Strategic integration of public transport networks with airport infrastructure in the megalopolis of Central Mexico: Evolution and challenges.

Conference paper.

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Abstract:

Airports represent the contemporary global gateways of metropolitan areas worldwide. In the case of the megalopolis of Central Mexico, air transport was traditionally used only by upper social segments of the population, however, during the last years, the introduction of low-cost airlines in the country has caused that the amount and economic range of people travelling by plane is expanding to other social segments requiring more affordable means of getting to the airport than those traditionally used in the past such as private car or taxis.

The starting point of this paper is the analysis of the airport infrastructure of Mexico City, which largely comes down to five airports: AICM, Toluca, Puebla, Cuernavaca and Queretaro. Investigated is their interrelation and the integration of public transport networks on both the local and the regional scale.

In spite of their role as relevant attractors in these specific airport regions and therefore necessary transport connections they require (not only for their travellers, but also for the people working at them), airports in the megalopolis of Mexico can be characterized by their lack of integration with public transport networks. Notably, the development of airport infrastructure has been realized gradually over the years and in most cases public transport connection, if implemented at all, was done in later stages of the airport infrastructure development process.

In the megalopolis of Mexico City this lack of integration affects negatively the attractiveness of the alternative venues of the metropolitan airport network that are currently underused,
indirectly contributing to the fast saturation of Mexico City main (international) airport, and negatively affecting the competitiveness of the other cities of the larger metropolitan region. This paper states that the development of mobility networks linking different airports to public transport in the region could be used as a strategic tool not only for enhancing airport accessibility, but also for improving the sustainable urban development and mobility in the larger metropolitan region for different types of regular (non-airport related) users of public transport.

Taking into account the current trends of development of public transport in the region (BRT, metro, trains) and the region’s airport accessibility is problematic, this paper explores the following hypotheses: What if the new proposed train lines and BRT systems in the metropolitan areas of the larger Mexico City region were used as tools for accessibility of this ‘megalopolis’ in a wider sense? and: What if those systems were used as part of a strategic vision for mobility linking the different metropolitan areas of the megalopolis of Mexico? Therefore, this paper explores the possibilities and potentials for improving the integration of the five existing airports to public transport as well as the challenges this integration would face and the benefits this might bring for the larger metropolitan region of Mexico City.

Keywords:
Airport accessibility, Mexico City airport network, multi-airport network, megalopolis of Central Mexico, multi-modal public transport integration.
Introduction

Airports are important interfaces between local and global scales. In a way they operate as articulators and filters between global and local flows of goods and persons. Urban regions around the world are interconnected like synapses in the brain via technology, transportation, trade and a postmodern metaculture (van Timmeren and Henriquez, 2013) that gives them a comparative advantage in our continually globalizing economic system. Airports in particular form the gateways towards other national and international hotbeds of innovation, entrepreneurship, creativity and culture, which all together generate 70 percent of global GDP (Glaeser, 2011).

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. "There is a network of metropolitan economies where countries talent, creativity and industry are concentrated.” (Holland, 2012). 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. This has led some experts to envisage a future of powerful city-states, rather than nation-states, that drive the world economy (Citigroup, 2010 ; Katz and Bradley, 2013).

Airports establish a complex interaction with the region in which they are located. Originally conceived only as transport infrastructure elements, today airports and their surroundings have evolved into economically strategic and conflictive areas. Though no two airport regions are exactly alike, they are all highly dependent on the built and natural environment of their surrounding hinterlands. Besides, their growth is inexorably linked to the network of infrastructures and mobility that ensure the free flow of essential materials, energy, and waste (van Timmeren and Henriquez, 2013). 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 aced nature as source of strong positive and negative externalities, especially air travel and transport possess strong planning and design problems.

In the context of the megalopolis of Mexico, Airport infrastructure faces complex challenges. For this paper, the megalopolis of Mexico is understood as a region comprising the metropolitan areas of the Valley of Mexico (that includes the Federal District and part of the states of Mexico and Hidalgo) as well as the metropolitan areas of Cuernavaca, Cuautla, Puebla – Tlaxcala, Tlaxcala – Apizaco, Tultepec, Pachuca, Tula and Toluca. A map of the region and its airports is presented in Figure 1.

The metropolitan areas are defined using the delimitation provided by INEGI (2010) even though the the clarification of the concept of megalopolis for Central Mexico has not arrived into a consensus and different conceptualizations have been proposed (López, 2010). Together, these metropolitan areas represent a megalopolitan region of around 28 million inhabitants with important historical links and interdependencies. This megalopolis represents almost one quarter of the total mexican population. The GDP of the metropolitan area of Mexico City alone, so without the neighboring metropolitan areas, already ranks to be the 8th largest urban economy in the world in terms of GDP (PWC, 2009). The megalopolis of Central Mexico is emerging as a” Functional Urban Region” (FUR). Antikainen (2005) describes the FUR as: the ‘travel to work area’, principally it is an agglomeration of work places attracting the work force from the surrounding area. If a certain share of the labour force in a defined fringe area are out-commuters it is attached to the municipality to which the largest portion of commuters go. In the megalopolis of Central Mexico it is increasingly more common to find people who are commuting from one metropolitan area to others in the region however, there is a lack of research studying these emerging dynamics.
Like other urban regions around the world, the megalopolis of Central Mexico is served by an airport network. 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”.

In this region nowadays five international airports in operation could be found: *Mexico City Airport* (MEX), *Toluca Airport* (TLC), *Puebla Airport* (CVJ) and *Queretaro Airport* (QRO). The latter is considered even though it is outside the megalopolis, since it is part of the regional airport network implemented in 2003. See Galindez, L. Nava Figueroa, B. (2009).

![Map of the megalopolis of Central Mexico and its airports.](image)

Airport infrastructure started to be developed in the center of Mexico since the 1930s when the first air terminal opened east of Mexico City. The development of airport infrastructure in the other cities in the region started a few decades later with the opening of an airport in Queretaro. The airports in the metropolitan areas of Puebla, Queretaro and Cuernavaca started
much later, in the 1980s, as part of infrastructure development programs from the National Mexican government.

Fig. 2. Timeline of airport infrastructure development in the megalopolis of Central Mexico.

Of these five airports operating in the region, traditionally the airport of Mexico City has been the most important one for both the region and the whole country, as it operates as a major international airport hub. Some authors place *Mexico City Airport* as one of the most recognizable connector hubs in North America together with New York, Chicago and Los Angeles (Guimerá et al., 2005).
The airport of Mexico City was rapidly surrounded by urban settlements, making it more difficult as time progressed to increase its operations. The need for increased airport capacity was first detected as early as during the presidential government of Gustavo Díaz Ordaz (1964-1970). Since then several proposals have been made to build a new airport for Mexico City. They were concerned mostly in the variation of two traditional options: A) Expanding the existing airport or building a new one in Texcoco Lake area in the northern part of the Metropolitan Area or B) Building a new one in Zumpango (State of Mexico) or in Tizayuca (State of Hidalgo). The difficulties for building a new terminal are strongly related to political and economic cycles in Mexican economy as Dominguez-Virgen, J. (2009) shows.
The vast spatial needs that this large mobility infrastructure required also faced confrontation with Mexico’s capital city additional explosive urban expansion, driven by squats and irregular settlements.

The urban expansion the region experienced at that time soon made some of the closer alternatives not feasible anymore. The more the urbanization in the area extended, the further away the location for a possible new airport from the center of Mexico City was. At the same time, uncontrolled urban expansion also affected people living at the continuously expanding edges of the city, which grew without a structured and formal public transport network.

In 2001, the federal government announced the construction of a new airport for Mexico City in Texcoco. However, due to strong political opposition the project was cancelled on August 1st, 2002. In 2003, the federal government announced the creation of a metropolitan airport network, the “Sistema Metropolitano de Aeropuertos” (SMA) to attend the overall airport capacity needs of the region. After the failed project in Texcoco, the strategy consisted in expanding the capacity of the airport of Mexico City by building a new terminal that together with the existing one, would be able to handle up to 32 million passengers per year. Additionally, the existing airports located in the neighbouring cities of Mexico City (Toluca, Cuernavaca, Puebla and Queretaro) were set to be improved as complementary airports (Galindez and Nava Figueroa, 2009).

Since then the number of passengers using the alternate airports of the region has steadily increased, both due to the improved airport infrastructure but also because of the start of the operation of low cost airlines in 2003 at Toluca airport. During the last decade along with the debut of low cost airlines in the country, Toluca Airport emerged as the de facto alternate airport for Mexico City.
As shown in Figure 4, after a period of fast grow, especially at Toluca Airport (in distance the closest to Mexico City and hub for the first low cost airlines) the number of passengers dramatically dropped in 2008 as a consequence of a conjunction of events. This included the world economic crisis and the H1N1 epidemic outbreak. Even though the number of travelers rose again after 2010, notably the airport of Toluca continued with a dramatic decrease in the number of passengers. This was due to the collapse of Mexicana airline, at that time the main aviation company of the country that used Mexico City Airport as its hub. The slots the airline was using were left free. As a consequence, low cost airlines were able to move there, which resulted for them to be able to offer a much more accessible and attractive terminal for inhabitants of Mexico City. This fact shows that even instability of airline industry is a
variable to consider and how airports can be strongly affected by external factors and how infrastructure planning should consider including certain resilience towards such risks.

The enormous demographic size of Mexico City has overshadowed the relevance of the surrounding metropolitan areas and airports in the airport infrastructure debate. Notably, some of the adjacent metropolitan areas like Puebla and Toluca are comparable in demographic terms with metropolitan areas such as Hamburg or Brussels. Comparing the airport capacity of these cities with the Mexican ones, the lag in infrastructure availability is crystal clear. In this regard the need for operation of the various airports together efficiently, serving the region of the larger megalopolis of Central Mexico, is evident.

In spite of having their own airports, the metropolitan areas of Toluca, Puebla, Cuernavaca and Queretaro currently still rely heavily on Mexico City Airport. This is due to the fact that the AICM is a main aviation hub for the country, as mentioned before. Besides this, the airports of the surrounding metropolitan areas show a marginal number of travelers in their terminals partly due to their lack of attractiveness in terms of flight connections, available services but also because of overall accessibility.

It is important to note that managerial aspects such as negotiation between government, airport operators and airliners, as well as market studies understanding the flight connections desired by the local costumers, is instrumental for using the potential benefits of the existing infrastructure. The role of an airport for metropolitan areas is that it could work as a pull factor for local urban economies (Schaafsma, M. et al., 2008). According to Schaafsma this applies especially for medium sized airport regions.

Despite the expansion of the airport and also the further development of airports in the surrounding cities, the airport of Mexico City has reached its saturation borders again. By 2013, the national aviation body officially declared saturation of flight capacity of Mexico City Airport for several hours a day. At the same time, in contrast to this saturation, the other
airports of the region are not entirely using their capacity, as shown in Figure 5. In fact, at this moment, state governors are playing an active role in promoting the development of these local airports. See Aviles, M. (2013) and Mérida, M. (2013).

Fig. 5. Airport capacity vs. the number of air passengers in the megalopolis of Central Mexico in 2012.

Currently, each time the airport of Mexico City gets saturated, the surrounding airports start handling more operations as a “spillover” effect quote. This fact remarkably resembles the effect described by Jane Jacobs (1970:17) who mentions how activities no longer possible to be done in the urban milieu are moved to the countryside. In the case of megalopolis of Central Mexico, in a similar way, when no longer any space is available for certain activities in Mexico City, e.g. due to spatial of regulatory restrictions and lower land prices like in the case of airport and industrial development in the region, the space needed is provided by the surrounding metropolitan areas.

In a context where the saturation of Mexico City Airport has become critical and the development of a new terminal is difficult due to environmental restrictions and governance complications, the use of the existing airports in the larger region emerges as a relevant option, both for decongesting the saturation of the main airport but also for supporting the
development of these other areas in the region. Additionally, recent events, like in September 2013 when labour union protests in Mexico City closed the airport of Mexico City causing severe traffic disruptions and cancellation of several flights, made clear the need to have alternative locations in case of emergencies. It is possible to affirm that a multi-airport system is more resilient to these kinds of unforeseen circumstances than having only one airport available.

**Shifting the paradigm: from distance thinking to time-distance thinking.**

Until today, the debate with regard to the airport saturation of *Mexico City Airport* has been centred on where to build a new terminal, or airport(s). In that debate generally the most common arguments for supporting or opposing a site are related with the distance of that alternative place to Mexico City metropolitan area center of user’s demand. Another question could be posed however: Why aren’t existing airports within the larger network being fully used? Bertolini and Dijst (2003) affirm that mobility patterns structural constraints “have to do with costs, and especially time rather than distance”.

From the point of view of users, one of the main constraints at the moment is that alternatives are not attractive because it takes too much time to get there making them less practical. Efficient high-frequent qualitative and faster means of transport rather than private car can improve this condition.

In this point another related problem should be highlighted: moving inside the Central Mexico larger metropolitan region or even inside the metropolitan areas takes considerable amount of time, not only for airport users but for all inhabitants of the megalopolis. For that reason the metropolitan area of the valley of Mexico ranked in the last position of the Commuter Pain
Survey in 2010 (Medina, 2012). Besides, this takes place in a country where dramatic social inequalities continue to rise and where the very rich and the very poor seem to be more segregated each time and living in completely different worlds. However, this fact could represent also an interesting opportunity for linking to apparently disconnected realities. Additionally, it is important to remember that airports are not only used by travellers but by a huge amount of people from all social levels working there in different areas. In a metropolitan area where most of the people do not have another choice than to use the overall inefficient public transport for getting to their destinations, improving affordable public transport infrastructure represents a key way for empowering them, as shown in best practices like Curitiba (Brazil) and, more recent in Bogota (Colombia). For it will help them access the different assets of the megalopolis, facilitating choices and improving competitiveness at different levels. Transit helps citizens to fully take advantage of the multiplicity of choices that metropolitan areas offer, an aspect that for authors like Jane Jacobs, is one of the most important points of cities. In the long term, this would represent for all its inhabitants an enhancer of opportunity and a potential social mobility mechanism. During the last years NGO’s such as ITDP have had an active role in emphasizing the importance of public transport and the negative effect that the current car policy is having upon Mexican cities (ITDP, 2012).

Linking airport accessibility needs with daily commuting public transportation needs is also a potential way for fostering cross-use of transit infrastructure, helping sustain its business cases. In that way, combining different transit needs also becomes a way to expand a transport costumer spectrum not relying only on one type of user and possibly even introduce variable charging of daily users and sporadic travellers. In the social realm, the mobility environments
described by Bertolini and Dijst (2003), as “the places and moments where mobility flows interconnect” might become potential points of social interaction between different users. Authors like Guller and Guller (2002) have reflected on the need for integrating airport infrastructure with land-side infrastructures. “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 used to interchange between regional and national public transport networks “rail-rail, rail-subway, rail-bus, bus-bus, etc”. According to them, an airport landside station is to be considered the first in line in relevance in the region, perhaps only surpassed by the city’s central station.

Contrary to this, accessibility to the airports in Mexico, notably in Mexico City, has been mainly planned for users arriving by car. Thus airports have been planned along road networks with important amounts of car parking. It is a direct result of car oriented infrastructure, which despite the existence of public transport in some areas has been given priority by government policies in Mexico for several decades. Furthermore, after the extinction of the passenger train services in the 1990s the main effort from Federal and State governments has been promoting the construction of toll roads, condition that “is sustaining private motorization and giving privilege to individual motorization” quoting Navarro-Benitez (2010: 206). It has resulted in social patterns of mainly travelling to the airport by taxi or by car, when possible accompanied by friend(s) or relative(s). In case of the other airports outside Mexico City however, the time and distance traveled by car is so big that this cannot be done easily any longer (due to too high costs or time spent).
Linking airport infrastructure to public transport has not been considered a priority so far. Out of the five airports in the megalopolis of Mexico, only the AICM has direct connection to public transport, even though it started to be introduced only in later stages of this airports development. In 1983, a connection with the Mexico City subway network was created, even though for getting to the metro station one should get out from the airport and walk as shown in Fig. 6.

![Connecting path from Mexico City Airport to Airport Metro Station.](image)

More than two decades later, in 2011, BRT started linking the airport with both the east coach station and Buenavista train station. The other airports have notably no connection to integrated networks of public transport; moreover there is nothing that could possibly be called public transport network in the other cities. In general transit now relies on uncomfortable and unreliable routes of minibuses ran by private concessionaries. There is however the potential of incorporating existing microbus drivers as shareholders in new and better-organized systems of public transportation, as experiences in the country have shown (Flores, 2011).
In the case of Toluca Airport, the lack of direct public transport connections has lead to a replacement by shuttle services coming from specific points in Mexico City by private companies, or even provided by the active airlines themselves. That phenomenon is especially relevant in the western parts of Mexico City, the closest areas to Toluca Metropolitan Area as shown in Figure 6. As cheaper and faster options are lacking, these shuttle services currently still represent the preferred alternatives for getting to Toluca Airport. This is mostly for they are cheaper than normal taxi services. Due to the reduction of passengers using Toluca Airport, some of the departing points, which existed previously for these shuttles, have been taken away. This is happening mainly as in spite of the fact that these shuttle services are attending a transport demand, facilitating access to Toluca Airport and actually reducing the cost of getting there, the shuttle services are not providing the opportunity for cross-uses and interconnection of flows that public transport would provide. The shuttle services are only creating direct links between specific places, and in doing so by-passing others. In this way they create faster connections for the people that can afford the service, but not for those needing transportation for their daily work. Some authors like Graham and Marvin (2008) have reflected on this in their book “Splintering Urbanism”. In other terms, airport shuttle services represent a transport solution but at the same time a lost opportunity for wider urban and social realms.
Currently, the government of Mexico is initiating projects for both reconnecting Mexico City with Toluca and Mexico City with Queretaro after more than one decade of the suspension of the train services. In some press articles it was suggested that the new train linking Mexico City and Toluca would have a stop at the airport (Mérida, 2013). However, there is little transparency of the government on showing the opted route, mostly due to avoid both (land) speculation as well as possible political disputes on the project.

A new stage in the search for alternative solutions came in December 2013, as the new Federal administration finally announced a new strategy for solving the airport saturation of Mexico City (CNN Expansion, 2013). According to the new plans, the federal government...
wants to expand the existing airport towards the east using terrains already owned by the federal government in the lake Texcoco. Additionally, the government wants to build a new runway at Toluca airport, and linking both terminals by fast transport connection so they can operate in an “articulated way”. The characteristics and routes of that connection have not been yet revealed, neither the fact whether it would incorporate a public transport connection or if it is again a new toll road. This most recent development can be considered both remarkable and positive, as for the first time the airport in Toluca is considered an alternative second airport for Mexico City in an official discourse. Unfortunate and not surprising however, is that in the announcement, neither both airports relation to public transport nor their potential relation to the Mexico-Toluca train connection were emphasized. In this way, an opportunity for integrating regional public transport with airport infrastructure is being lost.

De Neufville (2006: 352) has commented regarding airport access, that special purpose routes for making airport accessible “are expensive to build…have relatively few riders which drives up the cost per ride”. With respect to dedicated airport high-speed access he concludes that “special purpose, high-speed airport access systems do not provide good value”. Furthermore, he suggest that due to changes in the air industry, namely the operation of low-cost airlines, “airport access now requires integrating the airport nodes into broadly based urban transportation networks, not special services to a privileged clientele” (2006: 354). Instead he proposes to “focus on door-to-door trips” and taking into consideration that some travelers “are sensitive to the difficulties of making connections on their way to and from the airport” (2006: 354).
The proposals for re-developing train infrastructure connecting the metropolitan areas also open the opportunity to include integration of existing airport infrastructure in the region, remarkably enhancing the attractiveness of the other terminals as part of inter-metropolitan transit corridors. This is only, if elaborated not as single lines but as a regional transit network. It would help facilitate not only the connection among cities, but also from the fringes of the metropolitan area to central destinations in the megalopolis and to the airports and other nodes of public transportation in the region.

This became the main hypothesis of the postgraduate study presented in this paper (Salinas, 2013). Main hypothetical questions in this context are: what if the new proposed train lines and BRT systems in the metropolitan areas of the larger Mexico City region were used as tools for accessibility of this ‘megalopolis’ in a wider sense, linking also airport infrastructures? And: What if those systems were used as part of a strategic vision for mobility linking the different metropolitan areas of the megalopolis of Mexico internally and globally?

**Strategic vision.**

The patterns of airport travellers in the airports of the megalopolis of Central Mexico provide insight in the major role that the metropolitan area of Mexico City plays in the urban system. On the one hand it works as an attractor, as it operates as a centripetal force in the case of the airports of the region. On the other hand, Mexico City acts as a centrifugal vector when airport saturation of its terminal capacity forces to use the air infrastructure in surrounding areas. At the same time there are many other similar processes taking place in the megalopolis. In relation to industry, for instance, some factories and activities, which were before situated in Mexico City, have moved to the surrounding areas attracted by more land
availability while still being proximate to Mexico City. In the case of housing, for some decades a rising number of persons are living in the metropolitan area while working in Mexico City. This applies especially for the case of Toluca, where by the year 2000, according to Casado (2008) around 250,000 inhabitants of its metropolitan area were working in Mexico City.

Regarding the relation of airports and regional public transport, the megalopolis of Mexico City offers opportunities to generate win-win relations, creating a self-reinforcing system for metropolitan, regional and attached National and global mobility. In this way the megalopolis of Central Mexico should start to be understood as a “Functional Urban Region” see Antikainen (2005). In that way the public transport coherence of the region as a whole should be strengthened. This urban system is likely to take advantage of the potential economies of scale which the megalopolitan region offers. The megalopolis of Central Mexico might become in this way into one of the most important urban regions in the world not only in population terms but also in economic and innovation potential. The integration of airport infrastructure and public transport at different scales in the region could be directed strategically for the improvement of mobility, enhancing competitiveness and widening the scope of time and cost leading to significant increased travel feasibility for its inhabitants with resulting positive economical and sustainability related effects.

From the perspective of sustainability and equity, society can no longer afford to be divided into strictly urban areas and their hinterlands. Future cities should consider polycentric urbanization and localization approaches where they are designed to have interwoven networks and overlap in terms of facilities and dependencies (van Timmeren and Henriquez, 2013). As architect and polymath Christopher Alexander once stated, “The city is not a tree”
(Alexander, 1977). Looking to the megalopolis of Mexico City and its neighboring towns offers opportunities for pragmatic and resilient design of new and existing areas based on the principle of decentralized, interconnected, polycentric urban systems. Not only will urban planners need to reexamine traditional political and geographic boundaries, but the scalability of solutions, infrastructure, interrelated networks and the role of public space as well (van Timmeren and Henriquez, 2013). At the city regional scale there are three principal elements:

- Urban land use distributions: how residents are distributed relative to workplaces and other key services, influencing trip lengths and the degree to which public transport or the private or shared cars become a ‘vehicle’ for their integration (OECD, 2011a; Brotchie et al., 1995; Gordon and Richardson, 1989).

- Urban transport systems: contrasting heavy (i.e. rail-based) and light (i.e. bus lanes) public transport investments, differences in energy use / CO2 footprint (reduction), and a shift from ownership to (mobility) services (Hall, 1997).

- Degree of compactness or density: Recent studies are highlighting the fact that there are a variety of housing typologies for forms capable of delivering a nominated residential density (Kenworthy, 2011), and that higher density does not have to be equated with high-rise and central city locations (OECD, 2011b; Newman and Kenworthy, 1999; Salat, 2011).

The surplus need for air travel of Mexico City Airport can partly be provided by existing airports in the region. At the same time, an improved connection of Mexico City Airport to a network of public transport would facilitate the surrounding areas to benefit from the global connections of this hub. Therefore it is important to achieve such synergy by introducing a
smart integration of public transport networks together with necessary airport related infrastructure at the local and regional scale levels.

As a consequence, the alternate airports might take advantage as much as possible of their existing infrastructure of public transport, benefiting the local users with a wider range of destinations and frequencies made possible by the external users’ related extra demand.

Fig. 7. Potential synergies in the megalopolis of Central Mexico. A) Facilitating local accessibility of airport for reinforcing its attractiveness through local public transport networks B) Facilitating the connections between Mexico City and the surrounding metropolitan areas by intermetropolitan transport networks, so it can be possible to de-concentrate flights from main airport. C) By facilitating the connection from surrounding areas also Mexico City Airport benefits reaping economies of scale able to handle wider range of long-haul destinations, at the same time the intermediate stops of the transit system benefit non-airport related users too.
The specific strategic actions operating at different scale levels in the Mexico City megalopolis should include:

- **Reducing the number of exchanges.** As De Neufville (2006) states increased quantity and quality of connections might become a factor that discourages the use of transit service.

- **Taking advantage of existing nodes that already concentrate public and private transport routes.** In this regard bus stations might play an important role, as bus transportation is currently the most popular and cheapest mean of transport in the country. But also new services such as car-sharing should be considered here. Providing car sharing and public transport services linking these terminals to other destinations in the cities already widens the regional transport exchange.

- **Identifying places of regional relevance potentially attractive for airport users and local inhabitants.** (City centers, educational institutions, industrial complexes, touristic points of interest, lateral services and existing public transport nodes).

- **Definition of stops in areas needing access,** according to specific studies analyzing demand and desired local connections the stops could be placed in strategic places.

- **Improving comfort in transit.** This aspect would include providing space or refurbishing the vehicles available for being able to handle luggage. This feature could be also relevant for non-airport related users moving goods as important number of vendors in Mexico does. This measure is highly compatible with accessibility for handicap users needing lifts.

- **Elaborating a phased introduction/realization.** Diversifying between light-road based public transportation at first, which later can be transformed easily towards rail based infrastructures.
As a result, different transport demands will be contributing to a cross-use of public transport infrastructure. In this way, different transport demands may be reinforcing each other in order to provide a reliable, high frequency and constant service and a clear business case in particular. Moreover, the whole travel experience might be improved in terms of comfort. Additionally, the new nodes generated will potentially transform into places for social interaction and attractive locations that could be developed towards new economic centers and real estate development, following principles of TOD (Transit Oriented Development).

![Image of public transport users](image)

Fig. 8 Public transport users carrying bags and boxes in one of the metro stations servicing the airport and the north bus station.

**Functional components of the vision (Projected scenario):**

Taking into account the existing developments and trends happening in the megalopolis, the following projected future scenario has been developed based on the research carried out by (Salinas: 2013).
- The megalopolis has one intercontinental airport hub in the current airport of Mexico City, which also serves as a major National and regional train node. This airport continues to work as a main air terminal, though with modifications improving its operation and linkage to national and regional networks.

- The megalopolis has one major alternative airport in Toluca for flights to North America, Central America and the Northern part of South America, offered by low cost airlines. This airport should be highly connected via a high-frequent Mexico City – Toluca train line. If not possible a BRT-line could be implemented at first, linking the train line to the airport and other destinations in the area.

- Mexico City Metropolitan Area has three main train stations: Observatorio, Buenavista and Aeropuerto.
  1. *Observatorio Train Station* (Trains connecting Mexico City to Santa Fe, Toluca Airport and Toluca City Center).
  2. *Buenavista Train Station* (Trains connecting Mexico City to Pachuca, Queretaro Airport and Queretaro City Center).
  3. *Airport Train Station* (Trains connecting Mexico City Airport to Pachuca, Chalco, Puebla Airport and Puebla City Center).

- A BRT-line or a light-rail line is linking the three stations with intermediate stops in relevant locations and public transport links in central areas of Mexico City.

- The megalopolis has three medium sized alternate airports, respectively in Queretaro, Puebla and Cuernavaca, offering National or North American low cost connections for
dedicated local demands. All of them are well connected by public transport and road infrastructure to their main hinterlands and supply.

In this projected future scenario, for a smart and resilient network, three specific type-cases with different needs and demands could be identified: A) The airport connection to public transport in Mexico City Metropolitan Area, B) The airport in Toluca, operating both for that metropolitan area as well as for Mexico City metropolitan area C) The connection of public transport in other intermediate metropolitan zones.

Fig. 9 Diagramatic vision for the integration of the airport network of the megalopolis of Central Mexico in relation to public transport. Self-elaborated.

A. The airport connection to public transport in Mexico City Metropolitan Area.

Objective: The airport should be connected to Mexico City metropolitan area at different scales (metro, BRT, bus) but also at the National and regional scale (suburban train, regional
train, BRT), especially with the areas that due to their proximity at the moment do have little to no options to connect with air transport.

**Current situation:** Currently this airport is already connected by BRT. The efforts include having an English version of their website. In spite of the fact the fare could be low if compared to international standards the current fare might be very expensive for local users, however, cheaper than taxi. For making BRT connections more attractive it will be wise to include other possible lines or connections, linking in particular the west and the south sides of the city, where the most important places attracting the majority of visitors are located. These services could largely operate on the same lines as the existing BRT, however with fewer stops. This improvement could also work for people needing to travel long distance.

Mexico City´s airport has a metro stop, however, that stop is architecturally not well integrated to the main terminal. Another negative characteristic of the actual situation is that this existing metro line leads to the north side of the city, making it an unattractive option for users travelling to the south or the east sides of the metropolitan area.

A huge potential arises in the nearby area of *Pantitlan Station*, the most important transport node of the metropolitan area. This is because 4 different metro lines connect here, as well as several local bus and microbus services. In fact, *Pantitlan Station* is located only 600 meters from airport’s terminal 2. They are however still separated by a facility. Luckily it is owned by the government, so it must be possible to open up towards a direct connection between the two. A plan restructuring *Pantitlan Station* then should include a direct airport link to terminal 2, which would improve the public transport based connectivity of the airport significantly, without having to build expensive new metro lines.
Fig. 10 Current condition of *Mexico City Airport* in relation to public transport.

Fig. 11 The restructuring and integration of *Pantitlan station* as part of terminal 2 infrastructure and its effect on the network.
In a way, the city is reconfiguring towards a situation where, like before several train stations play an important role. This has been started with the reactivation of Buenavista Station in 2008 and can be continued further with the upgrading of Observatorio station for receiving the train from Toluca in the coming years, and the Mexico City Airport in the future. An opportunity that arises from this new condition is to connect the three stations facilitating direct exchanges and providing transit services for intermediate stops. An important stop here easily could be one serving Nuevo Polanco, an important business area that is experiencing important growth, and is becoming an important attractor at the metropolitan scale, while it currently still lacks proper public transport services. Another positive aspect to be aware of is that the transit link between these stations could be created using for more than 70% of its trajectory existing ‘train rights of way’.

Fig.12. A BRT or light train connection linking Mexico City Airport to Buenavista Station, Nuevo Polanco, and Observatorio future Bus / Train station
Additionally to the metropolitan public transport a regional transport system is integrated using some existing train lines, leading to the north and southeast of the metropolitan area, including links to Puebla and Pachuca.

Together with the future re-activation of the train infrastructure the *Mexico City Airport* could integrate a train terminal that will improve its regional connectivity facilitating the access to users from the other cities within the megalopolis of Central Mexico, and becoming both the international and regional gateway to the region.

Fig. 12 *Mexico City Airport* linked to potential suburban and regional train lines using existing train rights of way in the area.
Fig. 13 Diagram of Mexico City Airport as a train station linked to Buenavista and Observatorio Station.

B. Toluca metropolitan area

Objectives: The airport should be connected both to the local scale of the metropolitan area of Toluca and also needs to provide a fast connection to Mexico City metropolitan area.

Current condition: Currently Toluca hasn’t any BRT operating in its metropolitan area. All public transport is provided by microbuses. The air terminal is now served by shuttle services operated by private companies. The creation of the train line Mexico City – Toluca will open the opportunity to connect Toluca Airport to the train network. As the airport is surrounded by urbanisation, some difficulties will be encountered regarding the introduction of a direct train connection. However, a solution might be to introduce a BRT line from one of the stop stations of the new train line, which could link train and airport infrastructure, similar to examples like Rotterdam Airport and Eindhoven Airport in The Netherlands. In the case of Toluca, the linking BRT line should include at least one stop at the bus station and another in area next to the city centre.
Fig. 14 Diagram showing *Toluca Airport* proposed integration to public transport.

Fig. 15 Toluca Metropolitan Area proposed integration of a BRT line linking some relevant destinations of the metropolitan area.
C. Medium size cities and medium sized alternate airports: Puebla, Queretaro and Cuernavaca.

Objectives: The airports of the other medium size cities in the megalopolitan area are likely to serve mainly the local air traffic needs. This is, at least for the coming decade. In addition, they could work as pull factors by taking advantage of touristic flows directed to these cities, attracted by their UNESCO heritage sites. Therefore they should be especially well connected to these relevant touristic places in their metropolitan areas.

Current condition and proposal: The basic model proposed for improving the accessibility to airport infrastructure in the cases of Cuernavaca, Queretaro and Puebla is creating a new connection, which links at least three important locations that generate transit demand: Airport, City Centre, and Bus station(s). Furthermore, these express-lines should always be integrated with other public transport lines to facilitate modal exchange. In that regard existing bus stations will play an important role as linking nodes concentrating important flows and routes, like they already do today, even further. Such a connecting line of public transport could become the first backbone towards implementing an integrated mobility network later, if it does not exist.

In the first stage the airport connections will be provided by shuttle services taking into account the experience already obtained in Mexico City in relation to Toluca Airport, as presented before. However, differently from that model, we propose a path of relevant destinations serving not only airport users. Transport companies could start offering services from regional bus stations and city centres towards the local airport. In a second stage and if the demand and the conditions are provided, the system could evolve into a regular bus or BRT line. Which in a (much later) third stage even might evolve into an interconnected Metropolitan service, connecting the different cities.
Fig. 16 Medium size cities of the megalopolis of Mexico integration model to public transport networks.

As follows is presented a chart displaying the current state and some potential locations to be connected to airport infrastructure in the medium size metropolitan areas of the megalopolis of Central Mexico already having international airports (Puebla, Queretaro and Cuernavaca.)

<table>
<thead>
<tr>
<th>Medium size cities</th>
<th>Current state</th>
<th>Locations with the potential to be integrated to the Airport-City centre corridor.</th>
<th>Diagram presenting possible public transport connection linking places</th>
</tr>
</thead>
<tbody>
<tr>
<td>Puebla metropolitan area</td>
<td>Currently Puebla has one BRT line, while the rest of public transport is provided by buses and minibuses.</td>
<td>• Cholula. An old town with relevant archaeological and touristic features with a vibrant city centre. Since the last decades it is also a place where people commuting to Puebla live. • University of Las Americas. One of the most prestigious private universities of the</td>
<td></td>
</tr>
<tr>
<td>Querétaro metropolitan area</td>
<td>Currently there are no BRT systems operating in this metropolitan area</td>
<td>Relevant locations along a possible connection between airport and city centre here concern:</td>
<td></td>
</tr>
<tr>
<td>-----------------------------</td>
<td>---------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
<td></td>
</tr>
</tbody>
</table>
|                             | currently there are no BRT systems operating in this metropolitan area | • Bernardo Quintana Industrial area.  
• Queretaro Bus Station.  
• Queretaro City Center. UNESCO World heritage site.  
• State University Campus.  
• North industrial area. |
| **Cuernavaca metropolitan area** | Currently there are no BRT systems operating in this metropolitan area | Relevant locations along a possible connection airport and city center here concern:  
- Temixco Hacienda. Historic site, hotel and water park.  
- Historic Centre. Cathedral declared UNESCO World Heritage site.  
- Bus station. Regional node located in proximity |

### Evaluating the scenario: Benefits

The benefits of strategically connecting the airports of the megalopolis of Mexico to public transport can be grouped according to three different focuses:

**Social**
- Time–distance reduction and improved comfort to access relevant destinations in the megalopolis by public transport.
- Reduction Automobile dependency in the region where the majority of the inhabitants has no private car.
- Improve accessibility to work offer/place from lower class groups.
- Shift from ownership to shared services (mobility and other services)

**Environmental**
- Reduction of CO2 emissions from both commuting cars and inefficient public transport.
- Reduction of fossil fuel dependence for regional and local scale travelling.
- Resilient mobility system based on servicing and offering alternative modes of transport in case of dysfunction.

**Economic**
• Increase of the competitiveness of the region facilitating direct links to other national and international destinations.

• Transport costs reduction due to the new dynamics generated by the introduction of faster transit connections.

• The combination of the “airport ingredient” to public transport networks could facilitate funding coming from public-private ventures. Airports as transportation and economic hubs have the potential to attract investments or joint ventures related not only with complementary works (such as road improvements, public transport investments) but also to function as tools for transit oriented development.
Evaluating the scenario: Challenges

One of the most complex aspects for the implementation of this strategy is the introduction of the proposed transit infrastructure in the existing consolidated and dense urban tissue of the megalopolis. This includes scarce territorial reserves for both airport and connecting infrastructures, train rights of way currently invaded by squats or without wide buffer areas (to cope with security and nuisance related aspects). At the same time the implementation of this infrastructure represents an opportunity for re-weaving the urban landscape in the areas directly related to the mobility infrastructures. The new stops will potentially generate new flows of people that would provide condensed developments and chances at certain ‘hot spots’ and opportunities for different types of uses and programs. On the other hand the development of parts of the mobility infrastructure, especially the train lines, will have to be planned carefully, since they could potentially create borders and divides if not properly weaved into the existing contexts.

Public vs Private interests.

‘Progress is impossible without change, and those who cannot change their minds cannot change anything.’ This can be adapted to the fact that ‘everybody wants progress, but nobody wants to change’ (van Timmeren and Henriquez, 2013). The realisation of the proposed integrated approach would require important processes of negotiation between government and private individuals or groups directly affected by the construction works. In the case of private transport concessions, it will lead to increased competition. At the same time, certain approaches or strategies should be found to include all stakeholders in the process, probably integrating them in a process of co-creation as partners or
shareholders of the new entities providing the services. A strategy similar to the one of Metrobus in Mexico City is relevant in this context, and should be considered.

The governance issue.

The development of this infrastructure has metropolitan, regional and even national repercussions affecting all levels of government; and in doing so it will also include all political parties. In this complex playing field, more effective mechanisms of negotiation should be developed to achieve political agreements and realise secured budgets for the infrastructure works. As previous ‘best practice’ experience, the Mexican case of the “Metropolitan found” could become a relevant governance tool for facilitating effective realisation of the works involved.

Mobility habits.

Currently, most of the people when going to the airport use private car, taxi or shuttle services. Changing the modal split and improving the mobility experience represent big challenges, which need to be met. This would require both push and pull incentives making it easier, more comfortable and cheaper to use public transport than private car. This incentive could include a wide range of possibilities in almost every aspect of urban life: from improving the pedestrian experience at the city scale and introducing parking meters to organizing efficient time tables, introducing public transport apps to improving the spatial qualities of metro and train stations among others.
Reflections

It is important to point out the need for an integrated approach towards airport and public transport planning, especially in rapidly developing countries, like Mexico, and moreover in complex urban megalopolis like the larger Mexico City region. It involves understanding the benefits and opportunities this could bring for local and regional economies, as well as social and environmental benefits.

A well-planned public transport infrastructure will improve the attractiveness of an existing air terminal currently not used at its full capacity, like in the case of Toluca Airport. The services of shuttle buses currently being provided linking Mexico City to Toluca Airport showcase how an airport accessibility problem could be overcome and even generate business opportunities.

Even though these transport services are flexible and resilient, since they operate according to the demand, they also fail in providing a cross-use service for other potentials users of the routes in the spaces between the servicing areas. It could be considered as a “tunnel effect” linking two places without almost any relation to the areas in the intermediate way. These shuttle services are only solving airport accessibility; and they do not provide the opportunities that a cross-use of transport would have for wider urban and even economic realms. Moreover, the lack of public transport prevails and these shuttle services use the same roads as cars, running the risk of getting stuck in traffic jams.

Interregional public transport connections to airport(s) appear as a relevant option for providing both airport accessibility and transit service for the in between areas, especially in metropolitan peripheries with low infiltration of public transport facilities. With this respect, it is fundamental to emphasize that the goal is not creating a line between airport and destination but an integrated network of different modes of mobility (from the neighbourhood scale to the
regional scale) connecting different places in the metropolitan areas, while linking to airport infrastructure too, if possible even by several modes. It is important to be aware that important improvements in comfort should be provided at different degrees of detail to improve attractiveness to travel by public transport. Another aspect, just as important, is offering competitive fares.

In the case of Mexico City these may need to be well-below pricing of other services as middle or low income groups are also important targets for such a system of public transportation.

In that sense, a progressive fare system should be established, e.g. according to the frequency of trips, to benefit daily commuters over people travelling incidentally to the airport.

In the Mexican case specific effort should be made in improving the connections of the existing public transport network to the airport infrastructure and to not consider these as separate realms. This actually implies an urgent need for direct action.

In the case of Mexico City Metropolitan area, a first step should involve a strategic intervention in the interface of the existing metro lines, and especially how Pantitlan Station could be linked directly to Terminal 2 of Mexico City Airport. Such interventions are likely to benefit not only air transport users, but also the large amount of people working at the airport. Indirectly it also will help improve the experience of public transport for other users of these existing metro lines.

A second action should involve facilitating connections from the airport terminals to other nodes. For instance the operation of the BRT linking airport and train station, initiated recently. Other BRT lines should be linking the Terminals to other relevant nodes in the network. With this respect, in the future, the airport could take advantage of the existing and still un(der)used train ‘rights of way’ to provide direct suburban train connection to other places in the metropolitan area, and in particular the cities of Puebla and Pachuca.
In the case of Toluca, the train linking Mexico City and Observatorio Station should be considered an integral part of Toluca Airport operation, helping it to become an attractive alternative to Mexico City Airport and thus reducing the pressure on airport expansion in the delicate lacustrine surroundings of Mexico City Airport. Additionally, the public transport links in the metropolitan area should be improved. If the measures and operation of Toluca Airport are well integrated, the inhabitants of that metropolitan area will benefit from a wide range of destinations and frequencies thanks to the critical mass provided by a potential large number of users coming from Mexico City metropolitan area. At the same time it will help Mexico City Airport significantly in reducing its constraints due to its actual saturation.

In the case of the other metropolitan areas (Queretaro, Puebla and Cuernavaca) at the same time a scaling and gradual improvement of airport accessibility should be introduced, which can start with the operation of shuttle services linking relevant destinations in those areas with the local airport. Differently to the joint solution of Mexico City Airport and Toluca Airport, a cumulative path of potential destinations could be introduced, by linking most relevant intermediate stops. This introduces entirely new groups of users, leaving these lines not solely to airport travellers.

Evidently these destinations could differ and adapt according to the operation of services. In later stages the service could potentially be scaled to a bus service or even a BRT, when needed.

In addition to their mere transport oriented significance, the different transit lines configure also mental maps and readings of the territory. The lines might help unravel possible links and destinations, even revealing hidden mobility desires. The transit lines linking spaces in the metropolitan or regional scale also create awareness of the existence of these distant bringing them mentally closer. In this way new geographic scales and functional relations in the region may be created.
It is fundamental a shift in the way airport infrastructure is currently planned. Nowadays, the most heard voices in the decision making process are those of air industry and construction corporations that take care only of this dedicated part of the story. As highly complex, conflictive but also potentially beneficial pull elements for local economies, airports and its relation with city economy and life should be understood in a wider and more integrative way. The interest of the city in decisions concerning airport or infrastructure development in the long term should play a decisive role, not only taking into account these specific sectors.

In such a way, the development of public transport networks represent a way of spreading out the benefits of (public) infrastructure through the territory servicing a variety of purposes and users and not concentrating them only to one point of attention as a construction of a new or extended main airport in Mexico City would imply. Moreover, facing future uncertainties related to air industry, the more potential beneficial legacies of their development today are integrated into the realisation of more sustainable mobility infrastructure and services, the more resilient the system as a whole becomes.

For further research it would be relevant to study in more detail some of the specific spatial strategies, policies and externalities this model might bring, as well the policies and measures to be applied along the new train corridors and their repercussions on the local level.

At the end, a high quality comfort standard for the users should be established. A comfortable, efficient and price attractive public transport experience should be the goal of the public transport providers and governments. In a highly mobile era with increased interregional and global interdependencies, citizen's experience as users of public transport infrastructure should be a central point in the urban agenda. From the existing spatial paradigm, focussing on distance alone, we should start considering more a time-distance paradigm where the comfortable, extensive, affordable and easy to use public transport becomes a main goal for improving life quality and economic competitiveness in the region.
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