km from the Popocatepetl volcano.
- **Water availability.** Water is provided by the Cutzamala system that also provides water to the Valley of Mexico.
SWOT ANALYSIS

STRENGTHS. The main strength of this option is that it is already operating as alternate airport to Mexico City having a developed capacity able to handle up to 8 million passengers per year. Additionally, important investments have been made in the area in the last years for improving highway accessibility. The airport could be expanded to handle up to 25 million passengers per year.

WEAKNESSES. The weakest points are related with environmental aspects like the noise it could generate in the nearby inhabited areas as well as the height of the airport (more than 2400 meters above sea level) that could prevent some aircrafts from landing there.

OPPORTUNITIES. The airport is located close to western part of Mexico City were more current users of air travel live. Additionally, it close to the financial center of Santa Fe, one of the most important corporate centers of the city that could benefit from the airport.

THREATS. The main threats are related with the process of urbanization in the surrounding areas that already limited the possibilities for expansion of the terminal. Additionally, the expropriations made for expanding the airport could represent sources of conflict.

- Conditions of the subsoil. The soil of the area is located in an ex-lacustrine area. Some additional investments could be required to avoid subsidence problems.
- Energy supply. The jet fuel is provided to the airport using pipes increasing the operation costs and air services in the terminal. The airport is linked to the electric grid.

Social / Governance indicators

- Interference with other airports. The terminal operates together with the airport network of the center of Mexico.
- External Support. Some users have started are getting used to travel via this airport as an alternative to the airport in Mexico City.
- Community support. Owners of properties in the nearby area that have settled down in the airport would be interested in expanding the airport. People under risk of expropriation would oppose to the expansion on the airport.
- Site Antecedents. The airport of Toluca was inaugurated in 1984 in an area that centuries before was partially occupied by the marshes of the Lerma River. After the failure of the project for a new airport in Texcoco it was integrated in the Metropolitan Airport Network.
- Land ownership. The airport is managed by a public-private consortium with the following shares. State of Mexico 26%, ASA 26%, Private investors 49%
Based on the Method of Dean and Nishry I made a qualitative weighted analysis of the indicators for each of the five locations. The purpose of this was to show give different priorities to each of the indicators analysed. Due to the short period of obtain available the analysis only presents the weighted valuations according to my point of view; however, it could be interesting to test the same analysis with several experts in order to obtain a more representative sample and valuation.

In the first phase of the method, I gave a value of 1 to the indicator if I considered it was more relevant and 0 if considered it was less relevant. A value of 0.5 was given when I considered both indicators had the same relevance. In all cases the sum of the two values in the matrix should sum up 1. The result of this matrix was a coefficient of relative importance (CRI) that gives each indicator a percentage of a total score of 100. According to this evaluation the values each indicator get are shown in Graphic 1.

In the second phase, I did a matrix for each indicator together with the 5 site options in order to understand for each indicator which options were stronger (1), equal (0.5) and weaker (0). Again, in this case at both sides the matrix the result should sum up 1. The result of these matrices was a coefficient that represents a percentage that gives each site a value per each indicator according to a comparison among them.

In a third phase, the CRI of each indicator was multiplied for the coefficient obtained in the second phase for each site, obtaining a weighted measure according to the relative importance given to each parameter and the particular value obtained by each site. At the end the results were summed up. The higher the value obtained, the stronger the option is in regard to the values assigned to the parameters. The detail procedure is shown in appendix no. 1. According to the results obtained from this analysis, the stronger options were: expanding the life cycle of the existing airport, start building a new airport in Tizayuca and expanding the airport in Toluca. The lowest ranked of the options was the one of building an airport in Texcoco.

Chapter conclusions

According to the results obtained it is possible to see that there is not perfect option. Each one the sites have specific pros and cons that should be taken into account.

The decision for developing an airport on each of the sites presented depends on the point of view that is favoured (economic, environmental, social / governance).

The weaknesses of the analysis I made consist in the following aspects:

- The indicators were defined by my individual criteria; therefore a personal bias is possible.
- Some of the indicators require very specialized analyses that should be done in multidisciplinary groups. In those cases, my valuations are assumptions based on my current knowledge on the issue and the sites.
- The analyses does not take into account possible combinations that could arise, for instance in the case of having a number of the sites operating at the same time.

However, the application of the Method of Dan and Nishry was useful for handling a complex set of indicators and still making transparent the different values I gave to each indicator according to the relative importance.

An interesting result could by obtained by combining the method of Dan and Nishry with the integration of different scenarios, in that way the outcomes would be affected by the specific conditions inherent to the considered scenarios.
CHAPTER 4:
What if the megalopolis of Mexico had a multi-airport network?
A centralized airport model.

The main pros for this model in a metropolitan area are related to the economies of scale and the benefits they can bring in terms of diminishing operative costs and increasing yields and profits.

This model facilitates, for instance, the operation of an air hub, since large numbers of passengers coming from all the region are concentrated in one terminal increasing the chance to achieve a critical mass needed for serving a specific destination. In this sense, a centralized airport is likely to offer a wider variety of destinations for its users in the same terminal.

Additionally, a centralized airport is likely to concentrate in its surroundings a big amount of related activities and companies. This aspect also introduces the main downsides of this model, an excessive concentration of both positive and negative aspects.

In that way, a concentrated airport operation for a whole region also represents increased environmental impacts, increased need for developing infrastructure to make the terminal accessible for the whole region, and more likely pressure on urban land development around the airport. Moreover, having only one airport that centralizes all the air operations in a region increases its vulnerability in case of disasters.

A multi-airport network model.

According to the definition put forward by (De Neufville and Odoni: 2003) quoted in (De Neufville: 2005) a multi-airport system is “the set of significant airports that serve commercial transport in a metropolitan region, without regard to ownership or political control of individual airports”. Examples of metropolitan region operating with multi-airport systems include some of the largest urban agglomerations of the world like London, New York, Paris and Tokyo.

It can be assumed that the presence of a multi-airport system in such urban regions is also a consequence of its large extension and the complex dynamics this type of urban environments establish with its territories. Some points in common can be found in the development of airport infrastructure in these megalopolises:

The first airport was located in the outskirts. After urban expansion, the first airport was surrounded by urbanization and additional airports were needed when the expansion of the first one was made impossible because of lacking space. As a consequence of this process, new terminals were built in the outskirts of the already bigger metropolises in locations much farther away.

The strengths of a multi-airport network specially when talking about the case of a megalopolis can be related to the flexibility, diversity and competitiveness of having several facilities. Each of the airports could develop specific features and specializations in relation with its location and access to infrastructure. At the same time, relying on several and not in only one facility reduces the vulnerability in case of externalities and provides flexibility in case of the need for maintenance on the other airports.

Taking into account the analyses carried out in the previous chapter, the airports that will be considered for developing a multi-airport network in the megalopolis of Mexico are Mexico City (MEX), Toluca (TLC), Cuernavaca (CVJ) and Puebla (PUE), as well as having reserves for building a new airport in the area of Tizayuca ready for the possibility of increased demand in the future.

According to GullerGuller (2002: 39) “An airport system has to provide equal access to air traffic for the whole region. On top of that, it has to allow for adequate distribution of the potential benefits” in this regard, the strategic objective of developing a multi-airport network (and starting developing in the future a new terminal in Tizayuca) is to facilitate immediate access to air transport not only to the metropolitan area of Mexico City, but to the other metropolitan areas of the megalopolis.
It is important to point out that even in a multi-airport system, one of the airports usually takes more relevance than the others in relation with its attractiveness for costumers unless different policies were implemented for regulating the flights offered by each airport as shown by de Neufville (1995).

According to the existing trends in the airports of the region, a possible characterization of the airport network of the megalopolis of Mexico as presented in the following pages.

Even tough airports are likely to develop specific market niches according to their specific characteristics, it’s also important to note out the relevance that public policies may have on the operation of this infrastructure and consequently, on the economic impact they can have on its surrounding region.

In this sense, its is highly important that the government follows a strategy for strengthening the alternate airports enhancing its attractiveness in relation with the consoliated and congested air terminal of Mexico City.

In this regard, these points appear relevant to increase the attractiveness of the alternate airports and decongest the airport of Mexico City:

- Enhance the accessibility of the alternate airports.
- Reduce to a minimum the number of low cost airlines operating in Mexico City airport. As some press report suggest, since they started their operation after the bankruptcy of a national air carrier, they attracted several travellers that were using Toluca airport that reported an enormous fall in the number of passengers.
- Redistribute the cargo operations to the other airports, helping to decongest the existing terminal forhub connections only.

The expansion works in the airports should be developed with careful analysis for not over-investing in them. However, as de Neufville (1995) suggest, territorial reserves should be bought by the government to have space for airport development and enough buffer areas for security and comfort issues. These actions are especially relevant for the airports that are not surrounded yet by strong urbanization, namely the ones of Puebla and Tizayuca.
MULTI-AIRPORT NETWORK FOR THE MEGALOPOLIS OF MEXICO

TOLUCA AIRPORT (TLC)
This airport will represent an important alternative for national, and international flights in North and Central America and in a smaller degree intercontinental flights. The airport can have also a moderate role in providing low cost flights and logistic services.

CUERNAVACA AIRPORT (CVJ)
The role of this airport is likely to be more limited in comparison with the other airports of the network. However, it can be orientated towards low cost airlines flights coming from other parts of the country.

TIZAYUCA AIRPORT
The development of this infrastructure should be organized in a gradual way focusing its first phases on logistics and low budget airlines.

PUEBLA AIRPORT (PUE)
This airport can keep providing logistic services for the local industries but can also have a strong focus on low cost airlines operating in the country as well as some North American and Central America connections.

MEXICO CITY AIRPORT (MEX)
This airport would continue being the hub airport for intercontinental flights with connections with other airports in North and Central America. Low cost airlines operation should be reduced to a minimum. Part of the cargo should be transferred to the other airports of the network.
CHAPTER 5:

What if the multi-airport network was connected by intermetropolitan mobility corridors?
As seen in previous chapters, enhancing the accessibility to the alternate airports is a basic precondition for help its operation as part of an airport network.

This very same aspect could be linked to the issue of public transport operation in the megalopolis of Mexico. Since the location of the airports is about more than 40 kilometers from the center of the metropolitan area of Mexico City, fast connections should be established for making feasible and attractive its operation. From this perspective, the most efficient public transport infrastructure in terms of time would be the operation of intermetropolitan trains running at an average speed of 120 km/hr (the existing suburban train in Mexico City has already that speed).

Additionally, trains have the advantage of no requiring fossil fuel and being three times faster than other means of transport like the BRT. The former passenger train lines were dismantled in the 1990s as part of neoliberal policies. However, 30 years ago, train infrastructure in the country used to move more than 25 million passengers (Cepeda: 2013).

If the case was just to connect Mexico City with other airports rebuilding the train infrastructure will not be reasonable. However, the connections are proposed among a city with more than 20 million inhabitants and “medium cities” with more than 1 million inhabitants having the airport as an intermediate stop. Nowadays, most of the intermetropolitan trips are done by car and by bus. The current energy policies are subsidising this model, which is sustained by a strong oil subsidies that have triggered an explosion in the use of car in the country as shown in fig. 53.

However, this situation seems to be changing, as part of the National Plan of Development, the Mexican government has announced the project for reintroducing passenger trains in the country, proposing indeed, the construction of a line connecting Mexico City with Toluca and another connecting Mexico City with Queretaro.

Reintroducing passenger infrastructure possesses however different challenges far beyond the economic one. After years of abandon, the oil train tracks have been abandoned and invaded for illegal settlements. Train tracks that were running one

Each year 74,485,196 travellers use the bus stations of the metropolitan areas of the megalopolis of Mexico. Each day more 170,000 cars use the highways connecting Mexico City and the medium cities.

Fig. 53. Oil subsidies in Mexico and its relation to car use. Base on Medina (2010).

<table>
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<tr>
<th>Year</th>
<th>Kilometers of travels by car in Mexico</th>
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<tr>
<td>1990</td>
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</tr>
<tr>
<td>1992</td>
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<tr>
<td>2000</td>
<td>300,000</td>
</tr>
<tr>
<td>2002</td>
<td>350,000</td>
</tr>
<tr>
<td>2004</td>
<td>400,000</td>
</tr>
</tbody>
</table>

Source: Mexico Ministry of Transport

Fig. 53. Oil subsidies in Mexico and its relation to car use. Base on Medina (2010).
hundred years ago in the countryside are now in the middle of densely inhabited areas making it difficult to completely reuse the rights of way of the old train lines, especially in the central areas of the cities. As a showcase of the current spatial conditions of the rights of way in Mexico City an analysis is presented in appendixes number 2 and 3.

Taking into account that situation, it seems clear that the rights of way of the old train lines can only be partially used by a new train passenger train system. Additionally, the train infrastructure was built mainly one hundred years ago for connecting relevant destinations at that time, since then the city has been entirely transformed and new centralities have emerged.

The development of Mexico City during the last decades can’t be understood without the influence the car had upon it and how the car reshaped and change the way of living the city. Highways replaced railroads during the second half of the 20th century as the main transport infrastructure. The construction of highways was privileged and their routes are connecting nowadays the most strategic points of the megalopolis.

In that sense, why not to use the trace of some of the main roads of the city as the routes were new public transport infrastructure (train and BRT) could be implemented? This move would imply a radical redistribution of the space of the city from the private car users to the public transport and a clear bet for a more even and sustainable region.

The operation of public transport should be considered in a broader scale, not only as lines connecting one place to other but as an integrated system of intermodal transport as basic precondition for being effective.

Transit can also be used as an instrument for guiding the development of the region in a more sustainable way as the one that has been followed in the last decades following TOD policies.
Intermetropolitan transit corridors for the megalopolis of Mexico.

For connecting the different metropolitan areas of the megalopolis of Mexico and its airports with public transport, I propose the implementation of intermetropolitan public transport corridors (ITC).

The objectives of the intermetropolitan transport corridors are:
1. Reducing travel times inside the metropolitan areas.
2. Reducing travel times among metropolitan areas.
3. Increasing the attractiveness of alternate airports.
4. Organizing the urban development of the region and improving the public transport experience in the region.

Fig. 54. Intermetropolitan public transport corridors (ITC)

A. Mexico - Toluca ITC.
B. Mexico - Cuernavaca ITC.
C. Mexico - Puebla ITC.
D. Mexico - Pachuca ITC.
E. Mexico - Queretaro ITC.
Fig. 55. The five intermetropolitan public transport corridors proposed for the megalopolis of Mexico.
Only Mexico City has a structured public transport network. Its airport manages most of air travel in the region. It takes more than 2 hours to get to the other cities by public transport.

Improving regional accessibility makes alternate airports more attractive for people and airliners. Reducing the time distance between medium cities and Mexico City enhances the attractiveness of alternate airports. People can travel between Mexico and Toluca in 30 minutes.

Continuing connecting Mexico City to the medium cities reduces travel time. The other airports increase its attractiveness and number of flights. It is possible to travel from Mexico City to other cities in less than one hour. The airport of Mexico City decongest.
CHAPTER 6: A challenge: Designing Mexico City - Toluca intermetropolitan mobility corridor.
inhabitants of Toluca and adjacent municipalities were working in the metropolitan area of Mexico City in 2000.
Chapultepec station: Connecting the inner city

Fig. 57. Chapultepec station transport hub.
Chapultepec metro station is currently one of the busiest in Mexico City. It is located between the business district of Paseo de la Reforma and Chapultepec Park, the main recreational facility of the city. At the south it is neighbouring Roma-Condesa area, a neighbourhood experiencing a process of gentrification since the 1990s after a period of decay following the earthquakes of 1985.

In the site are linked the line 1 of the subway with several lines of buses.

The conditions for changing for one mode of transport to another are quite uncomfortable due to the presence of excessive number of stalls and poorly designed facilities.

Additionally, the site is crossed by an underground bypass that dificults the pedestrian connections among the neighbouring areas.
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At the front of the station a new public space defined after reorganizing the existing transport hub becomes a public square activated by organizing the stalls and food sellers already operating there.

The proposal will contribute to the consolidation of the investments done by the government on Reforma corridor since the 2000s.

Objectives for the site:
Connect different modes of transport and improve the experience of public space in the area.
Facilitate connections from the new station to the surrounding areas healing this broken part of Mexico City.

Proposal:
The station for the train Toluca - Mexico could bridge the inner road highway creating a new link between the surrounding areas.
The site will articulate the train line with the existing metro line as well with proposed BRT lines and pedestrian and bicycle facilities.

Fig. 61 Intermodal transit proposal for Chapultepec Station.

Fig. 62 Schematic proposal for Chapultepec Station.
Fig. 63. Proposed section for the site.
Fig. 64. Visualization of the site.
Santa Fe station: Connecting the inner city

Fig. 65. Santa Fe Mexico - Toluca highway.
Site problematic and potential:

Santa Fe is located in an area where previously operated open cast sand mines that later were used as dumps.

Since the 1980s the government sponsored the recycling of the area for transforming it into an area attractive for international headquarters to settle down. Decades later, the area is now highly developed and is a major business center in Mexico City and a site where an important amount of people work. However, the conditions for accessing by public transport this area are very poor. The area was completely designed for cars and the pedestrian experience is painful. There is no current metro or BRT linking this site with inner Mexico City in spite of the large amount of workers without car that work in the area.

Although the policies that drove the development of the area are highly questionable, the site is now a reality that should be enhanced to really fulfill its role as a western centrality of Mexico City.
Proposal:
As a major node on the Mexico - Toluca corridor, Santa Fe station will benefit from its intermediate location among Mexico City center and Toluca Airport. The proposed site as an unbuilt area next to the largest mall in Mexico.

The intention is to develop the station node as a social condenser where the interaction of transport environments and different uses, help to activate a public space that balances the overwhelming presence of large shopping mall facilities.

Objectives for the site:
Integrate with fast and efficient public transport this area with inner Mexico City and Toluca Airport.

Provide public spaces alternative to the shopping mall and enhance the pedestrian experience in the area.

Fig. 69 Intermodal proposal for Santa Fe Station.

Fig. 70 Schematic design of Santa Fe station.
Fig. 71. Proposed section for the site.
Fig. 72. Visualization of the site.
Toluca airport station: Connecting air and public transport networks
The conditions of public transport are poor and fragmented, being small buses the main mean of public transport in the city.

Site problematic and potential.

The proposed location for a new train station linking airport and train system with a BRT is located on the highway that connects Mexico City with Toluca.

This highway is really a parkway that also incorporates existing train tracks used mainly for cargo.

The highway is also an important divide in the city. North of it, the airport and most of the largest industrial sites are located. While south of it, the pattern of urbanization corresponds to formal and informal settlements.
Objective for the site:
Enhance public transport accessibility and facilitate the integration between public transport and airport facilities.

Proposal:
The train station would become a node that articulate proposed BRT lines to the train network facilitating the access to public transport in the region.

The link to the airport will facilitate the accessibility of the terminal both for travellers and workers.
Fig. 78. Current section of the site.

Fig. 79. Proposed section of the site.
Toluca central station:
Recycling the old rail infrastructure

Toluca airport station:
Recycling the old rail infrastructure

Fig. 80. Old Toluca station.
Site problematic and potential:

The train station of Toluca is located in an old industrial area northeast of the city’s historic centre.

In the site, the existing train line is located in between two differentiated areas. West of it, a consolidated grid-organized pattern, and east of it, an old industrial area, partially dismissed with an important number of warehouses.

As in other areas of Toluca, the street pattern is highly fragmented and lacking continuity.

As interesting assets of the surroundings of the area is possible to identify old and heritage protected structures dating from the end of the 19th century that could be recycled into new uses.
allowed to stay in the area creating a combination of uses with different types of medium rise dwellings and housing typologies that will help to increase the density in the area. Old warehouses can be reconverted into different activities according to temporary needs.

**Objective for the site:**
Facilitate access to the train station and improve street connectivity.
Take advantage of underused places and reconverting them into areas of mixed uses.

**Proposal:**
The central station of Toluca will become a metropolitan node were different means of public transport will be articulated. For facilitating the access to the area is proposed the extension of existing grids into areas where they are currently disconnected facilitating spatial continuity.
Non-pollutant industries and warehouses will be

Fig. 83 Intermodal proposal for Toluca Central Station.

Fig. 84 Schematic proposal for Toluca Central Station Area.
Fig. 85 Site visualization.
CHAPTER 7: Conclusions and discussion.
One of the possibilities the megalopolitan scale offers, is the development of a multi-airport network using the airport infrastructure already available in the other metropolitan areas. The multi-airport network can not only decongest the existing airport and expand the airport capacity of the region, but also contribute to a more complex development of the medium metropolitan areas taking advantage of the direct availability of air transport.

One of the main challenges the development of this multi-airport network faces is how to make the alternate airports attractive and accessible in reasonable amounts of time. In this sense, a link with the demands for more efficient metropolitan and intermetropolitan public transport can be established. The development of intermetropolitan public transport corridors, including the re-introduction of train lines in the region as part of an inter modal system, can be used as a tool for reducing travel times inside the metropolitan areas and among them in order to reduce the travel times required for accessing the airports of the region, enhancing their attractiveness.

As part of an integral urban strategy, the development of these ICT can also be used as a tool for guiding the future growth of the region following transit oriented strategies and enhancing the conditions of public space improving the experience of public transport.

At different scales and locations, the introduction of these corridors open interesting urban possibilities around the intermodal nodes, where different types of centralities activated by the interaction of different flows and activities.

At the scale of the megalopolis, the central stations might be recycled and given a relevant position revaluing its architectural heritage and the urban potential of the surrounding areas. At the scale of the metropolitan area of Mexico City, the interaction of the new train lines with their connection with other metropolitan public transport systems could generate two specific conditions for urban development: the “gateways” or peripheral stations that can become metropolitan centralities and the “inner city stations” that will help enhancing the articulation of public transport in the central parts of the city and the improvement of public space conditions able to generate new urban references. Also, at the megalopolitan scale, the integration of these corridors can act as a tool for clarifying urban policies and helping to build up consensus about the megalopolis of Mexico and even extending to cover the mega urban region of the center of Mexico.

The analysis of problematic of the airport of Mexico City was used as a starting point for exploring the dimension of the megalopolis and the relations it establishes with the world and with the region. Means of transport and technology available at each time strongly modify the way we live the city and how we perceive it and a region. Due to the extreme development of mobility technology during the 20th century, the previous notions of regions and their limits have been blurred and new macro urban geographies have appeared. In that regard, air travel as the fastest mean of transport available nowadays, poses intriguing questions about the limits of cities and how they will be in the future. Will they be based on geographical proximities and historical processes? Will they be based on temporal proximities? Will Mexico City be closer in time to New York than to Tlaxcala?

These facts make us reflect about mobility at different levels, from the pedestrian and public transport to air travel. The objective was trying to find ways of how this seemingly different mobilities could interact in the context of the megalopolis of Mexico.

The pressure for developing larger airport facilities for fulfilling the demand for long haul connections the city requires for its economic development can dangerously put a threat on ecological and water management infrastructures as is clearly noticeable in the proposal for building a new hub airport in the wetlands of Lake Texcoco. Thus, the implications of the development of this type of large mobility infrastructure in the case of the Mexican capital are strategic and can potentially define the future sustainability of the city and the region as a whole.

Due to the growth of Mexico City, the other options for developing airport infrastructure are kilometres away from the city center. However, these alternate airport locations are part of the “medium-sized metropolitan areas” that integrate the megalopolis of Mexico. This fact, thinking not just in Mexico City, but of it as a part of larger megalopolitan system open several possibilities for the solution of the airport problematic and serve as a way to underline the interactions, dependencies and discontinuities in the megalopolitan scale.
However, the implementation of these corridors faces numerous challenges from the political fragmentation showed in Fig. 9 to the difficult conditions for reintroducing the lines in the existing rights of way due to the reduce space available and the difficult social conditions that can be found there as presented in appendix 3.

This is a design hypothesis. Doing a critical evaluation of it, I am certain that it can help to reduce travel times but especially in the areas closer to the train lines, while the areas far from them may remain with transport problematic if no other mobility strategies are applied. Additionally, the large scale of the intervention would require important investments.

The specific policy tools for the implementation of the proposed infrastructure requires further studies, especially at a local scale. Measures for protecting sensitive natural and urban areas need to be implemented, avoiding and reducing to a minimum the negative externalities infrastructure brings.

I consider a value of the proposal its role as a vision for showing an alternative point of view for mobility at different scales in a polycentric megalopolis. It explores how the city could be beyond the limitations established by daily life problematic and it also represents an optimistic stance about the future of a megalopolis like Mexico.

Coming back to the paradox, if applied, this model will allow to connect even more the cities and the region with the world. Mexico City will be as close than ever to New York, but at the same time the metropolitan areas of the region and its people will be more connected than ever too.

Getting to Tlaxcala should remain faster than going to New York.
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IMAGE REFERENCES:
Fig. 11. P. 28. Highway construction and urban expansion in the last 10 years. Obtained from: http://commondatastorage.googleapis.com/static.panoramio.com/photos/origin/7563984.jpg

Fig. 13. P. 29. The new suburban train. Obtained from: http://commondatastorage.googleapis.com/static.panoramio.com/photos/origin/7563984.jpg http://upload.wikimedia.org/wikipedia/commons/thumb/d/d1/Ferrocarril_Suburbano_de_la_Zona_Metropolitana_del_Valle_de_M%C3%A9xico_estaci%C3%B3n_Buenavista.jpg/250px-Ferrocarril_Suburbano_de_la_Zona_Metropolitana_del_Valle_de_M%C3%A9xico_estaci%C3%B3n_Buenavista.jpg

Fig. 26. P. 54 -55. The international airport of Mexico City just after its inauguration in 1952. Source: CODIFICA.

Fig. 40 P. 73 Entrance to terminal 2 of the International Airport of Mexico. Obtained from: http://www.aeropuertos.net/imagenes/aeropuerto-ciudad-mexico-salidas-vuelos.jpg?c6276d

Fig. 42 P. 79, Aerial view of Texcoco wetland area. Obtained from: http://vivedeviaje.com.mx/wp-content/uploads/2012/11/PA150005.jpg

Fig. 51 P. 93. Toluca Airport. Obtained from: http://img230.imageshack.us/img230/2002/00917808ox2.jpg

Fig. 75.  P. 148. A reference: Zuidtangent bus in Amsterdam Shiphol. Obtained from:  http://upload.wikimedia.org/wikipedia/commons/e/ec/Zuidtangent-op-halte-Beukenhorst.jpg


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### Appendix 1: Supporters, arguments for, arguments against and supporters of each of the airport options.

<table>
<thead>
<tr>
<th>Option 0.</th>
<th>Expanding life cycle of the AICM</th>
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<tbody>
<tr>
<td><strong>Supporters</strong></td>
<td>Government of the Federal District</td>
</tr>
<tr>
<td></td>
<td>College of Civil Engineers of Mexico</td>
</tr>
<tr>
<td></td>
<td>Secretary of Communications and Transportation</td>
</tr>
<tr>
<td><strong>Arguments for</strong></td>
<td>The current airport is not obsolete but insufficient. Investments have already been made in developing a complementary airport in Toluca. Location close to the existing airport. It is possible to construct up to 6 parallel runways.</td>
</tr>
<tr>
<td><strong>Arguments against</strong></td>
<td>CONAGUA: &quot;An airport in the area would be constantly facing flooding and would affect the most important system for water flood regulation in the whole metropolitan area&quot;. The terrain was previously a lake. The site presents problems of differential subsidence in the terrain. Building the airport in Texcoco would imply the closing of AICM. Volcanic ashes from Popocatepetl volcano. The Military Base should be relocated or operate together with the airport. High costs for building linking infrastructure.</td>
</tr>
<tr>
<td><strong>Alternatives</strong></td>
<td>Option 1: Texcoco.</td>
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<tr>
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<th>Expanding Tolulca Airport</th>
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<td><strong>Supporters</strong></td>
<td>CONAGUA / National Water Commission</td>
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<td></td>
<td>Environmental NGO's</td>
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<td><strong>Arguments for</strong></td>
<td>The airport currently operates a complementary airport to Mexico City. Investments have been made in the terminal.</td>
</tr>
<tr>
<td><strong>Arguments against</strong></td>
<td>The airport already operates a complementary airport to Mexico City. Investments have been made in the terminal.</td>
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<td><strong>Alternatives</strong></td>
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<td><strong>Arguments against</strong></td>
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<td>Option 4: Expanding Toluca Airport</td>
</tr>
</tbody>
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<table>
<thead>
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<tr>
<td><strong>Supporters</strong></td>
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<td>Option 5: Texcoco.</td>
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<table>
<thead>
<tr>
<th>Option 5.</th>
<th>Expanding life cycle of the AICM</th>
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<tbody>
<tr>
<td><strong>Supporters</strong></td>
<td>Students, possible real estate investors for the new airport? Construction companies?</td>
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<td><strong>Arguments against</strong></td>
<td>CONAGUA / National Water Commission</td>
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<tr>
<td></td>
<td>Environmental NGO's</td>
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<tr>
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<thead>
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<tr>
<td><strong>Supporters</strong></td>
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</tr>
<tr>
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<td>Option 2: Santa Lucia Military Base.</td>
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### Arguments against:
- Insufficient length and number of runways?
- Noise concerns?
- Airsafety concerns?
- CONAGUA: “An airport in the area would be constantly facing flooding and would affect the most important system for water flood regulation in the whole metropolitan area”. The terrain was previously a lake. The site presents problems of differential subsidence in the terrain. Building the airport in Texcoco would imply the closing of AICM. Volcanic ashes from Popocatepetl volcano. The Military Base should be relocated or operate together with the airport. High costs for building linking infrastructure.
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- Altitude of the city affecting the operation of long-haul flights. The airport of Toluca has not gas duct for transporting jet fuel what increases the operation costs of the terminal. High prices in Toluca highway.
Appendix. 2. Method of Dean and Nishry for evaluating the different airport site options.

<p>| Site appications | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | SUM | % |
| Site antecedents | 1.0| 0.5| 0.5| 0.5| 0.5| 0.0| 0.0| 0.0| 0.5| 0.0| 0.5| 0.0| 0.0| 0.0| 0.5| 0.0| 0.0| 0.5| 0.0| 5.5| 0.32 |
| Land ownership  | 1.0| 1.0| 0.5| 0.5| 1.0| 0.5| 1.0| 0.5| 1.0| 0.5| 1.0| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 13.5| 0.79 |
| Soil characteristics | 1.0| 0.5| 0.5| 0.5| 0.0| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 5.880635 |
| Highway connection | 1.0| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 5.882353 |
| Train network connection | 1.0| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 8.5| 0.48 |
| Energy supply | 1.0| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 5.879641 |
| Water supply | 1.0| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 5.706824 |
| Regional strategic position | 1.0| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 5.998824 |
| Real estate development | 1.0| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 7.00| 0.41 |
| Space for expansion | 1.0| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 11.176567 |
| Recycle of existing elements | 1.0| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 4.0| 0.24 |
| Noise effects on population | 1.0| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 10.5| 0.62 |
| Weather conditions | 1.0| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 5.3| 0.32 |
| Initial investment | 1.0| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 7.20| 0.41 |
| Presence of migratory birds | 1.0| 0.0| 0.0| 0.0| 0.0| 0.0| 0.0| 0.0| 0.0| 0.0| 0.0| 0.0| 0.0| 0.0| 0.0| 0.0| 0.0| 0.0| 0.0| 0.0| 0.0 |
| Interference with other airports | 1.0| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 11.5| 0.65 |
| Community support | 1.0| 1.0| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 11.0| 0.65 |
| External support | 1.0| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 9.5| 0.55 |
| Nonutilal | 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 0.5| 4.80725 |
| | | | | | | | | | | | | | | | | | | | | 170.0 |</p>
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<th>Weighted scores</th>
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<td>0.333333</td>
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<td>0.66667</td>
<td>0.333333</td>
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<td>External support</td>
<td>0.079</td>
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<td>0.133333</td>
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| TOTAL | 3.000 | 2.900 | 3.550 |

174 175
Appendix 3. Examples of the conditions of the rights of way in peripheral areas of the metropolitan area of Mexico City.