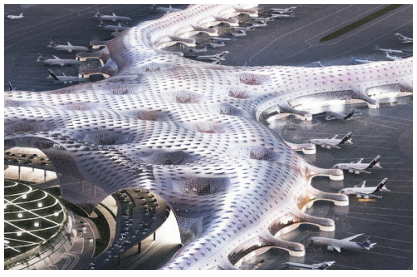
International Transport Forum

Surface Access to Airports

The Case of Mexico City's New International Airport

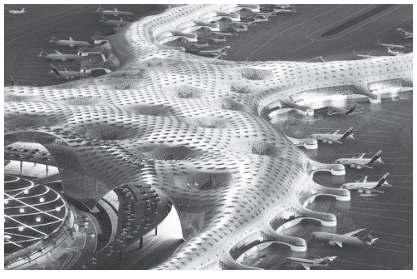


Case-Specific Policy Analysis

OECD

Surface Access to Airports

The Case of Mexico City's New International Airport



Case-Specific Policy Analysis

The International Transport Forum

The International Transport Forum is an intergovernmental organisation with 59 member countries. It acts as a think tank for transport policy and organises the Annual Summit of transport ministers. ITF is the only global body that covers all transport modes. The ITF is politically autonomous and administratively integrated with the OECD.

The ITF works for transport policies that improve peoples' lives. Our mission is to foster a deeper understanding of the role of transport in economic growth, environmental sustainability and social inclusion and to raise the public profile of transport policy.

The ITF organises global dialogue for better transport. We act as a platform for discussion and pre-negotiation of policy issues across all transport modes. We analyse trends, share knowledge and promote exchange among transport decision-makers and civil society. The ITF's Annual Summit is the world's largest gathering of transport ministers and the leading global platform for dialogue on transport policy.

The Members of the ITF are: Albania, Armenia, Argentina, Australia, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Canada, Chile, China (People's Republic of), Croatia, Czech Republic, Denmark, Estonia, Finland, France, Former Yugoslav Republic of Macedonia, Georgia, Germany, Greece, Hungary, Iceland, India, Ireland, Israel, Italy, Japan, Kazakhstan, Korea, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Mexico, Republic of Moldova, Montenegro, Morocco, the Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russian Federation, Serbia, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, the United Arab Emirates, the United Kingdom and the United States.

International Transport Forum
2, rue André Pascal
F-75775 Paris Cedex 16
contact@itf-oecd.org
www.itf-oecd.org

Case-Specific Policy Analysis Reports

The ITF's Case-Specific Policy Analysis series presents topical studies on specific issues carried out by the ITF in agreement with local institutions. This work is published under the responsibility of the Secretary-General of the ITF. The opinions expressed and arguments employed herein do not necessarily reflect the official views of ITF or OECD member countries.

Foreword

Air passenger travel and freight transport make significant contributions to the economies of OECD member countries. Good air connections facilitate trade and investment, enhance communication and business interaction and are fundamental to tourism and to inter-regional and international labour markets. The importance of air transport to the economy of Mexico City is reflected in the sustained growth of services at its principle airport, which is now operating at capacity. The decision to build a new significantly bigger airport presents a unique opportunity to increase the beneficial impact of air connectivity on the region.

Few passenger journeys begin or end at the airport itself and the overall quality of air connectivity is dependent on the length and reliability of journeys to and from the airport. The quality of surface access options is particularly critical to the higher value business travel. In particular, the potential for day return trips across the country has an impact on the productivity of firms and the economy as a whole. A day return trip however can be very challenging if getting to and from the airport can take a significant part of day and disruptions are difficult to predict.

Major airports are significant contributors to traffic on the roads around them. As with any major trip generator, investment in airports must be accompanied by investments in roads and mass transit systems if impacts on road congestion and related air pollution are to be maintained within acceptable bounds. In most OECD jurisdictions such investments are an essential condition for planning consent.

The quality of surface access links, by road – including bus and BRT systems – rail and metro will be critical to the success of the New International Airport of Mexico City. This applies to how successful the airport will be in attracting passengers and achieving acceptable environmental outcomes beyond the airport perimeter. The Federal Government is currently developing plans for investment in surface access to serve passengers and the people who will work at the airport. This report seeks to inform the decisions to be made through a review of policies and planning controls applied to surface access at a selection of comparable airports in other OECD cities. The work was undertaken in co-operation with Mexico's Ministry of Communications and Transport and the Airport Group of Mexico City.

Stephen Perkins

International Transport Forum

Acknowledgements

"Surface Access to Airports: The case of Mexico City's New International Airport" is part of a series of reports prepared by the OECD accompanying the development of the new airport. It was prepared by the International Transport Forum at the OECD together with the OECD's Public Governance Directorate. The project was led by Stephen Perkins, Head of Research and Policy Analysis at the International Transport Forum and Paulo Magina, Head of the Procurement Unit of the Public Governance Directorate of the OECD in co-operation with the Ministry of Communications and Transport of Mexico and the Airport Group of Mexico City.

The International Transport Forum and the OECD are grateful to the experts that assisted in the preparation of this report by providing information on the cases reviewed, or by participating in discussions of experience in planning rail-airport links at a workshop organised with Mexican aviation stakeholders in March 2017. Thanks are due in particular to Per Henriksen, Confederation of Danish Industry; Oliver Mulvey, UK Department for Transport; Jaehak Oh, Korea Transport Research Institute; Lee Simms, IBI Group Canada; Brian Zackon, Independent Consultant. The report was drafted by members of the International Transport Forum Secretariat: Aimée Aguilar, Jagoda Egeland, Stephen Perkins, Daniel Veryard, Bernardo Vázquez, Seungkook Wu and Nathan Zhivov. Jacobo Garcia Villarreal from the OECD Secretariat co-ordinated the work.

Table of contents

Executive summary

Background

Mexico City's international airport is operating close to capacity and will be replaced with a new airport that is currently under construction. The airport terminal is being designed to the highest standards of sustainability. Decisions on investment in infrastructure for surface access to the new site will be critical both to the success of the new airport and the overall impact of the airport on the environment as providing good alternatives to access by car and taxi will be essential if the airport is not to exacerbate Mexico City's chronic congestion and air pollution problems. This report reviews the planning framework for airport expansion and decisions to invest in rail, metro and protected bus links to airports in a number of relevant cases in other OECD cities with a view to informing policy toward surface access to the new airport in Mexico City.

Findings

The decision to build the new airport in Mexico City was taken without the prolonged delays characteristic of many major airports elsewhere in OECD countries. Such delays usually result from the need for a prolonged period of consultation and negotiation to reconcile the benefits of air travel accruing to the population as a whole with the noise, pollution and road congestion impacts that fall on residents in the proximity of the airport. Plans for investment in alternatives to access by road were clearly not a condition for planning consent in Mexico City but are nonetheless essential to the success of the new airport. Mitigating air pollution is a critical challenge for Mexico City and passenger demand is determined by the quality of the end-to-end journey, not just the airport-to-airport leg of a trip. Business traffic is particularly sensitive to time costs. Long and unreliable access times to airports work to depress demand and affect the decisions of international businesses as to where to locate. Ultimately, the success of the new airport will depend on its accessibility and the efficiency of its surface access links

The Ministry of Communications and Transport is considering a broad range of potential investments in rail, metro, BRT and bus links for access to the new site by airport workers and by passengers. Priorities now need to be established along with investments to improve the safety, security and accessibility of stations and interchanges. Rights of way and alignments for future investments that cannot be financed in the short term need to be preserved now and the airport's multi-modal public transport station needs to be designed to be future-proof. Overall the development of the airport needs to be an integrated part of the process of improving strategic regional transport planning and inter-jurisdictional integration in the Valle de Mexico.

Policy insights

Integrate the new airport into strategic plans for sustainable urban transport

The surface transport access plans for the new airport will need to be compatible with the overall direction of policy in the Metropolitan Zone of the Valle de Mexico, and contribute to the attainment of established objectives for inclusive and sustainable mobility. The overall goals for strategic transport planning in relation to the new airport should clearly include the following two main objectives. First,

provide for effective surface access to the airport from all parts of the Megalopolis, i.e. the whole of the airport's natural surface hinterland, through development of road, rail and metro infrastructure and extension of public transport services from its neighbouring cities. Second, contain the impacts of the new airport on road traffic congestion and air pollution through provision of high-quality public transport alternatives to transport by private car and taxi.

Prioritise access by public transport in the layout of the airport terminal

The success of public transport services in securing a large share of trips to and from the airport will depend to a significant degree on the design of the multimodal surface transport access facilities to be developed by the Airports Group. Facilities should prioritise access by public transport at the terminal, providing short, direct, step-free and unobstructed access to check in areas and exit gates from rail platforms and bus stops. This requires locating rail and bus stations directly below or adjacent to terminals.

Establish priorities for investment in public transport links to the airport

Funding is not available to initiate all of the potential public transport projects simultaneously. The next stage in strategic planning is to prioritise projects and establish an order of development.

Preserve alignments for infrastructure than can only be funded later on

Planning powers should be used to preserve alignments for investments in infrastructure for public transport that can only be made at a later stage. Future potential interconnections should be accommodated in the design of terminal and station infrastructure constructed in the first phase of investment.

Plan now for links that will serve both developments on the old airport site and the new airport

Future integration of transport links to the new airport and to the redeveloped site of the existing airport should be planned for, as some of the facilities developed on the old site are likely to be prime destinations for air passengers and the alignment of the sites is fortuitous for connections to central Mexico City.

Integrate new public transport links with existing networks seamlessly

Seamless, reliable journeys will be important to the success of public transport in catering for air passenger journeys. Integration with the wider public transport network, as planned, is important to reach a large catchment population. This is particularly important for workers accessing the airport but will also determine the overall number of air passengers able to use public transport.

Create the framework for investment in fast, seamless, reliable rail or metro links

The success of the airport in providing the business community with fast, seamless, reliable access to international markets is highly dependent on the planned express metro and rail projects. These are therefore particularly important to the potential economic benefits to be generated by the airport.

Explore a range of potential funding options for premium rail or metro services

Air passengers are likely to be prepared to pay a price premium for faster, more direct services to key centres of business and tourism and this may merit investment in dedicated links as well as extension of existing transport networks. The potential for attributing a share of fare box revenue to secure funding for a potential express metro service in the first phase of development should be examined. Experience from the case studies suggests any blurring of the distinct role of an express service with standard metro provision should be avoided. It is possible to run express and stopping services with different tariffs on the same line, as is the case for example with Heathrow Express and Heathrow Connect in London, serving different combinations of air passengers, airport workers and local communities along the route.

Maintain today's world-class long distance coach services

The long-distance bus terminal adjacent to departures and arrivals at the existing airport and the high quality bus services provided are world-class. This facility needs to be replicated in the new airport with an extended range of destinations.

Fund public transport investments with the potential to relieve road congestion and air pollution

Delivery of key parts of the Ministry's plans for BRT, metro and rail infrastructure in time for the opening of the new airport is essential to containing the negative impact of airport on air quality and congestion in the Metropolitan area. This argues for prioritising investment in these projects by Mexico's funding authorities. The success of the airport in serving the population of the whole of the catchment area of the Megalopolis is dependent on the quality of the road and public transport services provided.

1. Introduction

This report discusses options for the provision of surface transport infrastructure to serve Mexico City's New International Airport (NAICM).[1] It first reviews the planning environment and surface transport provision for new and expanded airports in a number of relevant case studies in OECD member countries.

London Heathrow, located similarly to the New Mexico City Airport in relation to the city centre and facing similar air pollution and congestion issues, is examined in terms of the strategic infrastructure planning environment and the use of public transport investments to meet conditions imposed on airport capacity expansion. Heathrow's Terminal 5 was also built to particularly high standards of accessibility by public transport. Incheon, South Korea's hub airport, is examined as it too was developed to particularly high standards of accessibility by public transport. In this case, the aim was to meet physical infrastructure constraints and extend the hinterland it serves rather than to meet stringent planning requirements. Experience with investment in metro links to Sydney, Copenhagen and to Canadian and US airports is briefly reviewed to reveal differences in potential types of users for metro links and the consequences for decisions on investment.

The strategic transport and land-use planning context for Mexico City is then discussed together with current plans for investment in expansion of road, BRT, rail and metro systems to serve the new airport. In the final chapter implications for Mexico City are drawn from the experience reviewed in other OECD member countries.

Expansion of airport capacity in Mexico City

Mexico City airport (Benito Juarez International Airport) is operating close to capacity. Thirty-nine and a half million passengers were handled in the year to 31 May 2016 with 433 000 air traffic movements (ATMs) on two runways that are too close together to be operated fully independently.

This is approaching the volume of air traffic movements at the busiest two-runway airport in the world, London Heathrow, which handled 75 million passengers in 2015 with 472 000 ATMs. Heathrow's runways are spaced far enough apart to be operated independently but are subject to an annual cap of 480 000 movements to limit noise. The runways are also currently operated in "segregated mode", which means one is dedicated to take-offs and the other to landings. The two runways are periodically switched to spread the noise exposure under flight paths more equitably, which also limits capacity. The much larger number of passengers at Heathrow reflects the larger average plane size operated at Heathrow, corresponding in turn to the atypical portfolio of routes served by Heathrow, which are relatively densely trafficked and relatively few in number.

Growth in passenger traffic at Mexico City's airport has averaged 5% per annum over the last decade and nearly 10% per annum since 2011, following recovery from the global economic recession (AICM, 2016). The facility is the busiest airport in Latin America.

To accommodate further growth and move flight paths away from the centre of Mexico City, operations will be entirely transferred to a New International Airport (NAICM) after 2020, at a site 20 km from the city centre along the same radial as the existing airport, with a distance of around 10 km between the old Terminal 1 and the planned new terminal. The new airport will have three independent

runway pairs (six runways in all) when fully complete. It will open with two runway pairs and a terminal with capacity for 68 million passengers a year. A second terminal will eventually take capacity to 125 million passengers a year (SCT, 2016). The existing airport will close as the alignment of the two airports would make operating both simultaneously impossible.

The decision to build the new airport was announced in September 2014 and planning for the airport and for access to the site has unfolded progressively since then. An earlier project to develop the location for a new airport was cancelled in the face of protests from stakeholders with an interest in the land in 2002. This halted any transport planning to service the site until the 2014 decision.

The site for the new airport lies on an enclave of federally owned land, the location of a former lake, in the State of Mexico, 4 km to the east of the boundary of Mexico City (the jurisdiction for the central part of the metropolis). This land ownership pattern both simplified the decision to build the new airport and complicates the strategic planning framework for surface transport development because of the need to coordinate between jurisdictions.

Surface transport planning framework

Large airports generate large surface transport flows: carrying passengers to and from the airport, airport workers commuting to the site and freight traffic. Impacts on road traffic congestion and air pollution are usually significant. Mitigating these impacts through investment in public transport systems to provide an alternative to access by car and taxi is particularly important in the case for expansion of airports like the NAICM that lie relatively close to city centres. As case studies examined in this report illustrate, this is often a condition of planning consents.

Most OECD capital cities have strategic transport plans and land-use planning controls that constrain large traffic generating investments to locations served by adequate surface (and underground) transport links, including rail and metro lines. Many planning frameworks also provide for property developers, or the business community more broadly, to contribute to investment in extensions to public transport systems where current capacity is inadequate.

For example, among other criteria all major real estate developments in London are evaluated according to their Public Transport Accessibility Level (ITF, 2016). Where sites rate poorly, developers have the option of negotiating a contribution to funding extension of the bus or metro network to provide a satisfactory level of access to allow the development to go ahead. A similar approach has been applied to London's airports. Authorisation of new terminals has been dependent on the airport agreeing to fund new rail connections to London. And as the case study of Heathrow outlines, consent for a new runway will be dependent on the airport agreeing further investments in road and rail connections.

In Mexico City, the decision to build the new airport was taken without the prolonged delays characteristic of many major airports elsewhere in OECD countries. This is partly because the merits of the new site are outstanding, including proximity to the city centre and to the existing airport, and to the investments already made by companies using air services and notably the freight community. More than half of Mexico's foreign trade by air uses the existing airport (SCT, 2014).

Plans for investment in surface access were clearly not a condition for consent (as is the case, for example, for expansion of Heathrow) but are nonetheless essential to the success of the new airport. Mitigating air pollution is a critical challenge for Mexico City. Passenger demand is determined by the cost (in time as well as money) and quality of the end-to-end journey, not just the airport-to-airport leg of the trip. Business traffic is particularly sensitive to time, quality and convenience costs. Long and unreliable access times to airports tend to depress demand and affect the decisions of international

businesses as to where to locate corporate headquarters and offices for higher value services. Ultimately, the success of the new airport will depend on its accessibility and the efficiency of its surface access links.

Box 1. **Seamless access**

Predictable and efficient end-to-end journey times are extremely important to passengers. For instance, the flight from Heathrow to Frankfurt lasts only 1 and 1⁄2 hours, but the office-to-office journey time from the City to Frankfurt will be closer to 5 hours. For outbound passengers, delays can occur on the journey to the airport, at check-in and at security, as well as to take-off. For the inbound passenger, there can be delays whilst the plane circles waiting for a landing slot, in securing access to a ramp, at immigration, at baggage reclaim and on the journey to their end destination. Improving performance across the end-to-end journey and understanding the pinch points in the system is critical if the UK is to maintain and improve its competitiveness in the face of continued growth in international trade of services and goods.

Transport for London is responsible for tube and London bus services to/from Heathrow. Network Rail is responsible for the rail infrastructure (track and signalling). BAA (the airport company) is responsible for the operation of Heathrow Express and Heathrow Connect rail services. The Highways Agency is responsible for motorways and trunk roads, e.g. M4, M25. Transport for London is responsible for other roads within the Greater London Authority boundary. Various other private and public sector operators (e.g. National Express) are responsible for coach and bus services to Heathrow.

In the past ten years, the number of passengers travelling to/from Heathrow has risen from 37.3 to 44.2 million. During this period the share of the private car has reduced from 38% to 34%. Access to Heathrow by heavy rail has established a 9% share following the opening of Heathrow Express and Heathrow Connect rail services.

In 2006, 44% of people travelling to Heathrow from Greater London used public transport . Three themes emerged from the DfT analysis. The first is the need to improve getting to and from the airport; the second is the need to make getting through the airport a more predictable and efficient experience; and the third is the need for increases in airport infrastructure capacity. The airport expansion plans and surface transport enhancements developed from this analysis are set out in the Heathrow Case Study below.

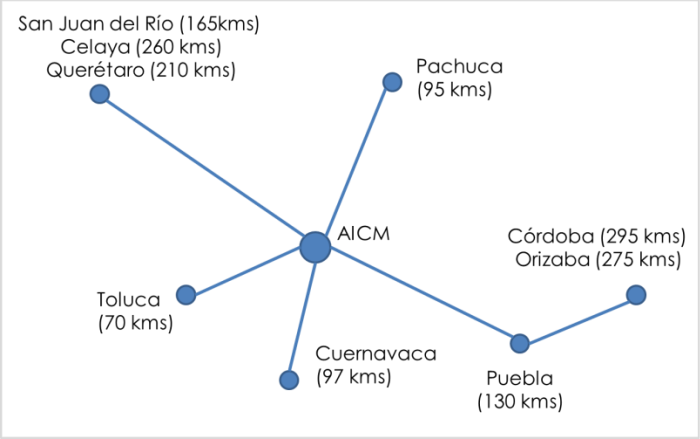
Source: Extracts from UK Department for Transport (DfT) (2007).

Surface transport access to Mexico City's airport today

Surface access to the current airport is mainly by road. Passenger access to the two terminals is by car, taxi and bus. Between 2002 and 2007 highly efficient long-distance bus terminals were opened adjacent to the terminals, providing direct services to nine cities up to 295 km away (see Box 2). Access for people working at the airport is provided for by road, bus, bus rapid transit (BRT) and the metro system. The BRT and metro links can be used by passengers. The BRT system serves both terminals and vehicles have baggage storage areas. The metro is not well suited to carrying baggage and the station (*Terminal Aerea*) is located at the perimeter of the airport at some distance from Terminal 1 – 300 metres from the first check-in counters and 750 metres from international arrivals – so not very convenient for use by air passengers. The station is 2.5 kilometres from Terminal 2. Transport between the terminals is provided by bus or, for passengers with tickets, by monorail. *Pantitlan* metro station is 600 metres from Terminal 2 but without a direct concourse access and generally used by commuters working at the airport rather than air passengers.

<table>
<tr><td>Long-distance buses</td><td>Box 2. Surface access options to the existing airport in Mexico City

Two long-distance bus stations operate in Mexico City airport (AICM); they are based in each terminal of the airport. Five different companies bring service to the cities of Celaya, Cordoba, Cuernavaca, Queretaro, Orizaba, Pachuca, Puebla, San Juan del Río and Toluca. Distances travelled vary from 70 kms (Toluca) to 295 kms (Cordoba).

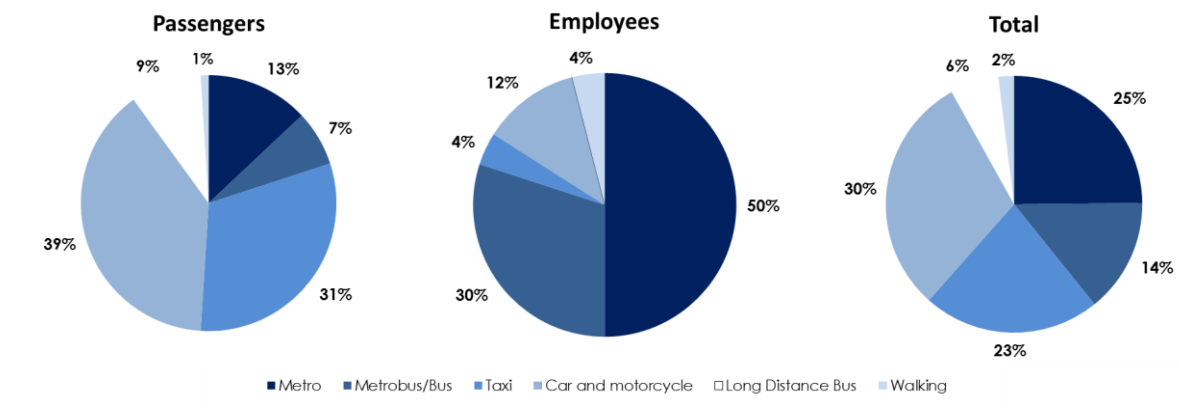
Figure 1. Destinations of buses that operate in Mexico City Airport
 

Source: ITF.</td></tr>
<tr><td>Taxis</td><td>Six companies are authorised by Secretaria de Comunicaciones y Transportes (SCT) to operated taxis from the AICM: Porto Taxi, Sitio 300, Nueva Imagen, Excelencia, Confort y Yellow Cab. Under the concessions, fares are regulated by SCT. Prices change depending on the time (day/night), the destination, and the size of the car, which is determined by the number of passengers it can carry. Points of sale for taxi vouchers are located in the area of arrivals in both terminals of the AICM.</td></tr>
<tr><td>Parking</td><td>Parking service is provided in three car parks operated by different companies. Two are located in Terminal 1 and the other in Terminal 2. The overall capacity is 6 350 places distributed over a total surface of 22 ha.</td></tr>
<tr><td>Metro</td><td>The metro station Terminal Aerea of line 5 is located outside of the airport perimeter at a distance of 300 metres from Terminal 1 and over a kilometre from Terminal 2.</td></tr>
<tr><td>Metrobus</td><td>BRT Metrobus line 4 serves both terminals with a loop out of San Lazaro station – the main part of the line circles the city centre.</td></tr>
<tr><td>Car rental</td><td>Several companies are located in Terminal 1 and Terminal 2.</td></tr>
<tr><td>Shuttle buses</td><td>Several hotels near the airport provide shuttle service to/for the airport.</td></tr>
<tr><td>Public buses</td><td>Several routes of city buses follow the “Circuito Interior” ring-road that runs along the western boundary of the airport. The nearest bus station is located outside the airport perimeter at a distance of 350 meters form terminal 1.</td></tr>
</table>

Taking into account the total number of passengers, employees and people that accompany passengers, around 322 000 trips are undertaken every day to/from the airport. By 2020 this number is expected to have increased to 423 000 and when the new airport is fully completed the number will be around 1 120 000 trips a day (GACM). Today, 80% of the employees arrive by public transport (metro, BRT, bus) and 16% by car or taxi. Only 20% of air passengers and accompanying people (“users” in the tables) arrive by public transport, 70% use taxi or private cars and 9% use long-distance buses. Overall

46% of employees and 86% of air passengers use road modes to access the airport. The tables below show current and future potential numbers and modal splits.

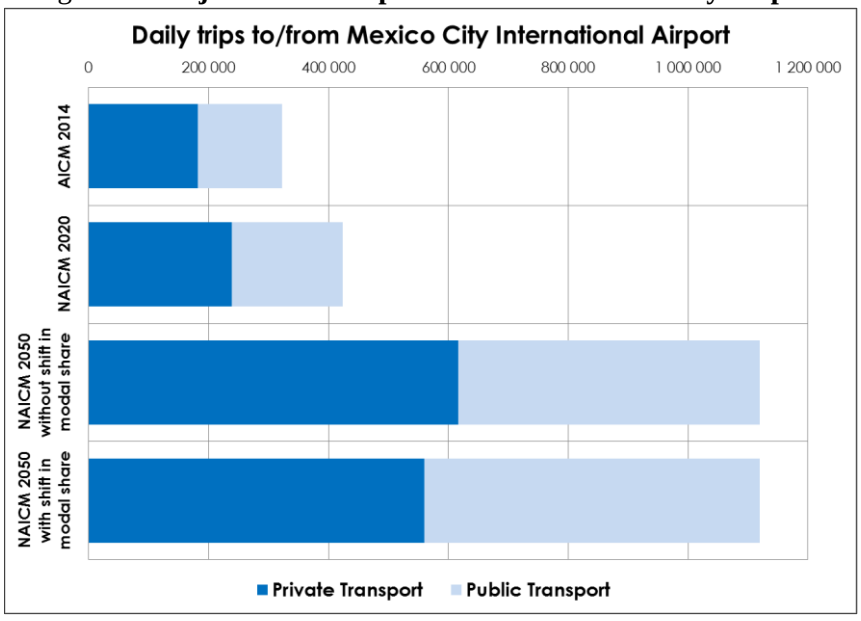
Figure 2. **Current modal shares for air passengers and airport employees accessing the airport**



Source*:* Grupo Aeroportuario de la Ciudad de México.

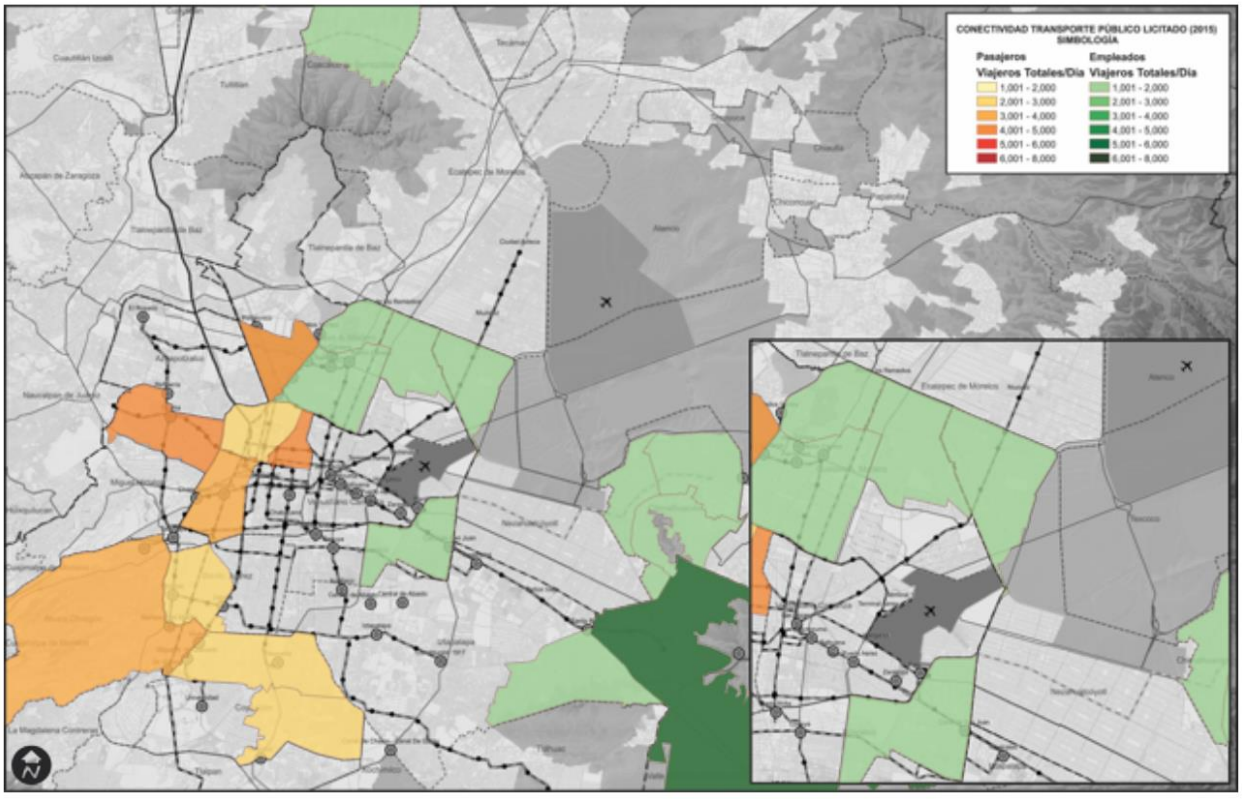
Travel patterns for surface access to today's airport need to be taken into account in developing plans for access to the New International Airport. As the accompanying figure shows, the majority of local passengers using the airport reside or work in western parts of the city whilst the majority of workers in the airport live in eastern suburbs.

Figure 3. **Projections for trips to and from Mexico City Airport**



Source*:* Grupo Aeroportuario de la Ciudad de México (n.d.).

Figure 4. **Origins for trips of passengers (orange) and workers (green) accessing the existing airport from Mexico City.**



Source*:* CTSEmbarq Mexico (2015).

2. Case studies of OECD experience in planning airport capacity expansion and surface transport

Case study 1: London Heathrow runway proposals and terminal expansion

London Heathrow Airport is the primary hub airport for London and the UK. Heathrow operates two runways and is located within the western edge of London's urban area. Both recently delivered and prospective developments at the airport have been politically charged, but have also been associated with careful planning and co-ordination of airside and surface access capacity.

Airport development context

Heathrow's close proximity to the heavily built-up urban area of London gives the airport strategic advantages (fast surface access to deep traveller markets) and disadvantages (large population affected by environmental impacts). The proximity to London's population places practical and political constraints on increasing capacity or utilisation of runways. Two examples of constraints are a cap of 480 000 flights per annum (Airports Commission, 2013b, p. 78), and regulations over the maximum number and noise level of aircraft permitted to use the airport during the designated "night period" (Heathrow Airport Limited, n.d.).

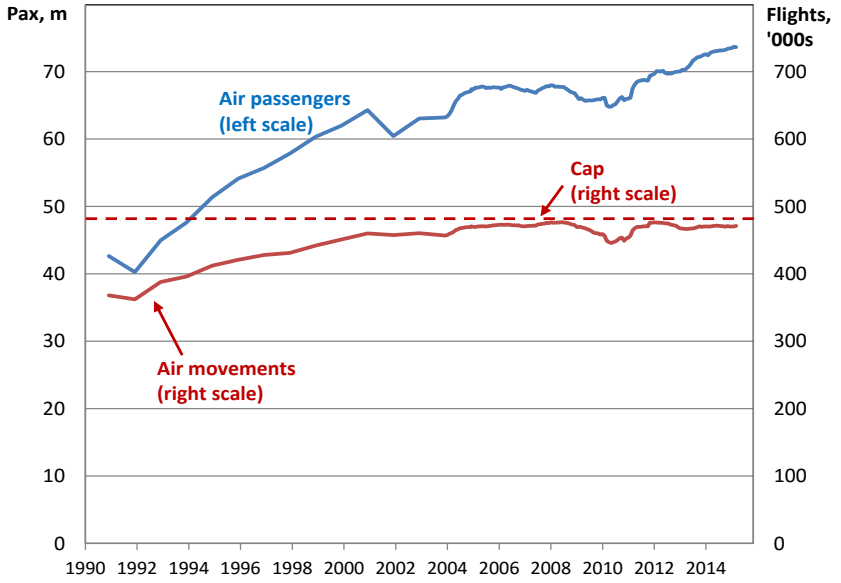
In light of these constraints, as well as the strength of air demand, Heathrow has been operating close to its aircraft movement capacity for the past decade (apart from the period of global air traffic disruption associated with volcanic ash in 2010) (Figure 5). Growth in passenger (and freight) traffic has as a result been to a significant extent constrained. In spite of this, passenger numbers have grown steadily since 2010, which has been possible due to gradually increasing aircraft sizes and building additional terminal capacity, including Terminal 5 that opened in 2008.

Air passenger demand in the South East of England is projected to grow further over the coming decades. In light of this growth and congestion at the biggest UK airports, the Government set up the Airports Commission in 2012 to examine the scale and timing of any requirement for additional capacity to maintain the UK's position as Europe's most important aviation hub and to identify and evaluate how any additional capacity should be met in short, medium and long term.[2]

In December 2013, the Commission found that, in order to maintain that position, one net additional runway in London and the South East needs to come into operation by 2030. The Commission also found that there may be a case for a second additional runway to be operational by 2050, or, in some forecast scenarios, earlier (Airports Commission, 2013b). Options for meeting future air travel demand were suggested by proponents, such as airports. These options were then reviewed by the Commission against a set of sift criteria (Airports Commission, 2013a).

Three options were shortlisted as a result of the Commission's sifting process, two at Heathrow and one at Gatwick (Airports Commission, 2013b). Other proposals for airport expansion were rejected. That group included proposals for an entirely new airport in the Thames Estuary, which were rejected in large part because of the cost of providing entirely new surface access roads and railway links to trunk networks.

Figure 5. **Annual Heathrow Airport air movements and passenger demand, year to date**



Source: ITF based on Civil Aviation Authority and Heathrow Airport data.

In July 2015, the Commission unanimously recommended to expand Heathrow Airport (Airports Commission, 2015). In short, the commissioners decided that building a third runway at Heathrow would deliver much greater economic and strategic benefits than any of the other short-listed options, and hence is the most likely route to achieving the Commission's terms of reference.

The recommendation, however, is not binding and it remains to be seen whether it will be endorsed by the British Government in the coming months.

Surface access as an important part of airport expansion considerations

Heathrow lies 15 miles west of central London and is currently very well served by a variety of surface transport links. The airport is accessible from the M4 and M25 motorways, which provide links for frequent local bus and long distance coach connections (Figure 6). The airport also benefits from direct Heathrow Express rail connection and Heathrow Connect stopping services on the same rail line, as well as the Piccadilly Line (London Underground) that plugs Heathrow into London's metro system (Figure 7). Heathrow has three London Underground stations – one for Terminals 2 and 3 and one each at Terminal 4 and Terminal 5.

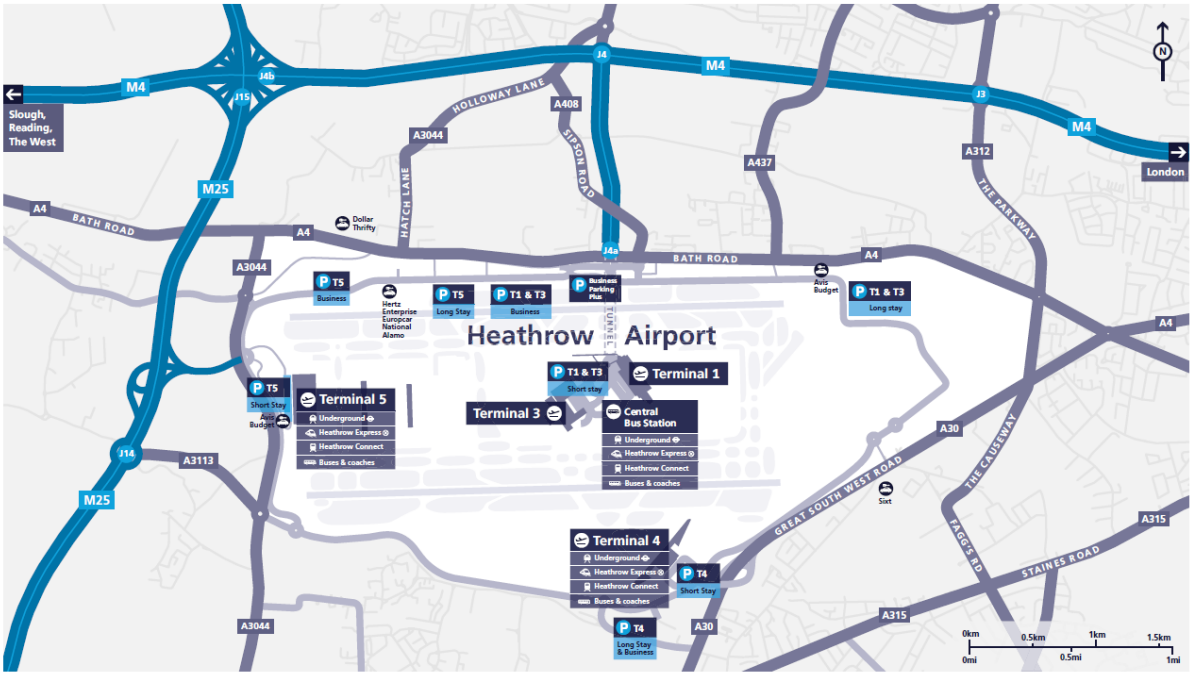
An important part of airport expansion considerations by the Commission was the assessment of surface access strategies for each of the short-listed schemes against the following objectives:

- to maximise the number of passengers and workforce accessing the airport via sustainable modes of transport
- to accommodate the needs of other users of transport networks, such as commuters, intercity travellers and freight
- to enable access to the airport from a wide catchment area.

The surface access strategies were submitted for each scheme by the scheme promoters. For the second runway at Gatwick and third runway at Heathrow schemes, the surface access strategies

submitted by the airport owners were first audited by the Commission's advisors on transport and then taken forward for more detailed assessments. Each strategy comprised both the already committed (in the absence of expansion) surface access developments as well as a set of developments that airport expansion would necessitate due to the projected increase in both passengers and employees travelling to and from the airport. A third runway at Heathrow was expected to increase passenger numbers from 73 million in 2014 to 116 million in 2030 and generate additional 59-77 000 jobs at the airport in 2030. The Commission then employed consulting engineers to produce a dynamic model of the way in which demand, and crowding in at peak times, would likely develop with expansion of the airports and expansion of the surface access network, with and without specific surface transport projects (Airports Commission/Jacobs, 2015).

Figure 6. **Overview of road links to Heathrow Airport**



Source: http://www.heathrow.com/file_source/Heathrow/Static/PDF/Transport_and_directions/Heathrow_car_park_map.pdf

The surface access strategy for expansion of Heathrow comprises a number of upgrades to the existing networks. On top of the already planned works to increase capacity on the key motorway links serving the airport, for example the improvements needed to transform a section of the M4 into a "smart motorway"[3] by 2021, the Commission identified a number of road widening schemes. In addition, a range of works that would be needed to accommodate expansion was identified, including the tunnelling of a section of the M25 (Figure 88).

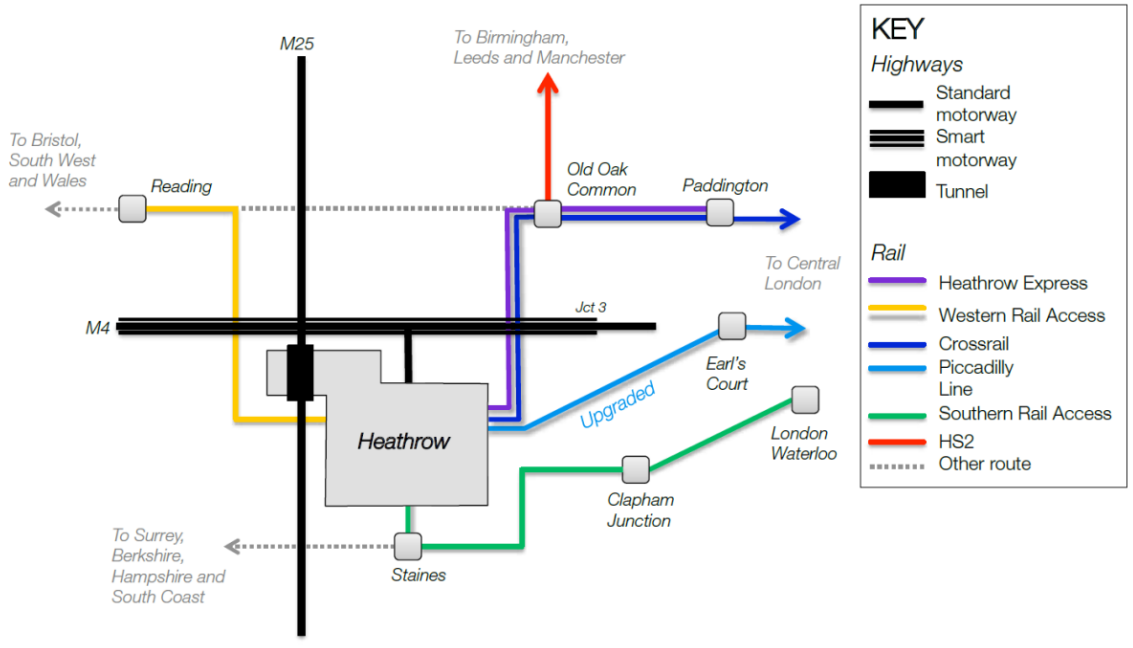
As several significant surface transport schemes that will benefit Heathrow in the future have already been planned (Crossrail, HS2 and Western Rail Access), there is relatively little bespoke new infrastructure associated with airport expansion. The only new link that would be constructed specifically for expansion is Heathrow Southern Rail Access, which would provide links to Waterloo as well as to these areas of West London that are currently poorly connected to the airport by public transport (Richmond).

Crossrail is a new metro line that will link parts of Berkshire and Buckinghamshire 40 km to the west of London, via central London, to South East London and Essex 30 km to the east, running on national rail tracks outside London. In the future, Crossrail will further enhance Heathrow's links to London, providing direct access to key business districts in the West End, City and Canary Wharf as well as to the rapidly growing areas of east London. With the planned connection to HS2 (a high-speed rail link that is planned to link London with major cities in northern England), Heathrow will be better connected to the Midlands and the north, while the planned Western Rail Link to Reading would improve connectivity with Wales.

Figure 7. **Overview of rail links to Heathrow Airport**

Source*:* http://www.heathrow.com/file_source/Heathrow/Static/GIF/Transport_and_Directions/Heathrow_Train_Map.gif

Figure 8. **Surface access strategy for expansion of Heathrow Airport**



Source: Airports Commission (2015), p. 22.

Planning for new airport infrastructure: Fit with relevant local, national and EU policies

Guidance in the use of the assessment methodology to estimate different impacts of airport expansion is provided by the UK Ministry of Transport (https://www.gov.uk/transport-analysis-guidance-webtag).The cost-benefit assessment and environmental impact assessment are summarised in a table of results that highlights critical issues for political decision makers to resolve. The use of synthetic indicators of overall benefit or overall loss of welfare is avoided and multi-criteria analysis is not employed, unlike in some other European jurisdictions.

The emphasis of the UK assessment approach is to reveal where development is in line with broader policy goals and where there are trade-offs to be made. These cover not just environmental issues but the current Government's key policy priorities (which might include, for example, promoting private business development or social inclusion).

In line with this assessment approach, the Airports Commission scrutinised each of the three short-listed options (together with their surface access strategies) with respect to its potential (positive and negative) economic, social and environmental impacts. An important part of this work was to assess the potential contribution of each of the schemes to wider economic and spatial development strategies comprised in any relevant existing local and national plans, as well as with respect to the relevant European Union requirements regarding environmental impact assessments.

Local government plans

On a local level, the Commission drew upon a review of all relevant existing plans – including local plans, strategic economic plans set out by Local Enterprise Partnerships (LEPs), and regional development plans. Generally, while airport expansion schemes usually help to deliver economic growth and employment in line with the priorities of local authorities and regional development plans, and hence also supporting the strategies of LEPs and other local business groups, they also go against these strategies when it comes to the environmental impacts that they induce.

In the case of Heathrow, local authority plans acknowledge that the airport's current activities produce economic benefits. In these plans Heathrow Airport is a "key employment area" (Hillingdon Local Plan) providing the local areas with "economic stimulus" (Hounslow Local Plan). The plans of local authorities do not unanimously support Heathrow expansion – for example, the local plans of Hillingdon and Hounslow rule it out, while the plans of Slough and Speltmore support expansion as long as certain conditions are met.

The London Plan was of particular relevance to assessing the short-listed airport expansion schemes. This spatial development strategy was developed by the Mayor of London, and most recently reviewed in 2015, to provide "the framework for the development and use of land in London" (Mayor of London, 2015, p. 14). The development plans of London's constituent Boroughs must be broadly aligned with the overall London Plan but are based on local community input. Spatial development and transport planning in London (through the Mayor's Transport Strategy) are focused, among other things, on developments that favour public transport, walking and cycling (Mayor of London, 2011), which was one of the explicit objectives against which the Commission assessed the three short-listed options' surface access strategies. The London Plan opposes Heathrow expansion due to its environmental impacts.

National Government planning

The Commission also investigated how each of the short-listed options could potentially affect any relevant parts of wider national strategic frameworks, such as the National Planning Policy Framework and Aviation Policy Framework.

The UK's National Planning Policy Framework (2012) sets out a general approach to planning that seeks to reflect the requirements of the EU as well as the input from local communities. In relation to transport, the Framework requires that "developments that generate significant movement are located where the need to travel will be minimised and the use of sustainable transport modes can be maximised" (Department for Communities and Local Government, 2012, p. 10).

For nationally significant developments (such as expansion of major airports), the framework requires a national policy to demonstrate how the development is consistent with other policies and how adverse impacts would be mitigated and managed. The statement is submitted to the Planning Inspectorate which makes recommendations to the relevant Secretary of State for decision (The Planning Inspectorate, 2012). An alternative route would be through submission of a "Hybrid Bill" to Parliament, which also provides a means of securing planning permission for a major infrastructure project. Although Hybrid Bills have historically been relatively less common, they were used for securing very significant infrastructural developments such as the Channel Tunnel Rail Link and Crossrail.

The Aviation Policy Framework (Department for Transport, 2013) sets out the Government's policy on aviation to ensure the sector continues to make a significant contribution to economic growth across the country. The framework provided the Airports Commission with Government objectives with respect to different issues relating to airport expansion, for example noise and climate change.

European Union requirements

The EU's Environmental Impact Assessment (1985) and Strategic Environmental Assessment (2001) directives set out the requirements for analysing environmental impacts of projects and programs in member states, including the UK. Plans, programmes and projects that are likely to have significant effects on the environment, including major airports, are subject to environmental assessment prior to approval. Public consultation is a central feature of these assessment procedures (European Commission, 2015).

The Airports Commission assessed the short-listed airport expansion options against a set of environmental criteria, one of them – to improve air quality consistent with EU standards – directly pertains to EU air quality regulation (Airports Commission, 2015, p. 91). The Commission also conducted its noise impact assessments using, among other metrics, the metrics used by the European Commission to assess aviation noise levels (Airports Commission, 2015, p. 170).

In the UK, the Air Quality Standard Regulations 2010 implement the requirements of the European Directive on Air Quality and Cleaner Air for Europe (2008/50/EC). The Directive requires EU Member States to incorporate a set of air quality limits regarding the concentration of various pollutants (NO_x and particulate matter) in the outdoor air. The UK is required to report on compliance with these limits on an annual basis.

Local governments in the UK are required to follow The UK Air Quality Strategy and Local Air Quality Management Plans that provide local government with air quality standards and regulation of key air pollutants, and set out how local stakeholders can achieve abiding by the Air Quality Management Regime (Mayor of London, 2011). The UK also follows the 2001 National Emissions

Ceiling Directive (2001/81/EC) that sets binding limits on the national emissions of four pollutants: NO_x, sulphur dioxide, ammonia and non-volatile organic compounds.

Requirements and approval processes for airport development

To develop any new airport runways or terminals, the scheme promoter would need to work within the requirements of the UK's planning system. The planning system ensures that proposed developments would be compatible with community expectations, the current and planned surrounding land uses and the capabilities of the transport system. Projects are subject to agreement by local government planning authorities and for projects with major impacts on land use and the environment, such as expanding Heathrow's runway capacity, national support in the form of a bill in Parliament.

Under the current planning framework, although airports in the UK are largely in private ownership, Central Government has a crucial role to play in the planning process. The Airports Commission has considered different possible approaches to securing a planning consent for new airport infrastructure and identified two credible alternatives for reaching a planning consent: a National Policy Statement (NPS) and a Hybrid Bill. As neither of these two approaches was used recently to deliver airport expansion, there is no clear precedent to follow.

As project assessment procedures must conform to the requirements of European Union Directives, including air quality standards and strategic environmental impact appraisal, these regulations form an important part of the Commission's assessments of its short-listed schemes. The EU Directives are in the main derived from good practice in member countries and incorporate for example environmental impact appraisal techniques that are routine in the UK. Air quality standards are more problematic as the UK, along with most other EU member states, fails to reach targets in a number of urban agglomerations. This accentuates the attention given to air quality in UK planning decisions.

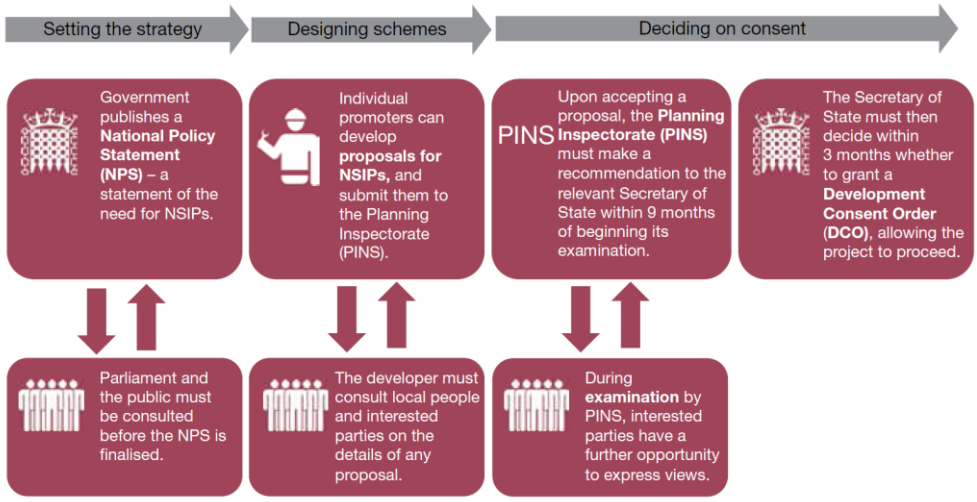
For controversial projects planning inquiries are held under a presiding judge to review the evidence for and against the project. The concerns of stakeholders such as NGOs, residents associations and environmental opposition groups are addressed by the planning inquiry in detail to maximise the chances of finding a consensus. Ultimately the Minister for Transport arbitrates when necessary with the support of cabinet colleagues and the prime minister. Class actions in the courts are possible to challenge whether due process was followed but not simply to contest a decision.

NPS/DCO route

The 2008 Planning Act (as amended by the Localism Act 2011) gives the Secretary of State for Transport the powers to publish a National Policy Statement (NPS) setting out the need for any potential Nationally Significant Infrastructure Project (NSIP) in the aviation sector. An NPS set by the Government would require investigation of how "actual and projected capacity and demand have been taken into account" and "must include an explanation of how the policy takes account of Government policy relating to the mitigation of, and adaptation to, climate change" (The Planning Inspectorate, 2012). Such NPSs have been commonly used in other sectors, for example energy and waste.

The private owner of the airport would then develop a proposal for the NSIP and submit it to the Planning Inspectorate that examines the NSIP in the context of the relevant NPS. The Inspectorate would then make a recommendation to Ministers who would decide whether a Development Consent Order (DCO) should be granted. In theory, a DCO is not essential to the planning process, but in practice it would be unlikely for the Government not to issue a statement on the need for new airport capacity. During each stage in the process, the relevant parties would be consulted on the details of the proposals and given opportunity to express views (Figure 9).

Figure 9. **NPS/DCO planning process**



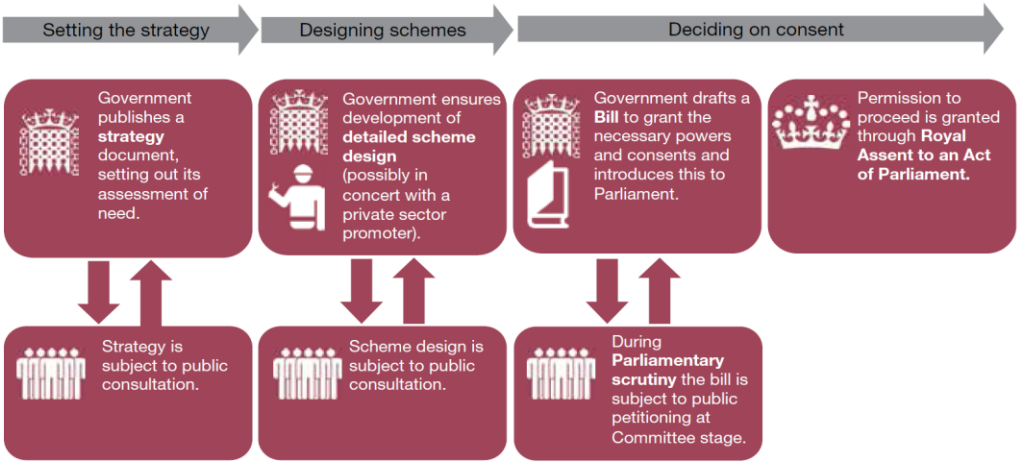
Source: Airports Commission (2015), p. 325.

Hybrid Bill route

Under a Hybrid Bill (i.e. a bill that mixes the characteristics of Public and Private Bills – see: http://www.parliament.uk/about/how/laws/bills/hybrid/), Parliament is responsible for debating and agreeing on the principle of the bill and the detailed design of the scheme. This has recently been the route taken for major publically funded transport projects such as the High Speed 2 railway or Crossrail. Since the third runway at Heathrow would most likely be a fully privately funded project (largely private ownership of airports in the UK means that airports normally do not rely on government funding to finance their new infrastructural developments), the Hybrid Bill route is generally considered to be less likely than an NPS one.

As in the case of an NPS/DCO route, during each of the stages in the process the relevant parties would be consulted on the details of the proposals and given opportunity to express views (Figure 10).

Figure 10. **Hybrid Bill planning process**



Source: Airports Commission (2015), p.326.

While the Commission acknowledged that Heathrow Airport Ltd has a preference for a NPS/DCO route, it decided not to make a firm recommendation in this respect. The decision would most likely be a product of discussions between the Government and the airport.

The Airports Commission's approach to investigations into expanded runway capacity reflects the ultimate requirements of the UK's planning system outlined above. As such, the information developed for each option (and the criteria each option is assessed against) reflects the challenges that would need to be overcome through public consultation as well as the statutory requirements that need to be satisfied. In practice there are three main issues that would largely determine the likelihood of approval and the types of conditions that would be placed on any approval; these pertain to the impacts of the expansion scheme on air pollution, surface transport impacts and noise.

Air quality impacts

Heathrow expansion creates significant air quality challenges with respect to abiding by the European air quality standards. The Airports Commission recommended a firm action on part of Heathrow Airport to ensure that emissions relating to the airport are minimised, together with a national strategy on addressing the background demand. The Commission recommended considering a demand regulation mechanism on the roads around the airport, such as an access or congestion charge for road vehicles (Airports Commission, 2015, p. 214).

To accommodate the existing regulation on air quality, the Commission recommended that any "additional operations at an expanded Heathrow must be contingent on acceptable performance on air quality" and that "new capacity should only be released when it is clear that air quality at sites around the airport will not delay compliance with EU limits" (Airports Commission, 2015, p. 338). This will mean that high mode shares for sustainable surface access options will need to be attained. Exactly how high will depend on the speed of technological progress in reducing emissions from aviation.

Surface transport impacts

The proponents of specific runway options presented to the Commission developed surface access strategies to complement their proposed airside infrastructure. The surface access plans were then scrutinised by the Airports Commission against three objectives: to maximise the use of public transport by the passengers and workforce, to accommodate the needs of other transport users (commuters, other travellers and freight), and to enable access to the airport from a wide catchment area. These objectives echo the London Plan: "the Mayor strongly supports efforts to make aviation less environmentally harmful, and promotion of more environmentally sustainable means of accessing airports through ensuring viable and attractive public transport alternatives for travellers" (Mayor of London, 2015, p. 254).

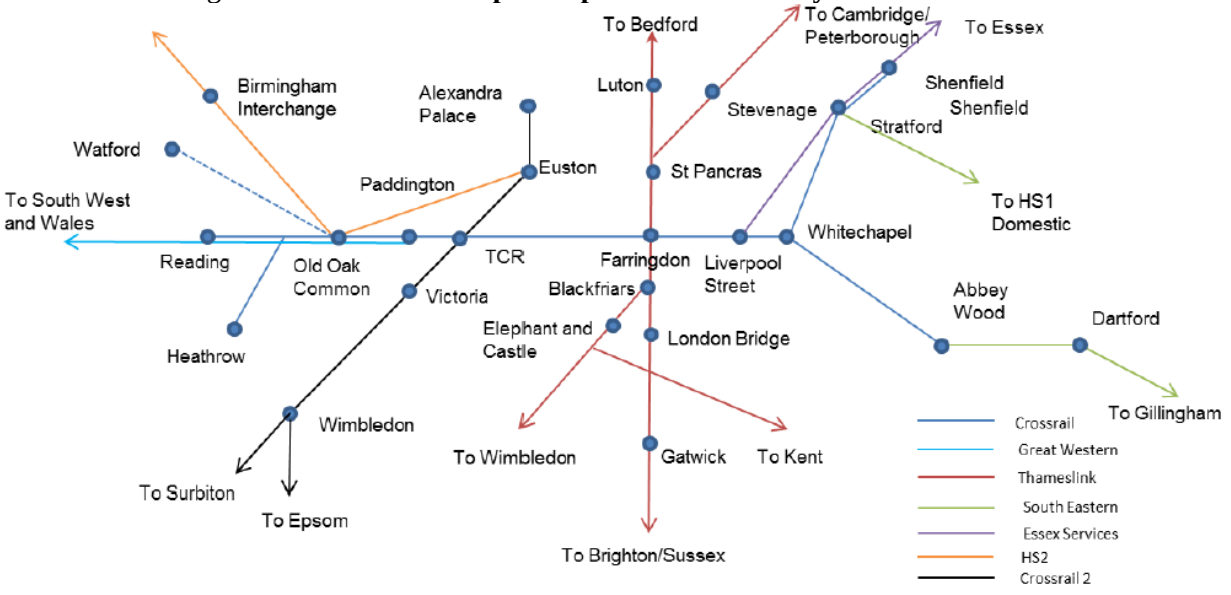
The Commission concluded that, although expansion of Heathrow would have a relatively modest impact on congestion on most links, the projected scale of the growth in background demand means that these impacts need to be carefully scrutinised and plans on how to address congestion need to be devised. The Commission identified a number of potential "pinch points" on the road and rail networks and recommended a set of recommendations – provision of new infrastructure, demand management measures or a combination of the two – to deal with congestion.

The Commission also assessed the potential impacts of the surface access strategy for Heathrow expansion on the ways in which people travel. The enhanced transport offering resulting from Heathrow expansion was forecast to enable a shift in the airport's public mode share from around 41% in 2012 (28% - rail, 13% - bus/coach) to around 53% in 2030 (over 40% - rail). These figures indicate that public

transport, and rail in particular, is expected to take up a much greater volume of Heathrow's passengers in the future – in 2030 over 56 million passengers would be expected to travel by public transport compared to around 29 million in 2012.

The greatest shift to rail as a mode of transport would be observed for trips starting in the South East and East of England as well as North West, thanks to both the already-planned improvements and the South Rail Access proposal. For example, Crossrail will serve many important London stations directly, hence also improving the connectivity for passengers from outside London by serving important commuter and intercity stations: Farringdon (Thameslink), Liverpool Street (Greater Anglia), Stratford (HS1) and Abbey Wood (North Kent Line), hence removing the need for passengers to change in central London (Figure 11). This and other network improvements are expected to incentivise passengers travelling to Heathrow from the South East (outside London) to switch to rail increasing the share of trips by rail in the total from 5% of in 2012 to over 30% in 2030.

Figure 11. **Schematic map of improved connectivity due to Crossrail**



Source: Jacobs (2014), p. 33.

Only a small number of major airports worldwide (Oslo Gardermoen, Hong Kong International and Narita International) achieve higher levels of public transport mode share today (ACRP, 2008). The Commission also investigated the potential impacts of different demand management measures and concluded that for example charging taxis and private cars for access to Heathrow could result in achieving a potential 60% or higher public transport mode share.

The Commission's forecasts also suggest that new rail links to the airport would incentivise a larger share of employees to switch away from travelling to work by car – from 53% in 2012 (estimate based on 2013 Heathrow employee survey) to about to 47% without implantation of any demand management measures (Jacobs, 2014). Implementing policies that encourage commuting by public transport and car-pooling could further reduce that share, up to as much as 25% in the most extreme of the scenario tested by the Commission's advisors (Jacobs, 2015).

The Commission also assessed the potential expansion of the airport's catchment area due to the network improvements identified in the surface access strategy. Due to the plans regarding Crossrail,

Southern Rail Access and HS2 Heathrow's, the 30-minute and 60-minute catchment areas are forecast to grow from 230 000 and 28 million today to 700 000 and 38 million of residents respectively by 2030.

The Commission recommended to the Government that, in the event of expansion, Heathrow should be held to performance targets to increase the share of employees and passengers accessing the airport by public transport to guarantee that the pressure on local roads (and resulting adverse quality impacts) is reduced. As already mentioned above, the Commission also recommended that demand management schemes, such as a congestion or access charge scheme, should be considered to ensure that adverse impacts on the environment are minimised.

The formal planning requirements for proponents of major developments are the production of:

- a transport assessment (to inform the development application)
- a travel plan (for implementation once development is operational).

These mechanisms seek to satisfy both the local community and the Planning Inspectorate/Secretary of State that transport impacts of the development have been anticipated, and to a reasonable extent mitigated, by improving transport accessibility particularly for walking, cycling and public transport. Where unmitigated impacts on the transport network are anticipated to be "severe" this can be grounds for refusing a development application (Department for Communities and Local Government, 2012, pp. 10; 57).

In line with the current planning procedures and strategies, emphasis in recent years has been placed on improving public transport access and uptake when airside capacity is expanded. For instance, planning approval for development of Terminal 5 at the western extremity of the airport was approved only on the condition that both the heavy rail and metro services were extended to the new terminal prior to opening, as outlined in a statement to Parliament by the Secretary of State for Transport (Byers, 2001).

Noise impacts

While noise impacts of airport capacity expansion proposals understandably have a high profile with affected residents, there are currently no formal noise limits imposed by European or UK laws that have to be met before proposals can be approved (Department for Environment, Food and Rural Affairs, 2010).

Nevertheless, there is a general principle in planning to avoid, mitigate, or reduce significant noise impacts on quality of life from any development (Department for Communities and Local Government, 2012, p. 29). The Airports Commission, in its efforts to follow these principles, recommended a package of measures to address the environmental impacts of expansion that should be taken forward together with the approval for the third runway at Heathrow.

These measures include a ban on all night flights in the period between 23:30 and 06: 00 and a "noise envelope" that should be agreed and which the airport should be legally bound to follow. The Commission also stressed that a third runway should allow periods of respite to be more reliably maintained. It also recommend that the airport should commit to spending more than GBP 1 billion on community compensation and for a noise levy to be introduced to ensure that airport users compensate the local communities for the negative externalities that they impose on them, in the form of funding noise insulation schemes and supporting local schools.

To ensure the delivery of its recommendations, the Commission advised the establishment of two new bodies: A Community Engagement Board (with an independent chair to have influence over how

the funds allocated to compensation should be spent and over the airport's operations) and an Independent Aviation Noise Authority (that would have a statutory right to be consulted on flight paths and other operating procedures). The Commission also recommended that the fourth runway should be ruled out for both environmental and operational reasons.

Funding and financing surface access development strategies for airport expansion

The previous section explained the formal planning requirements to improve public transport surface access to Heathrow when capacity is expanded. However, the owners of the airport are also motivated by sustainability concerns, traveller experience and staff accessibility, to ensure that high quality public transport options are available (Heathrow Airport Limited, 2014b).

The prominent role of public transport surface access to Heathrow can be seen in the planning, design and layout of Terminal 5 that opened in 2008. Before construction, the terminal's design directly incorporated a station and rail tunnels for extensions to existing rail services (Heathrow Express/Connect and the Piccadilly Line). In addition, the station embeds two additional platforms to allow for the potential future (westward or southern) expansion of the rail network.

The current layout and space allocation at Terminal 5 also favour passenger use of public transport. Underground rail and metro station entrances are directly accessible from the Terminal ground floor immediately after emerging from the secure arrivals area; once outside the terminal building, the closest kerbside bays are allocated to public buses and coaches; arriving passengers have to cross to a second traffic island to access taxis, car parks and off-airport car park shuttles.

In considering the implications of further runway capacity for surface access transport, the Airports Commission developed network strategies for scenarios with and without this additional runway capacity at Heathrow. This allowed the specific projects that would be required due to airport expansion to be identified, including several road upgrades as well as a rail project (Southern Rail Access to Heathrow) that would likely be required to meet the additional surface demand. The cost of these projects was estimated at around GBP 5 billion in present value terms (Airports Commission, 2015, p. 224).

The approach used by the Commission distinguishes between the schemes that would be required irrespective of expansion due to the expected increase in background demand and the surface access developments that would be directly linked to expanding airport capacity. This is a helpful distinction as the allocation of costs of developing surface transport infrastructure typically depends on the function of the link. Infrastructure that exclusively connects the airport to the wider transport network tend to be borne by the owners of Heathrow, Heathrow Airport Holdings (HAH, formerly BAA), while broader network expansions that more generally improve connectivity within London (including Heathrow) will have more diverse funding sources.

The decision on which party should pay for the latter will be made on the basis of commercial negotiations between the Government and the airport operator. The Commission undertook financeability assessments of the scheme and concluded that in a scenario in which the airport is required to fund 100% of the surface access costs, the expansion proposal would be fully commercially viable.

The extension of the rail and metro lines to Terminal 5 is an example of a surface transport project funded entirely by HAH. This investment is financed, at least in part, from rail and metro revenues.[4] This funding and financing approach reflects the original development (in the 1990s) of the railway line joining Heathrow with inner London. The government (through Network Rail) owns the Great Western Main Line track connecting London to the west of England. However, the stations, tunnels and track from the main line to the Heathrow terminals are owned by HAH. HAH also owns Heathrow Express,

which operates train services from Paddington to Heathrow terminals and part owns the company that runs the Heathrow Connect stopping services along the same route (Fender, 2014). HAH's investment in the rail connection to the mainline, including tunnelling, was valued at GBP 440 million in 2000.

Heathrow Express began services in 1998 after five years of construction. It carries passengers to Paddington Station in the west of central London in 15 minutes on non-stop services that run every 15 minutes. Fares are relatively high, and highly differentiated for yield management, and carriages have space for baggage. Operating speed averages 90 km/h. Tickets can be bought in advance or at machines on the platform and on the train itself (with a surcharge). Heathrow Connect services operate on the same route, serving the airport and intermediate stations at lower speeds and around half the ticket cost, aiming principally to serve airport workers. Trains depart every 30 minutes and end to end journeys take 25 minutes. In addition to its value to the airport, Heathrow Express contributed to redevelopment of the area around Paddington Station, helping to attract businesses to an area designated the Paddington Special Policy Area by Westminster Council in 1988.

Table 1. **Selected fares on Heathrow Express**

	Express Standard	Express Saver	Business First	Advanced Express Saver	Advanced Business First
	Buy on-board (GBP)	Buy online, less than 14 days ahead (GBP)	Buy online, less than 14 days ahead (GBP)	Buy online, more than 90 days ahead (GBP)	Buy online, more than 90 days ahead (GBP)
Single	27.00	22.00 off-peak 25.00 peak	32.00	5.50 weekend 12.10 weekday	7.50 weekend -
Return	42.00	37.00	55.00	-	-
Carnet of 6 tickets	-	109.80	160.00	-	-
Carnet of 12 tickets	-	198.00	288.00	-	-

Source: Heathrow Express, https://www.heathrowexpress.com/tickets-deals/prices-fares

Table 2. **Fares on Heathrow Connect**

To and from Heathrow Airport:	Single fare (GBP)	Open return (GBP)
Hanwell	6.90	13.80
West Ealing	8.00	16.00
Ealing Broadway	8.00	16.00
London Paddington	**10.30**	**20.70**

Source: Heathrow Connect, https://www.heathrowconnect.com/tickets

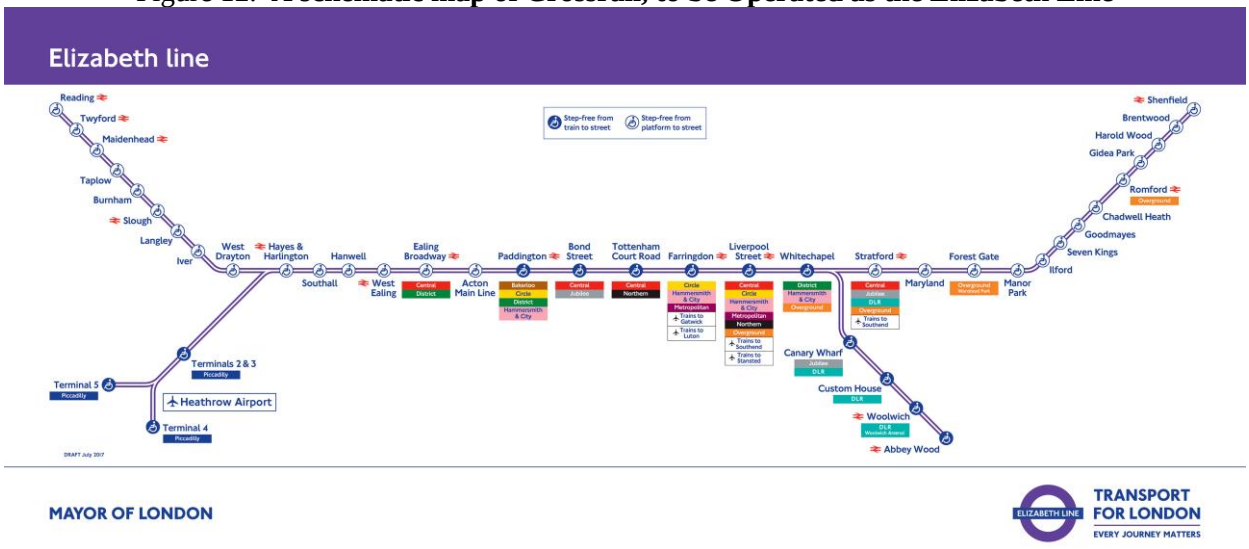
The Crossrail project is a wider network upgrade that will enhance surface access to Heathrow on a larger scale than Heathrow Express. Crossrail will link the Heathrow terminals, the West End of London, the City of London, Canary Wharf[5] and the Thames Gateway area with frequent heavy rail services. (Figure 1212). It will also replace the Heathrow Connect services. Cross rail will be tightly integrated with the existing underground railway system, with interconnections at a series of key central London stations. Overall it will add 10% to the capacity of the London underground system.

Reflecting the benefits that the improved surface access will offer Heathrow, HAH agreed to a contribution of GBP 70 million (in 2011/12 prices) to the GBP 14.8 billion project.[6] Beyond such specific payments, the Greater London Authority and Transport for London financed the Mayor's GBP 7.1 billion Crossrail funding contribution through a range of sources (Mayor of London, 2013):

- Business Rate Supplement (GBP 4.1 billion) – paid by occupiers of commercial property in recognition that Crossrail will enable economic development and further employment growth in London
- Developer charges (GBP 0.3 billion) – contributions from approved development applications for projects that are assessed as likely add to congestion on the rail network that Crossrail is intended to mitigate (under Section 106 of the Town and Country Planning Act 1990).
- Community Infrastructure Levy (GBP 0.3 billion) – a developer contribution to support the overall requirements of growth areas.[7]

The remainder of the Crossrail's capital costs are to be covered by government (national and London).

Figure 12. **A schematic map of Crossrail, to be Operated as the Elizabeth Line**



Source: Crossrail (2017). http://www.crossrail.co.uk/route/maps/route-map

Case study 2: Public transportation network development for Incheon International Airport

Kimpo International Airport (KIA), serving Seoul in South Korea, experienced a significant increase of air traffic in the 1970s and 1980s with the nation's rapid economic growth and its role as the main airport for both international and domestic flights. To share the burden the government decided to build a new airport mainly for international flights in the late 1980s and after 10 years of planning,

design and construction, Incheon International Airport (ICN) was opened in March 2001. Access by public transport was a key part of planning, with 43 airport bus lines provided in the opening year and 117 airport bus lines in service today. The Airport Railroad, connecting ICN to Seoul Station was opened in 2010 and with connections to the existing national and regional railroad network the service effectively transports passengers all over the country. In this case study the current public transportation services feeding ICN are summarised and the background and rationale to their development explained.

Table 3. **Air traffic volume trend at KIA, 1971 to 1991**

		1971	1981	1991
Passenger (passenger/yr)	Domestic	792 868	1 108 889	9 470 138
	International	418 345	2 715 158	8 997 191
	Total	1 211 213	3 824 047	18 467 329
Cargo (ton/yr)	Domestic	5	10 867	135 480
	International	776	200 180	755 982
	Total	781	211 047	891 462

Source: Korea Transport Database.

Table 4. **Air traffic volume trend at KIA and ICN, 2000 to 2014**

			2000	2002	2008	2014
KIA	Passenger (passenger/yr)	Domestic	18 738 579	17 082 195	12 295246	17 483 670
		International	17 898 488	9 900	1 969447	4083 276
		Total	36 637 067	17 092 095	14 264 693	21 566 946
	Cargo (ton/yr)	Domestic	306 377	302 152	171 859	195 231
		International	1 891 302	89	32 118	76 759
		Total	2 197 679	302 241	203 977	271 990
ICN	Passenger (passenger/yr)	Domestic	0	371 510	410 142	605 286
		International	0	20 548 895	29 563 380	44 906 813
		Total	0	20 920 405	29 973 522	45 512 099
	Cargo (ton/yr)	Domestic	0	5 955	5 994	9 198
		International	0	2 010 913	2 898 090	3 233 913
		Total	0	2 016 868	2 904 084	3 243 111

Source: Korea Transport Database.

Background of ICN project

Located 17 km west of the centre of Seoul, Kimpo International Airport served as the main gateway to the country and the city of Seoul before ICN opened in 2001. The number of passengers and the tonnage of cargo handled at the airport increased more than 15 times and 114 times respectively for the

20 years before the ICN project was initiated (Table 3), with KIA operating near capacity. Noise issues were a problem as KIA is located inside Seoul and close to residential areas. For these reasons, the government decided to build a new international airport. Since beginning full operations in 2002, ICN has successfully replaced the international function of KIA.

Geographical layout of ICN

ICN is located 55 km west of the centre of Seoul on a reclaimed landmass of 56.2 km^2 over two islands; Youngjong Island and Yongyoo Island (Figure 13). As the runways are more than 20 km off the shore of the nearest city, Incheon, the airport is free from noise and pollution issues. When opened in 2001 the airport was equipped with two runways and one passenger terminal. Later in the final stage of the project two more runways and one more passenger terminal will be added and up to 100 million passengers and 7 million tonnes of freight can be served in a year (Table 5).

Table 5. **Facility size and capacity of ICN project**

		Opening stage (2001)	Final stage (2040)
Facility	Site area (1 000 m^2)	11 700	47 400
	Number of runways	2	4
	Number of passenger terminal/total area(m^2)	1/369 000	2/875 000
Capacity	Passengers (million passenger/year)	27	100
	Cargo (million tonnes/year)	1.7	7.0
	Flights (flight/year)	170 000	530 000

Source*:* Kwon and Jo (2000).

Figure 13. **Location of ICN and its connection to Seoul Metropolitan Area**

Source*:* Kwon and Jo (2000).

Connections between ICN and Seoul Metropolitan Area

When the airport was opened, the only connection to Seoul Metropolitan Area was the 40.2 km long six to eight lanes wide Airport Highway which includes Youngjong Grand Bridge (Figure 13). As the cost of the project at USD 1.87 billion was beyond the government's financial capability, it was funded by a public-private partnership (the first PPP in Korea) and the toll was about six times more expensive, USD 6, than that for a similar length publicly owned tolled highways.

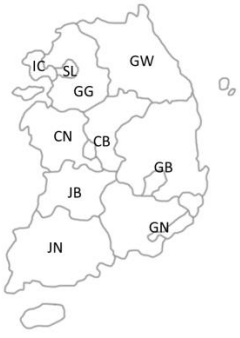
In March 2007 the first 37.6 km segment of the ICN railroad service was opened and it connects the airport to KIA. The railroad is located at the lower deck of Youngjong Grand Bridge when it passes over the sea. In December 2010 the remaining segment (23.4 km) was completed and ICN was directly connected to the center of Seoul. In May 2010 Kyungin Expressway 3 including the 2nd Bridge (Figure 13) was opened to serve the highway traffic from the south of Seoul Metropolitan Area. From the ICN opening to 2010, the highway part of Youngjong Grand Bridge was the only effective link connecting ICN to Seoul Metropolitan Area and the toll was much higher than that of exiting highways. These contexts lead to the development of the national bus networks to feed ICN.

Public transportation service development

Bus services at ICN

At the opening of ICN 43 bus lines were provided, serving all regions of the country except Gyeongsangbuk-do and Gyeongsangnam-do in the far south-east. As of 2015, 117 bus lines from all over the country are in service and 60% of the passengers, visitors and employees are bus riders (Table 6 and Table 7). Bus stops are located all along the kerb-side immediately in front of the entrances/exits at the ground level of the terminal (Figure 14), making the bus mode more attractive in terms of walking distance than the rail mode introduced later in 2010 and also taxis that pull up at a second parallel lane of the access road. Car parking is provided beyond the taxi lane, making less accessible again.

Table 6. **Number of bus lines at ICN in 2001 (opening) and 2015 (current)**

Region code	Region name	Number of bus lines to ICN		Region code map
		2001	2015	
SL	Seoul	21	32	
GG	Gyeonggi-do	9	30	
IC	Incheon	5	12	
GB	Gyeongsangbuk-do	0	6	
GN	Gyeongsangnam-do	0	9	
CB	Chungcheongbuk-do	1	4	
CN	Chungcheongnam-do	4	9	
GW	Gangwon-do	2	6	
JB	Jeollabuk-do	1	2	
JN	Jeollanam-do	4	7	
Total		43	117	

Source: Kwon et al. (2001); Kwon et al. (2012).

Table 7. **ICN passenger terminal access mode share (based on survey in 2011)**

Mode	Car	Taxi	S. bus	L. bus	Rail	Total
Ratio	23.49%	3.33%	6.4%	60.47%	6.47%	100.00%

Source*:* Kwon et al. (2012).

Figure 14. **Kerb-side bus stop layout at ground level of passenger terminal at ICN**

Source*:* Incheon International Airport Corporation, Airport Bus Guide, http://www.cyberairport.kr/pa/en/d/3/1/1/index.jsp

Rationale behind bus service development

The overall cost to access ICN is much more expensive if a car or a taxi is chosen instead of public transport. As ICN is located further from Seoul, the fuel cost became higher. In addition a high level toll incurred by the private investment on the Airport Highway made the travel from outside the island airport expensive. Since the rail service was not available at the opening, providing bus services at a reasonable cost was an essential consideration to include all classes of airport users. This rationale is clearly seen in the growth of the bus and rail user proportion after the opening of ICN (Table 5 and Table 8). Since ICN has been in operation, car and taxi modes have become less affordable as seen in the cost comparison by mode shown in Table 9.

Table 8. **KIA passenger terminal access mode share (based on survey in 2000)**

Purpose\mode	Car (%)	Taxi (%)	Bus (%)	Rail (%)	Other (%)
Business travel	30.1	17.3	37.9	14.2	0.5
Leisure travel	27.4	14.6	41.9	11.0	5.1
Farewell	52.0	8.1	25.4	14.4	0.1
Greeting	44.4	4.4	32.0	19.0	0.2
Other	10.6	5.4	39.7	43.7	0.6
Total	34.9	10.9	36.0	16.5	1.7

Source: Kwon et al. (2001).

Table 9. **Cost comparison by mode from the center of Seoul to KIA or ICN as of 2015**

Destination	Mode	Travel time (min)	Fare/fuel (krw)	Toll (krw)	Park (krw/day)	Total cost (krw)
KIA	Car	40	2 400	0	12 500	2 400+12 500/day
	Taxi	40	19 000	0	0	19 000
	Bus	75	1 400	0	0	1 400
ICN	Car	60	7 400	6 600	24 000	14 000+24 000/day*
	Taxi	60	44 200	6 600	0	50 800
	Bus	90	14 000	0	0	14 000

Note*:* * parking fee from October 2015; For the calculation cases of car and taxi, 1.4 occupancy/trip is applied. In a peak time period the travel time and cost of car and taxi may increase due to congestion.
Source*:* Off-peak time (23:00) navigation information by Naver Map Service.

As mentioned, from the opening to 2007, ICN is connected only by a highway bridge with eight lanes. Right before the opening, the traffic demand on the bridge was forecast to be around 52 000 vehicles a day (40% of the capacity), which turned out to be very close to the traffic two years later counted at 53 000 vehicles a day (Kwon et al., 2001; Traffic Monitoring System, http://www.road.re.kr). The forecast assumed that the car and taxi demand is 30% of the total with average occupancy 1.4 and that the remaining 70% is carried by bus with average occupancy 20. Simple maths shows that if the bus services had not been available the bridge would have reached capacity on the very opening day.

Bus network design principles: Complete coverage, punctuality and continuity

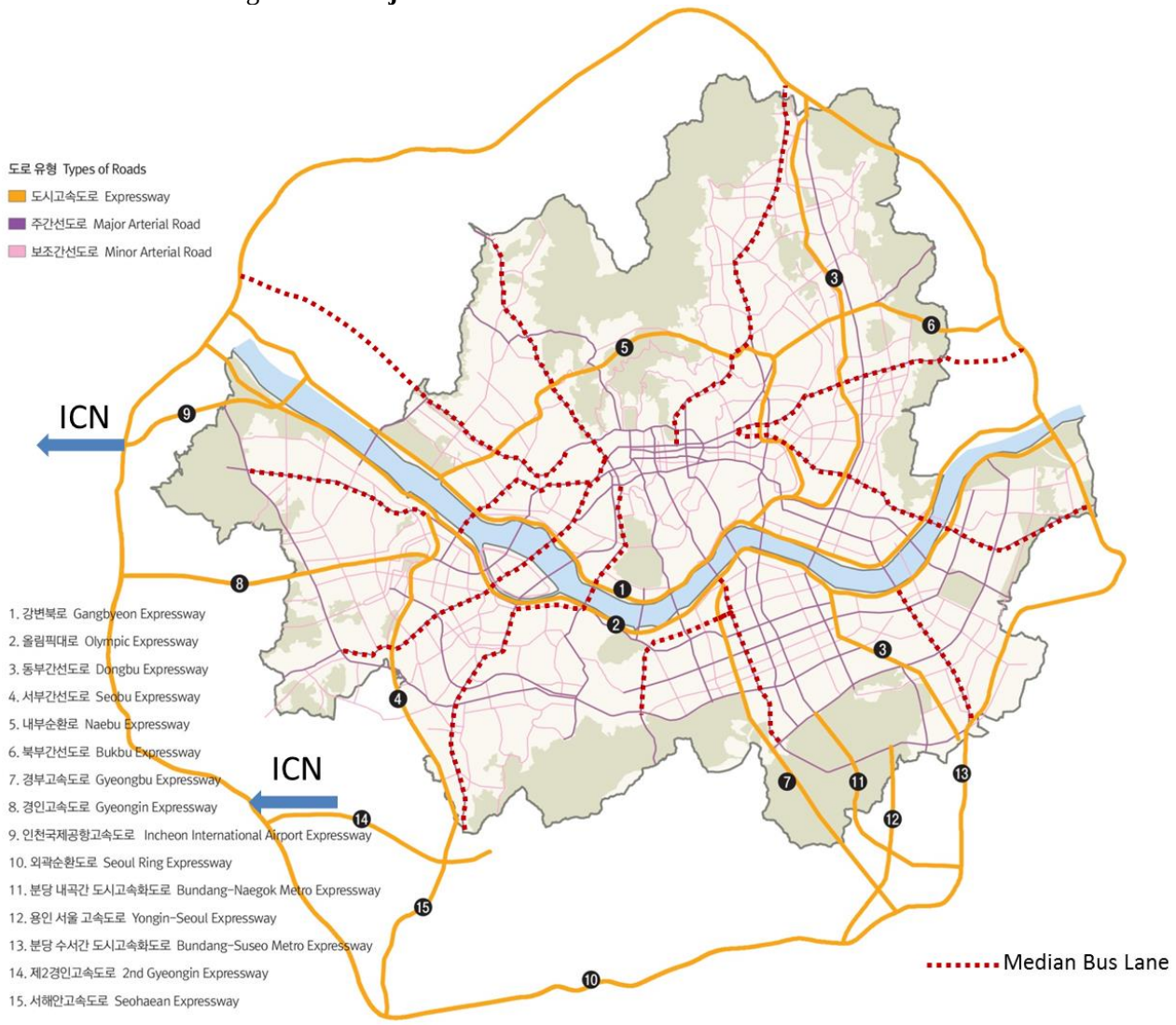
All metropolitan cities were directly connected to ICN. All small cities were connected either to the nearest metropolitan cities by feeder services or to major transport hubs in Seoul. The travellers from small cities were then connected to ICN by a transfer. To facilitate transfers in Seoul, Seoul Station and Samsung Bus Terminal have a city airport terminal function. The ticket/baggage check-in and the security check are finished before riding a rail or bus connection and the passengers skip those processes

at ICN. This function provides more comfortable travel to passengers and also reduces processing traffic at the ICN terminal.

Considering a high value of time of international passengers visiting ICN, the arrival and departure schedule punctuality should be a high priority when designing bus routes to ICN. Congested areas were avoided as best as possible and the stops were chosen in such a way that the line was as straight as possible. By equipping busses with GPS, arrival information was available for passengers at the bus stops.

Especially in Seoul Metropolitan Area there had been many exiting bus lines feeding the international passenger terminal at KIA. Since the bus lines were familiar to passengers and visitors to ICN, the existing bus operators extended their line to ICN and kept their bus ID numbers. This saves additional efforts to advertise the bus lines that still serve the same locality.

Figure 15. **Major roads and median bus lane routes in Seoul**



Sources*:* Major roads - Seoul Solution; Median bus lane routes - *Namu wiki.*

Seoul's bus system reform

When the city of Seoul reformed its bus system in 2004, the existing bus network was transformed to a trunk and feeder network. Also, as seen in Figure 13, along the thirteen trunk routes connecting the centre of the city to suburbs, BRT systems with exclusive median bus lanes were installed. The bus connection to ICN was not explicitly considered when selecting the routes. However, as the new bus system increases the speed of buses to access Gangbyeon Expressway, Olympic Expressway, and Seoul Ring Expressway, which are major freeway connections from Seoul to Youngjong Grand Bridge and the 2nd Bridge (Figure 15), the bus system reform benefits the bus access to ICN. With the exclusive median bus lanes, an integrated fare card system was introduced to make the fare scheme based not on the number of boarding but on the distance travelled. This feature reduced the transfer cost and made the bus mode more attractive.

Legal basis facilitating public transportation network development

Under the Passenger Automobile Operation Business Act, passenger transport services traversing more than two cities must obtain an operating license from the government (Ministry of Land Infrastructure and Transport). Before ICN was in service, candidate bus lines and fare levels were established by the government with the cities that the lines stop in. The proposed routes were then used as the basis for negotiations with interested bus operators over the license details, such as stop locations and fare levels. The government's licensing regulations facilitated negotiations and was successful in avoiding excess profits from running public services.

During the overall planning and implementation steps involved in the ICN project, a great number of legal requirements should be processed. To facilitate these processes the government enacted New Airport Construction Facilitation Act in 1991. Following NACFA, the Incheon International Airport Corporation was established and it was in charge of the planning, construction, and operation. Also the New Airport Construction Board was established and its decision is regarded as satisfying all the related legal requirements on land, water, highway, rail, farm, forest, harbour, city, transport, building, pollutant, safety, and security. This strong legal support facilitated the development of public transportation networks for ICN directly and indirectly.

Through the City Transportation Improvement Facilitation Act, if a traffic generating or transporting facility project is located in a city whose population is over 100 000 and its size is over a predefined threshold (size measure and threshold presented by CTIFA Decree), the project should conduct a traffic impact study. The goal of the study is to analyse the traffic impacts on the surrounding land use and transportation network and build plans to minimise the project's negative influence. The study and plans should be approved by the government's traffic impact assessment board, which is the New Airport Construction Board for the ICN project by NACFA. Incheon International Airport Corporation conducted the study because ICN's passenger demand, the predefined size measure at its opening is over the threshold 300 000 passenger/year and the population of Incheon where ICN is located is around two million. Regarding public transportation systems of the ICN project, the New Airport Construction Board approved the negative-impacts-minimisation plans on condition that details about ICN-to-cities bus and inside-airport shuttle bus services should be included in the project (Park et al., 2004).

Railroad services at ICN

In December 2010, the Airport Railroad connecting ICN to Seoul Station was opened. The service consists of a regular line stopping at all the stations and an express line, called Airport Express (AREX) connecting the airport directly (Figure 16). The AREX service is more expensive, and its service

frequency is less, but its travel time is about 25% shorter (Table 10). 60% (about USD 3 billion) of the project investment was from private parties, so the fare level of the regular line is around double the price of government-funded rail services in Seoul Metropolitan Area and that of the express service is quadruple more expensive.

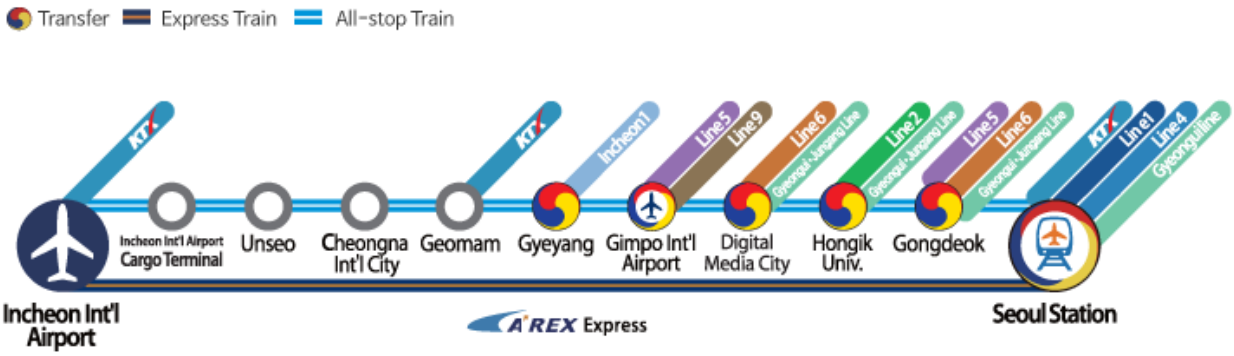
Table 10. **Airport railroad fare policy for Seoul Station to ICN by service: Express vs. regular**

Service	Fare (USD)	Travel time (minute)	Service frequency (train/hour)
AREX – express	8.0	43	2
Regular – stopping all stations	4.2	56	10

Source: Incheon Airport Railroad (2015).

As shown in Figure 16, seven Airport Railroad stations are connected to the existing railroad network and by one or two times of transfer most trips in Seoul Metropolitan Areas are connected to ICN. Currently, a small portion of travellers use the rail service, but at least in Seoul Metropolitan Area, rail mode travellers have benefits of lower fare and punctuality in schedule.

Figure 16. **Airport Railroad service layout**



Source*:* Incheon Airport Railroad (2015).

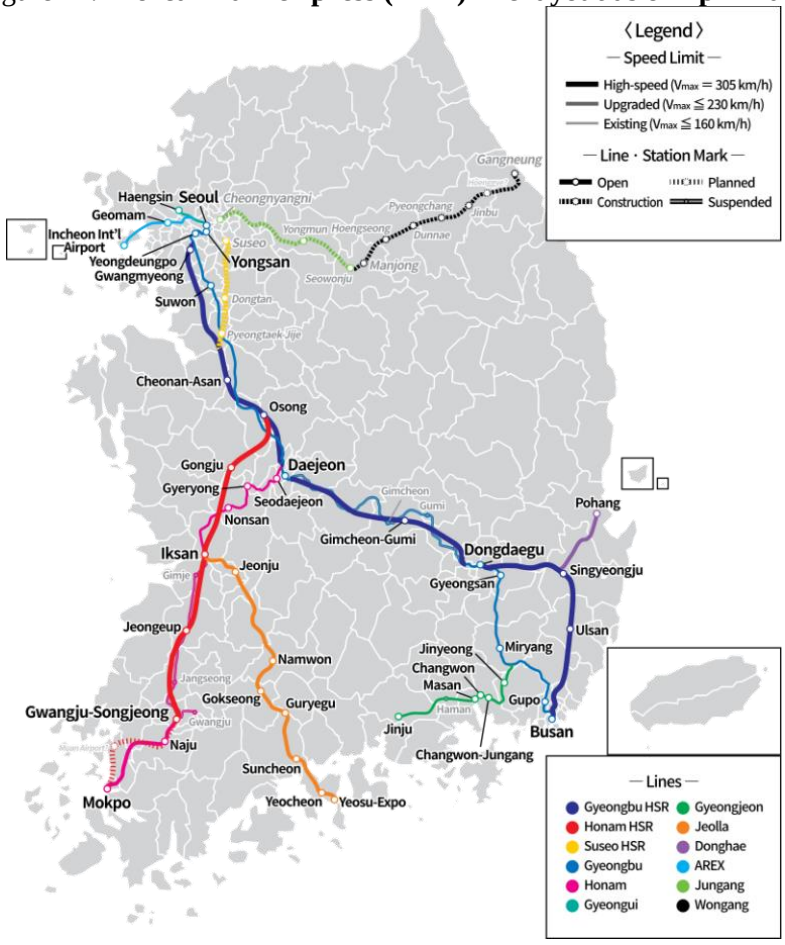
Travelers from outside Seoul Metropolitan Area use Korea Train eXpress (KTX, Figure 17) either directly to ICN or to Seoul Station and transfer to Airport Railroad. Compared with the bus access the railroad access saves time but costs more. For example, the travel time from Dajeon, a metropolitan city located at 150 km south of Seoul, is shorter by around 30%, but the fare is more than 50% higher (Table 11). Also a transfer is required in most railroad access cases because of the lower frequency of the direct service. Despite the time saving, higher cost, transfer, longer walking distance to check-in counters may make the railroad service less attractive compared with the bus service.

Table 11. **Fare, service frequency, travel time comparison by mode from Daejeon to ICN**

Mode	Connection		Fare (USD)		Service frequency	Travel time	
Bus	Direct	Daejeon-ICN	23.1		3-4bus/hour	2 hr 50 min	
Rail	Transfer	Daejeon- Seoul	33.2	37.4	4-6train/hr	59 min	2 hr 10 min*
		Seoul-ICN (regular)	4.2		10train/hr	56 min	
	Direct	Daejeon-ICN	36.1		8train/day	2 hr 1 min	

Note: *15 minute transfer time is added.
Sources*:* Inter-city bus ticket reservation system (2015), KTX ticket reservation system.

Figure 17. **Korea Train eXpress (KTX) line layout as of April 2015**



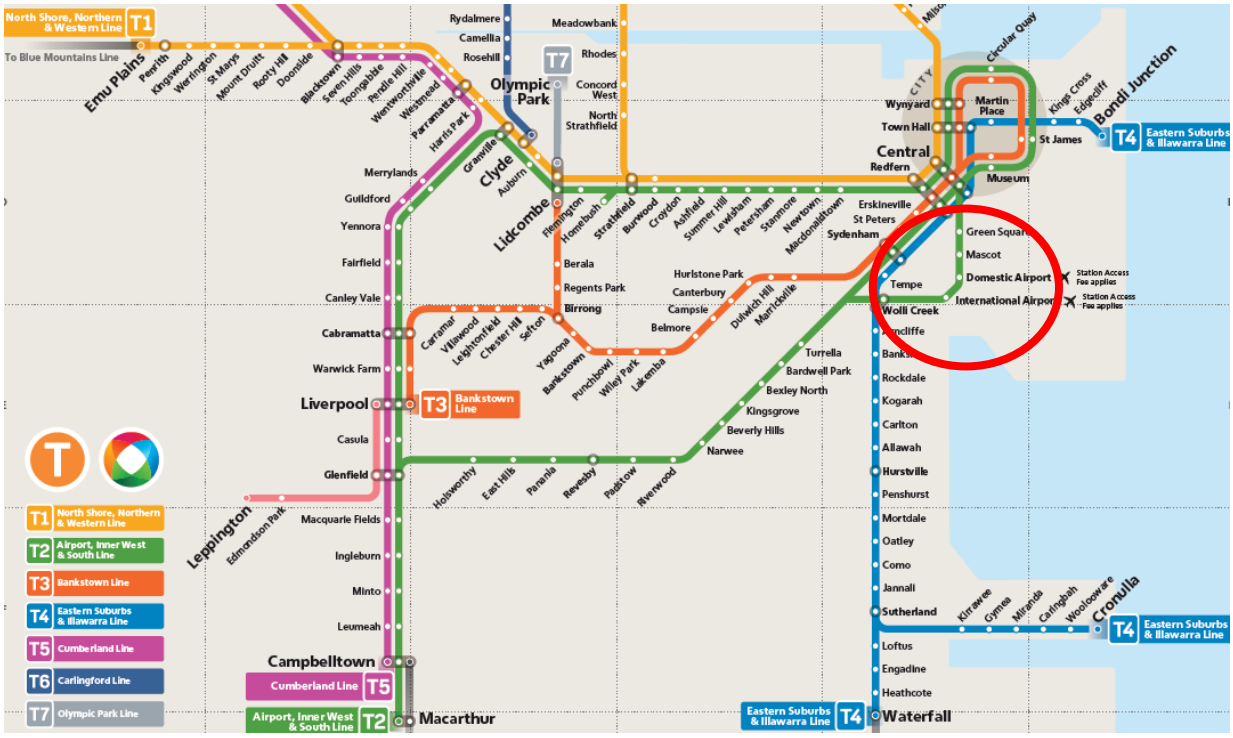
Source: Kojects (2015).

Case study 3: Sydney Kingsford-Smith Airport rail extension

Sydney is Australia's most populous city and the capital of the state of New South Wales (NSW). The city is served by the Kingsford-Smith Airport (KSA) for international and domestic services. KSA is just under 10 km south of the central business district (CBD), towards the east of the Greater Sydney area. Prior to the construction of the Sydney Airport Rail Link, all surface access to the airport was by road: by private cars, taxis, buses and coaches.

In 1995, the NSW Government began construction of a new rail tunnel and link between Central station and Wolli Creek junction (Figure 18). Separately, the government awarded the Airport Link Company (Transfield and Bouygues) a concession to design, construct, finance, lease and then operate and maintain four new stations on the line for 30 years (New South Wales Parliament, 2014). The new stations are at Green Square and Mascot, which are on the way from the city centre to the airport, and at the Domestic Airport and International Airport terminals. At the same time, the NSW Government funded and constructed (and now operates) Wolli Creek station, where the new Airport Line was connected to the broader suburban network (South Line). This configuration allowed some South Line services to operate via the Airport Line. This in turn created new capacity as the section between the CBD and Sydenham is shared by services on multiple lines.

Figure 18. **Airport Line within broader Sydney rail network**



Source: Extract from Sydney Trains Network (2014).

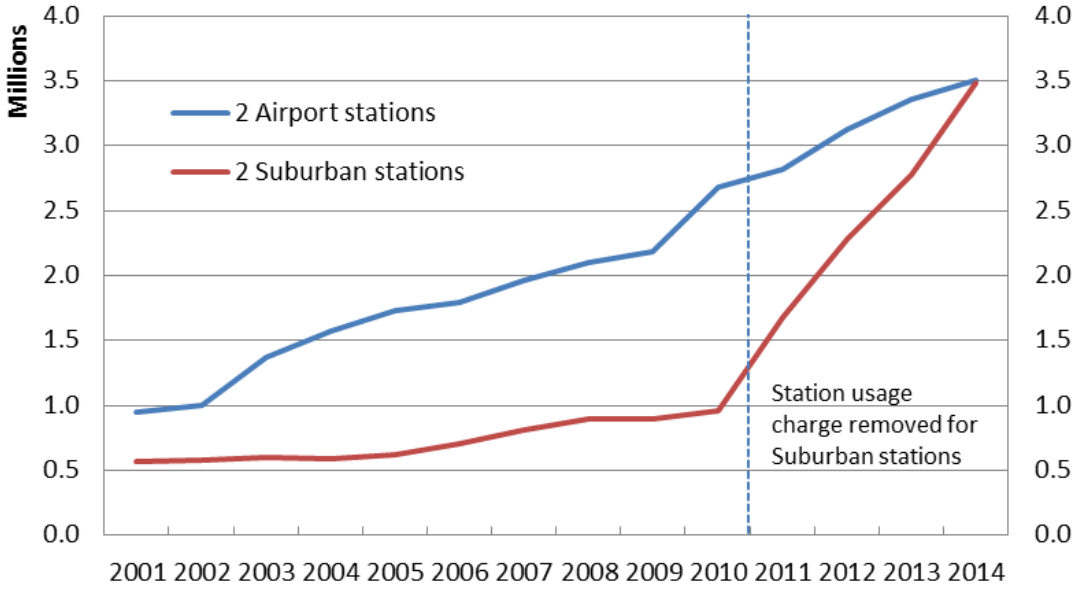
The public-private partnership required the NSW Government to construct the track and operate the rail services to serve the new stations. The combined tunnel, track and station project cost an estimated AUD 673 million, comprising a government contribution of AUD 542 million and private sector contribution of AUD 131 million (NSW Treasury, 2005). The private sector's component is financed by station retail revenue and a "station usage fee". This fee, which is set each year by the Airport Link Company itself, is a surcharge of around AUD 13 per trip that is added to the (substantially smaller) standard fares of passengers using one of stations.[8]

When the Airport Line opened in 2000 (just prior to the Olympic Games), patronage was well below the government's forecast, resulting in the company defaulting on its debt payments within six months of operation commencing (NSW Treasury, 2005). The contract was subsequently renegotiated, with the government paying the private operator AUD 80 million between 2001 and 2005 by diverting most of the government's component of the fare revenue to the private stations (NSW

Treasury, 2005).[9] When this is offset against the AUD 131 million initial input, the net contribution of the private sector has proven to be modest.

Rail only accounts for around 15% of surface access trips at the airport (NSW Parliament, 2014). However, patronage on the Airport line has grown strongly in recent years (Figure 19), increasing its share from just 11% in 2006 (Sydney Airport Corporation Limited, 2006). There has been much policy debate about how to increase public transport's share of the surface access market, including removing (or reducing) the station usage fee, or increasing bus services. Any of these options would be constrained by the conditions within the PPP contract, which will be in operation until 2030 (NSW Parliament, 2014).

Figure 19. **Patronage on four airport line stations since 2001**



Source: Bureau of Transport Statistics, 2015 [E2015-15 -Train-Patronage (to March 2015)].

From a transport perspective, part of the weakness of the project's initial financial performance was its mixed objectives in implementation as part of Sydney's broader commuter rail services. By splitting focus between air passengers and other passengers, it has struggled to cost-effectively serve either:

- Air passengers – there is no dedicated space in the carriage for luggage, and during peak hours services can be very crowded by the time they reach the airport stations (NSW Parliament, 2014). This diminishes the attractiveness of the service, particularly as the surcharge makes the fare quite high (around 50% of a taxi fare to the CBD), particularly for groups of travellers needing to purchase multiple tickets.
- Users of the non-airport stations (Mascot and Green Square) and airport workers – the surcharge made the train services uncompetitive with car and bus for day-to-day travel, which supressed a significant amount of demand until the surcharge was removed on non-airport stations in 2011 and discounts were offered for airport workers (New South Wales Parliament, 2014). Once the surcharge was removed, demand tripled in less than four years (Figure 19).

The experience with the Airport Rail Link in Sydney suggests a few considerations to take into account in developing new airport rail lines:

- Be clear about the objectives and the user segments targeted for the line (airport travellers versus airport workers versus urban regeneration) and tailor pricing accordingly. By introducing a surcharge fare on all travellers from the date of opening there was an initial barrier to use for all segments. Relaxing the surcharge for non-airport travellers demonstrated the degree of supressed demand. An alternative pricing structure that incentivised early take-up of the rail link may have produced greater revenue and patronage overall as users became accustomed with the rail service – and might then have been increased later when users that have tried the service might be prepared to pay more for its use.
- Carefully consider the possibility that demand will be lower than forecast since the ramp-up to full scale use can take a number of years (especially if premium prices are charged from the outset). The optimal arrangement with private sector partners may depend on the sharing of revenue risks and in Sydney as in many cases, the risk transfer was not sufficient to protect the government from later renegotiation.

Case study 4: Copenhagen International Airport Metro Link

Surface access

In 2015, 26.6 million passengers travelled through Copenhagen Airport (Copenhagen Airports, 2015). This makes it the busiest airport in Scandinavia (Avinor et al., 2015) and 11th busiest in Europe,[10] but outside the 50 busiest airports worldwide (Airports Council International, 2015). The vast majority of the airport's passengers travel internationally (94%) (Copenhagen Airports, 2015). These are mostly short haul flights within Europe (especially to London and other Scandinavian capitals), while there are currently 32 cities with direct long haul connections from Copenhagen Airport (Copenhagen Airports, 2015).

A key share of Copenhagen Airport's passenger traffic (39%) derives from one customer, Scandinavian Airlines, which uses the airport as its main hub. The next largest airline to use the airport is Norwegian Air Shuttle, which accounts for 17% of passengers (Copenhagen Airports, 2015).

Copenhagen Airport has extensive surface access links to Copenhagen and the rest of Denmark and to Malmö and southern Sweden. The airport is located at Amager on the Øresund coast of Denmark. This makes it close to both the centre of Copenhagen (8 km) and the centre of Malmö, Sweden (24 km). As the airport is adjacent to the Øresund tunnel and bridge it is able to serve Malmö and the remainder of southern Sweden[11] as well as Copenhagen and Denmark.

Public transport to the airport has a very substantial modal share of surface access. A 2008 study of 46 airports in the USA, Europe and Asia found Copenhagen Airport had the 10th largest public transport modal share (37% at the time) (Transport Research Board, 2008).

Road access includes an exit from the Øresundmotorvejen, the motorway that crosses the Øresund bridge and tunnel, connecting Copenhagen in Denmark and Malmö in Sweden. For private cars, the airport includes short- and long-term parking, as well as drop-off "Kiss and ride" zones. Only 21% of arrivals at Copenhagen Airport are by private car. Of these, only 28% use parking. The Kiss and ride zones seem to be the preferred form of road access to the airport for private vehicles. Fourteen per cent of arrivals use taxis and 3% of arrivals use the various bus services linking the airport to parts of Copenhagen and Malmö (Copenhagen Airports, 2015).

The majority of arrivals at the airport are by train (36%) or metro (23%) (Copenhagen Airports, 2015). This level of rail public transport mode share is the result of many years of planning and investment in rail access to the airport.

The first rail link to Copenhagen Airport opened in 1998. This heavy rail link is integrated with the Danish and Swedish rail networks; it was designed to take advantage of the Øresund bridge and tunnel and assists Copenhagen Airport to position itself as the airport of choice for all of Denmark and for southern Sweden, up to Gothenburg.

For Copenhagen, trains run 24 hours a day at ten-minute intervals and the journey is 14 minutes (20 minutes less than the bus journey). For Malmö, trains run every 20 minutes and the journey is 29 minutes. These rail links are not a dedicated airport express. Each has stops prior to reaching the local town centre (Copenhagen Airports, n.d.). However, the travel times remain relatively short.

Not having a dedicated airport express service appears to have been a deliberate choice of the Danish and Swedish rail authorities. Instead, they restructured their national heavy passenger rail systems to fully integrate Copenhagen Airport with their respective rail services. This provides high frequency services aimed at enticing air travellers from around the region to use the train as the primary means of access to the airport (Transport Reasearch Board, 2000). For example, trains run every two hours to Gothenburg in Sweden (303 km away) and there are, at least, daily direct services from the Airport to regional other centres such as Odense (164 km away) and Aarhus (192 km away) (Copenhagen Airports, n.d.). Trains run across the border and through Copenhagen Airport forming integrated regional rail links between southern Sweden and Denmark (Danish State Railways (n.d.).

In 2007, a second rail link opened, extending the driverless Copenhagen metro to the airport. Like the national rail link, metro services run 24 hours a day with services to Copenhagen every four to six minutes during the day (15-20 minutes during the night). The journey to central Copenhagen takes 15-20 minutes.

Copenhagen airport, together with rail operators and other stakeholders have taken several deliberate steps (in addition to the rail services themselves) to make rail a more attractive form of surface access to the airport than road. These include:

- using the standard zonal fare for trips to and from the Lufthavnen station, rather than charging a premium
- self-service check-in counters to allow rail passengers to check in and drop their luggage at Copenhagen Central Rail Station
- both national rail and metro stations are adjacent to terminal three, the terminal from which Scandinavian Airlines (the airport's key tenant) departs
- self-service check-in counters for over 30 airlines are located in the lobby of the train station so that rail passenger need not walk to other terminals with heavy luggage
- a free shuttle bus links the train stations to other airport terminals.

Copenhagen airport metro link: Learning from previous difficulties

The Copenhagen airport metro link illustrates the importance of learning from previous difficulties to successfully finance, construct and operate an airport surface access rail link.

The airport metro link is the third stage of the Copenhagen metro, built in conjunction with the development of a previously uninhabited area south of the centre of Copenhagen – Ørestad. Financing for the metro involved passenger charges, revenue from land sales in Ørestad and government debt (Rigsrevisionen, 2000, pp. 33-35). This made the whole metro's financial sustainability particularly sensitive to the accuracy of passenger demand forecasts, land values and interest rates (Rigsrevisionen, 2000, pp. 42-43).

In 1991 legislation was introduced into the Danish Parliament to provide for the construction of the first two stages of the metro. At that time, the estimated cost of the three stages of the metro (including the airport link) was DKK 2.9 billion (Danish kroner). By the time the legislation passed in 1992, that estimate had grown to DKK 3.9 billion. Also, the legislation did not specify what form the link was to take. That decision was left to Ørestadsselkabet, the Ørestad development company (Flyvberg, 2007).

Ørestadsselkabet considered several options for the link including a tram, light rail and automated mini-metro. In 1994, Ørestadsselkabet decided on an automated mini-metro. This was the most expensive option. However, it was also expected to deliver higher ridership, greater service frequency, greater safety, higher prices for land sales adjacent to the metro and a higher NPV of benefits in the long term. This decision resulted in cost estimates growing to DKK 5.2 billion. When contracts were signed in 1996, cost estimates had grown further to DKK 6.9 billion (Rigsrevisionen, 2000, p.11; 42;145).

Issues started to arise soon into the project's construction. These included unrealistic timelines leading to delays, uncertainties in the contracts regarding the interface between different contractors' work, too light-handed contractor oversight from Ørestadsselkabet and limited information flow to senior levels at Ørestadsselkabet because of a lack of transparency provisions in contracts (Rigsrevisionen, 2000, p. 18). As a result of these and other issues, drilling for the metro tunnels commenced only in March 1998, seven months late[12] and costs increased further. By 1999, the cost of the metro was estimated at DKK 9.3 billion, 138% above the 1992 estimate and 35% above the estimate at the time of entering contracts (Rigsrevisionen, 2000, p. 145).

These factors led to substantial scrutiny, including a 2000 report from the Rigsrevisionen, the Danish national audit office, which reports directly to Parliament. The audit listed the change of technology together with the contracting and governance issues above as the causes of the cost escalation (Rigsrevisionen, 2000, p. 25). It considered more conservative budgeting and demand assumptions and tighter governance (especially around control over contractors) should have been in place (Rigsrevisionen, 2000, p. 25).

In October 2002 and May 2003 stages 1 and 2A of the metro opened, two years and one year late respectively (Rigsrevisionen, 2000, p. 27). Stage 2B opened in October 2003. In the initial years, passenger numbers on stages 1 and 2 of the metro was below forecast. In 2003, there were 35% fewer passengers than predicted. In 2004, it was 46%. In fact, ridership was lower than predicted for the rejected tram and light rail options. This translated into passenger revenue being below forecast. This pressured Ørestadsselkabet financially (Rigsrevisionen, 2004, pg. 13), even though revenue from land sales in Ørestad substantially exceeded forecasts and a period of record low interest rates mitigated the user revenue shortfall's impact. Low passenger numbers also resulted in passenger forecasts being lowered 33% for 2005, 14% for 2008 and 7.5% for 2010 (Flyvberg, 2007, pp. 14-15).

The metro attracted further scrutiny from the Rigsrevisionen in 2004. The audit noted that there was great uncertainty around future passenger numbers in developing usage forecasts which, in turn, created uncertainty about the metro organisation's financial viability (Rigsrevisionen, 2004, pg. 13; 56).

It seems that many lessons from stages 1 and 2 of the metro were learned and applied in developing and constructing the airport link in stage 3. Budget contingencies were enhanced and the Ørestadsselskabet Traffic Model (OTM 5.0) was revised. The airport link was delivered a little early and within budget in September 2007.[13] It has outperformed its passenger forecasts to date. In 2011, 2 578 014 people used the Lufthavnen metro station at Copenhagen Airport, beating the OTM 5.0 forecast for 2012 a year ahead of schedule. Since then, passenger numbers have further grown to 3 299 545 in 2015,[14] giving metro the second highest modal share for surface access to Copenhagen Airport.

Experience with Copenhagen Airport's metro connection suggests a number of lessons for rail surface access to the new Mexico City airport. First, fully integrating airport rail services into city and national rail services makes the service more useful to a larger number of consumers. In turn, this increases the chances of consumers choosing the rail service over road access, thus reducing air pollution resulting from surface access to the airport.

Second, appropriate contingencies are necessary to avoid cost overruns, especially when building new infrastructure rather than extending existing infrastructure. While the Copenhagen Metro's airport extension was delivered on budget, this seems to result from lessons learned with cost overruns on the earlier stages.

Finally, it may take longer than expected for demand to reach desired levels. Forecasting a speedy take up of rail services can lead to revenue shortfalls and undermine the credibility of the infrastructure investment. As a result, it is prudent to forecast a slow ramp-up in patronage.

Case study 5: Airport rail links in Canada and the United States

Canada

The three largest airports in Canada are Toronto, Vancouver and Montreal. Toronto and Vancouver both have rail links while Montreal is planning one. Enplaned/deplaned passengers for each are compared to those of Mexico City airport in Table 12.

Table 12. **Annual enplaned/deplaned passengers**

Toronto	44.3 million
Vancouver	22.3 million
Montreal	16.5 million
Mexico	41.7 million

Sources: Websites of the airports.

Rail link to Toronto Airport

A rail link to Toronto Airport, the Union Pearson Express or UP Express was opened in 2015. As shown on Figure 20, the route of the UP Express is mostly on existing railway lines with a short 3-km spur built into the airport. The UP Express starts at Union Station downtown, the centre of intercity and regional rail services in Toronto. The UP Express makes connections with the metro at Union and Bloor stations and with the regional commuter rail passenger lines at all three non-airport stations.

Figure 20. **UP Express Route**

Source: UP Express.

The UP Express was originally conceived as public-private partnership (PPP). The private consortium would build the new spur and stations and provide the rolling stock and manage operations. The PPP consortium would also pay a fee to use the upgraded regional rail line. The consortium would earn all of its money through fares. A consortium was selected but financial close was not reached with the government; which may have been partially because of the recession of 2008 and the following years.

After the failure of the PPP, public agencies took over. Metrolinx, the provincial agency responsible for regional transportation in the Greater Toronto Area took responsibility. The concept of a high quality service paid for by fares was kept. When the service opened in 2015 ridership was much lower than expected and high losses were suffered. As a result, fares were lowered in 2016. The old and new fares, shown in CAD (Canadian dollar), are described on Table 13.

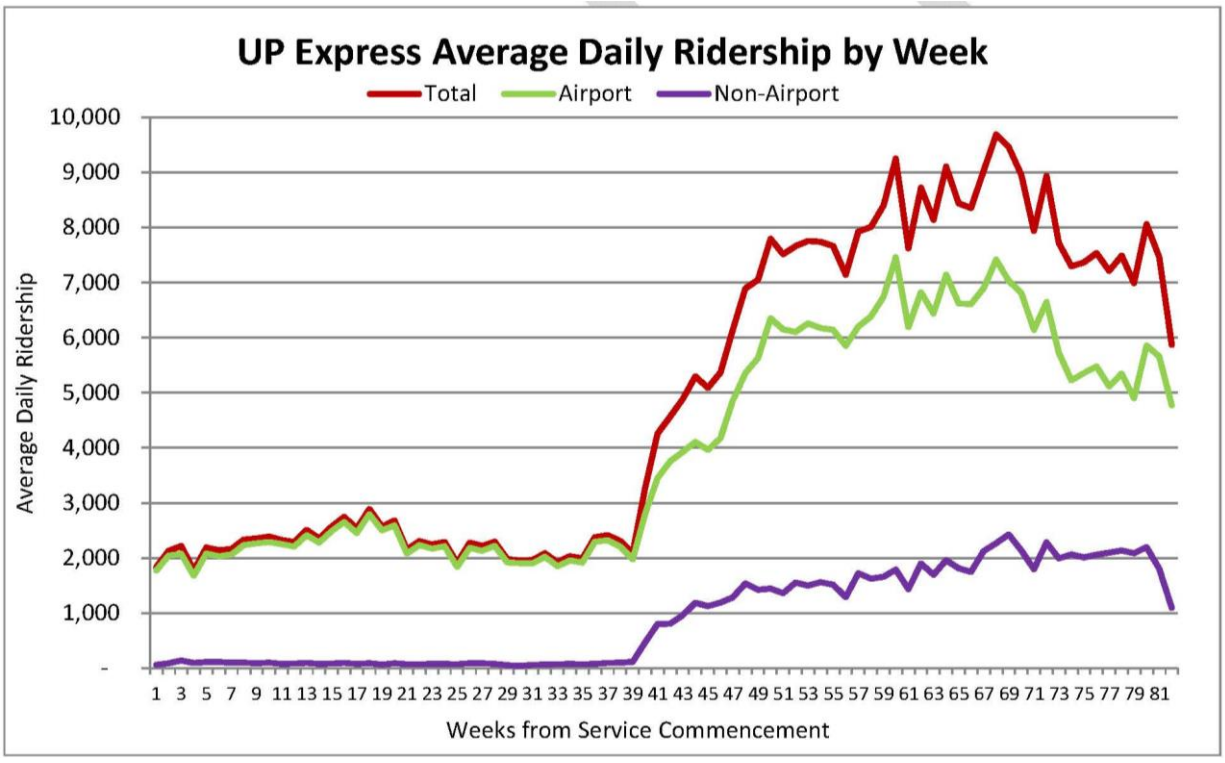
Table 13. **UP Express Fares**

	Initial fares (CAD)		**New fares (CAD)**	
	Cash	**Card**	**Cash**	**Card**
Adult	27.50	19.00	12.00	9.00
	Cash	**Monthly pass**	**Cash**	**Monthly pass**
Airport worker	10.00	250.00	3.50	140.00

Source: UP Express website, https://www.upexpress.com/

The resulting change in ridership is shown on Figure 21. Ridership more than tripled and now, in addition to airport travellers some non-airport passengers, travelling between the three other stations on the line, were attracted.

Figure 21. **Ridership**

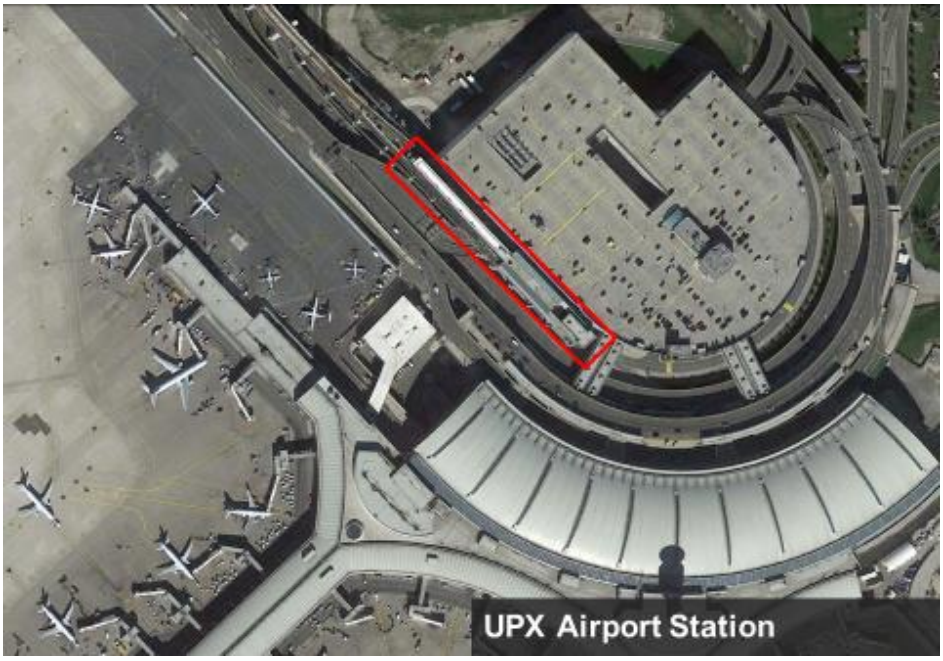


Source: UP Express/Metrolinx.

The airport station is located adjacent to Terminal 1, between the Terminal and its parking garage. An internal people mover moves UP Express passengers to and from the other terminal. There are three stops to the City Centre.

Toronto Airport is located in the Toronto suburb of Mississauga. Mississauga is constructing a BRT line into the airport area with direct service to the terminals. The City of Toronto similarly is constructing a new LRT line as part of its Metro system; the second phase of this LRT line will link into the air terminal area. Figure 23 shows the interior of the train.

Figure 22. **Location of the UP Express Terminal at Toronto Airport**



Source: UP Express.

Figure 23. **High standard interior of UP Express Train**

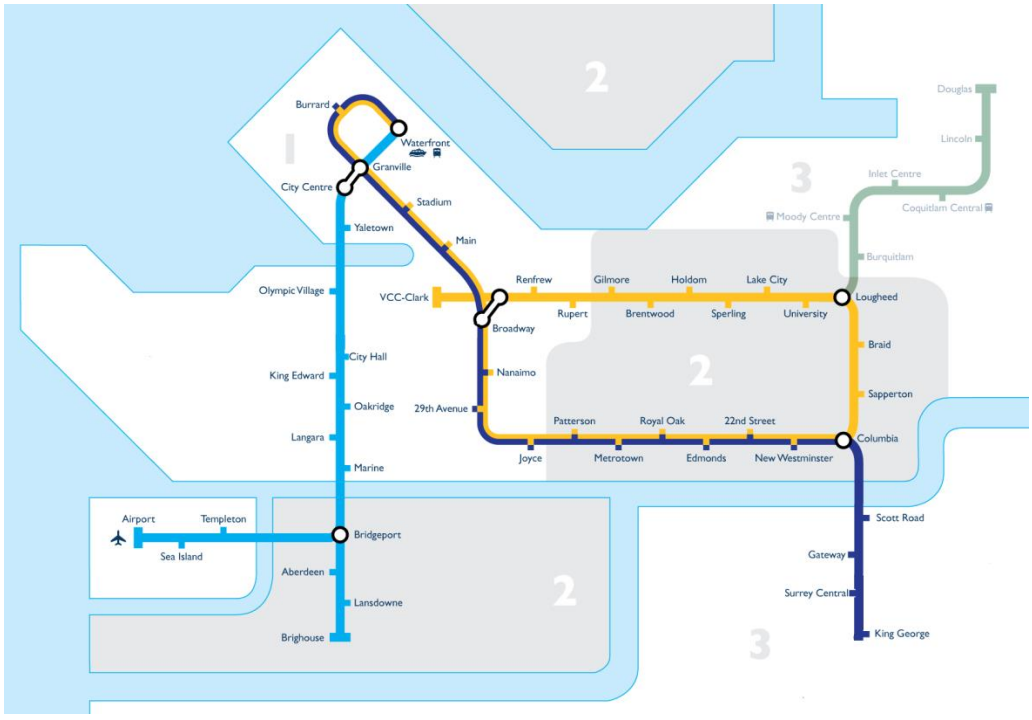
Source: UP Express.

Vancouver

The Canada Line, an automated rapid transit line which is part of the Vancouver metro system, opened to Vancouver Airport in 2009. This line has two branches with one going to the airport and the other one serving suburban Richmond as shown on Figure 24.

The Canada Line was built as a PPP by a private consortium. As it was not expected that the Canada Line would be profitable, various public sponsors provided capital funding. The original financial commitments are shown in Table 14 although some additional money had to be supplied as the construction costs went over-budget. The consortium is paid an on-going availability payment for operating the line. Public agencies collect and keep fares.

Figure 24. **Vancouver Metro System**



Source: TransLink.

Figure 25. **Canada Line Train at Vancouver Airport**

Source: The Canada Line, http://thecanadaline.com/

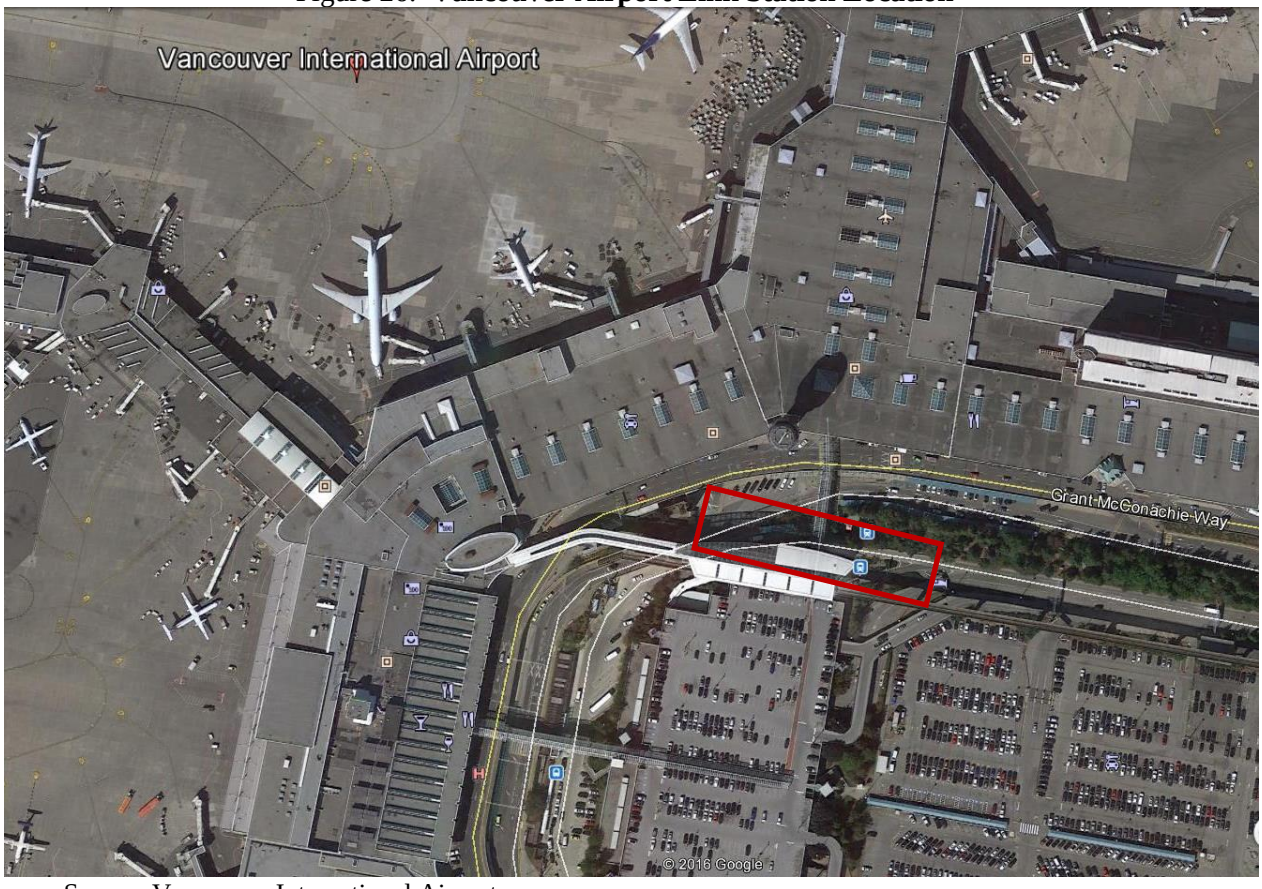
Table 14. **Initial funding commitments**

Source	Funds (CAD)
Translink, the Vancouver Region Transit Operator	334 million
Government of Canada	450 million
Government of British Columbia	435 million
City of Vancouver	29 million
Vancouver Airport Authority	300 million
Constructor	200 million

Source: Wikipedia, https://en.wikipedia.org/wiki/Canada_Line

There are 11 stops to the City Centre. Regular fares are charged on trips to the airport but an extra CAD 5 fee on top of the normal fare is collected from passengers starting at the airport. The airport terminal is shown on Figure 26.

Figure 26. **Vancouver Airport Link Station Location**



Source: Vancouver International Airport.

Montreal

The Montreal International Airport is to be served as part of a new rapid transit network that is going to be constructed as part of a major metro expansion, the Réseau Electrique Métropolitain (REM).

This is an automated line and is planned to be a PPP. Figure 27 shows the relationship of the new REM network to the existing Metro system.

The new REM line goes through the central area and to the west of Montreal Island and splits into three separate branches. Only one in four of the trains will go to the airport. From the airport to downtown there will be 10 intermediate stops.

Airport rail links in the United States

There are currently 16 air-rail links operating in the United States. These are summarised in Table 15. All of these lines were constructed by public agencies, either the local transit agencies or the airport authority. Most also charge regular fares rather than premium fares. None of these links have been built by a Public-Private Partnership (PPP). This may be because airports in the United States receive grants from the Federal Government and also finance capital expansion by issuing tax free bonds. Neither of these would be available to a PPP.

Figure 27. **The REM and Montreal Metro Network**

Source: Société de Transport de Montréal.

Summary

There are 18 operating air–rail links in Canada and the United States. Only one was constructed as a PPP, with public contributions to capital investment. A second Canadian link was conceived as a PPP but taken over by the public sector. All others were constructed by public agencies including public transit agencies and airport authorities.

On most lines regular fares are charged but Premium fares are used on some that provide a premium service, i.e. a service with few stops to the city centre and seats configured for comfort and baggage space. In these cases adjustments sometimes have to be made for airport workers, providing discounted fares for these users.

Table 15. **Air-rail links in the United States**

City-airport	Type of rail service	Implementing agency	Fare policy
Boston Logan	Shuttle bus to Metro	Transit Authority	Regular fares
New York Kennedy	Automated shuttle to Metro and to regional rail	Shuttle link by Airport Authority	Shuttle faire of USD 5, regular fares on metro and regional rail
New York Newark	Automated shuttle to regional rail and Amtrak	Shuttle link by Airport Authority	Additional fare of UDS 5.50 on both regional rail and Amtrak
Philadelphia	Regional rail with multiple stops at terminals	Transit Authority	Regular fares
Washington-Reagan National	Metro	Transit Authority	Regular fares
Baltimore-Washington	Baltimore LRT and bus shuttle to Amtrak/regional rail	Amtrak, Transit Authority	Regular fares on Baltimore LRT, Amtrak and regional rail
Atlanta	Metro	Transit Authority	Regular fares
Cleveland	Metro	Transit Authority	Regular fares
Chicago O'Hare	Metro	Transit Authority	Premium fare of USD 5 charged on entry at O'Hare
Chicago Midway	Metro	Transit Authority	Regular fares
Minneapolis	LRT	Transit Authority	Regular fares
St Louis	LRT	Transit Authority	Regular fares
Seattle	LRT	Transit Authority	Regular fares
Portland	LRT	Transit Authority	Regular fares
San Francisco	Metro	Transit Authority	Premium on fares less than USD 5
Oakland	Automated shuttle to Metro	Transit Authority	Premium on fares of about USD 6

Sources: Websites of the transit agency and/or airport in each city.

3. The strategic transport and land use planning context for the Valle de Mexico region

The administrative area of the Mexico City conurbation, the Zona Metropolitana of the Valle de Mexico (ZMVM), is home to over 20 million people (OECD, 2015). It comprises Mexico City (formerly the Federal District) at the centre, 59 municipalities in the State of Mexico (which wraps around Mexico City to the west, north and east) and one municipality in the State of Hidalgo, further north. The main built up area stretches 50 km east-west and 50 km north-south. The ZMVM is part of a bigger urban conglomeration known as the Megalopolis, extending into three more States, to the south (Morelos), east (Tlaxcala) and south east (Puebla). The centres of population in the two latter states are fairly close to the new airport. The population of the Megalopolis is over 27 million. Development of strategic transport infrastructure in relation to the new airport, and for the City in general, therefore concerns the Federal government and six States together with their municipalities and districts, which makes co-ordination challenging.

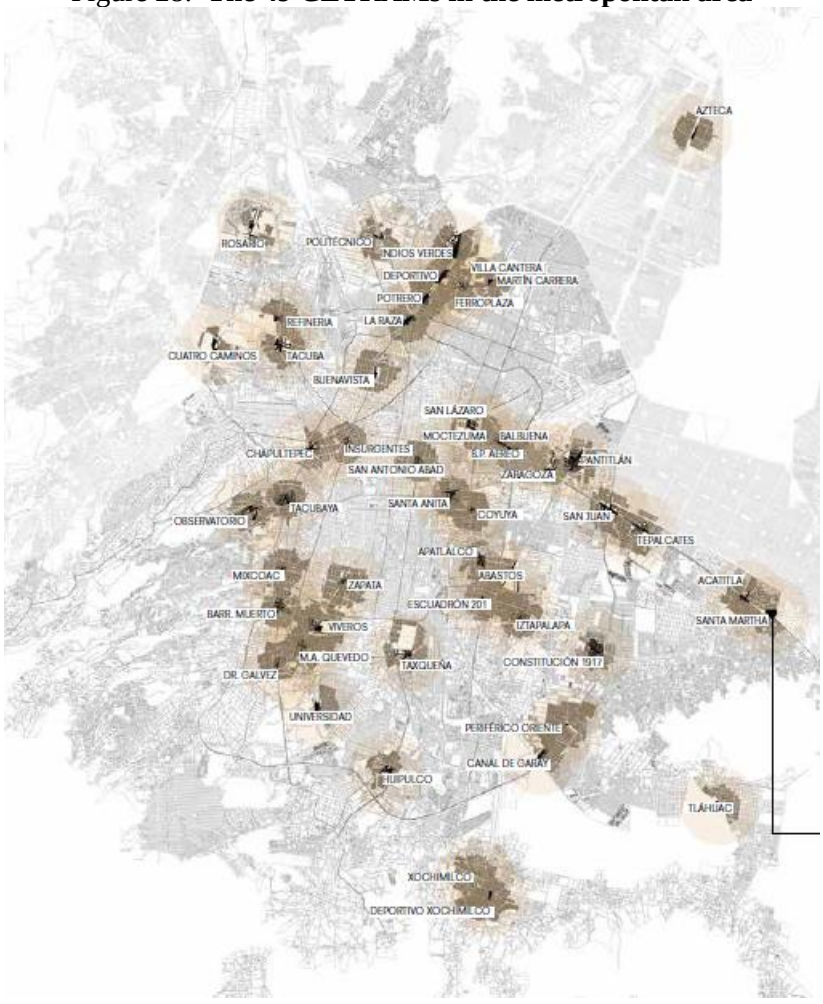
The location of the new airport site on Federal land in the State of Mexico and close to the jurisdictional border of Mexico City emphasises the relevance of co-ordinated planning and establishing arrangements to overcome jurisdictional boundaries. This will be essential for aligning operational and financial responsibility for transport services with the natural transport hinterland of the airport. Current arrangements for management of the City's metro system illustrate the challenges that will have to be overcome. The metro was constructed by an agency established in 1967, with federal funds for the initial investment and operating subsidies from the federal budget. While most of the system is inside Mexico City's boundaries, two of the lines extend into the State of Mexico. In 1997 responsibility for the metro was transferred to the Federal District (now Mexico City), which covers maintenance costs and provides the operating subsidies – including for the sections operated within the State of Mexico. This arrangement acts as a disincentive for enhancements in the State of Mexico as they add fiscal pressure to Mexico City's budget. Although the Federal Government will provide the funds for investment in new and extended metro lines to serve the new airport, responsibility for operating costs may hinder decision-making until arrangements for shared responsibility are agreed (OECD, 2015).

Concessions for operating buses and bus rapid transit services are also fragmented by jurisdictional boundaries. Exclusive concessions to operate routes are awarded by Mexico City and by the States over their respective territories. Through-services are not provided for and at administrative boundaries passengers have to transfer, inconveniently, from one concession to another. This also increases the cost of the trip as two fares have to be paid; there are no arrangements for integrated ticketing. Because of the inconvenience of transfers a number of informal direct long-distance commuting services have arisen, with their legality contested by regular concession holders. The new Mobility Law for the Federal District reinforces the transfer arrangements by requiring that out-of-state services bring passengers only to the nearest purpose-built exchange station (CETRAM) where passengers can transfer to in-state services. Clearly better integration will need to be achieved for BRT and bus lines serving the new airport if high quality public transport options are to be provided. The precedence this will set will be valuable for further development of bus transit corridors throughout the ZMVM.

Institutional arrangements to overcome these jurisdictional barriers have been established through metropolitan commissions but so far with very limited impact on strategic transport planning or the organisation of public transport. The Metropolitan Transport and Road Commission (COMETRAVI)

was established in 1991 to standardise legal frameworks and provide the evidence basis for development of a Master Plan for Transport and Roads in the Metropolitan Area. The Commission's activities are, however, currently suspended. In parallel, the Metropolitan Commission for Human Settlements (COMETAH) has developed a spatial planning programme that includes transport but has yet to produce a long-term development plan; its guidance is not used to date in transport planning or funding decisions. In contrast, the Metropolitan Commission for the Environment (CAM), now the Environment Commission for the Megalopolis (CAMe), has been highly successful in developing and implementing measures to monitor and reduce air pollution, including a range of measures to mitigate emissions from the transport sector. The authorities in the three States of the ZMVM are currently considering how one of these commissions, or a new collaborative agency, might be developed to establish metropolitan-wide urban mobility plans as a basis for strategic transport infrastructure planning. The goal is to establish urban mobility plans of the kind developed in France under the Ministry of Transport's 1982 Law on the Organisation of Inland Transport (LOTI), replicated in many OECD countries.

Figure 28. **The 49 CETRAMs in the metropolitan area**

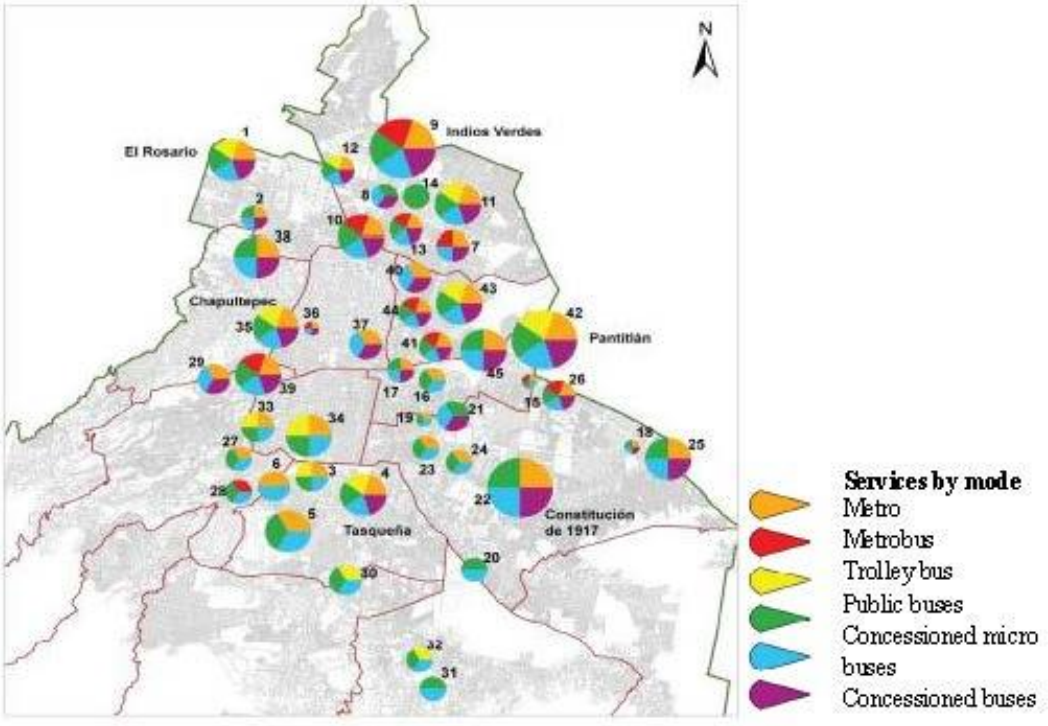


Source*:* ITDP (2014).

The strategic transport investment project priorities for the Federal Government are outlined in the "Program of Investment in Infrastructure for Transport and Communications 2013-2018". The main objective of the programme is to provide the infrastructure needed to deliver on the administrations

programme to improve productivity, competitiveness and economic development in order to create jobs and improve the well-being of all Mexicans. Another objective of the programme is to invest in better and safer roads, with core roads that improve the connections between the regions of Mexico in order to reduce costs and improve transit times. Facilitating mobility and overcoming distances is the overall objective of the programme. The new airport was developed separately from this programme but is a critical strategic project to solve the problem of saturation in the current airport and to achieve a better level of service with more flights and reduced costs for the aviation sector.

Figure 29. **CETRAMs by volume and modal split of services**



Source*:* Gaceta Official Distrito Federal, 2014.

The 2015 OECD Territorial Review of the Valle de Mexico summarised the strategic transport planning challenge for the Mexico City conurbation in the following terms. The ZMVM has to cope with a range of negative consequences, chief among them congestion and air pollution, from decades of automobile-oriented transport policies. Prioritisation of road infrastructure investment and a focus on improving traffic speeds for private vehicles has resulted in a public transport service with severe capacity and quality limitations and deteriorating conditions for walking and cycling. At the same time, the focus on road expansion has not been effective in coping with congestion and in a context of high income inequalities, poor-quality but relatively cheap public transport has maintained a high modal share. In 2010, 74% of all trips (except walking) in the ZMVM used public transport (with cycling accounting for 1%). While Bus Rapid Transit and commuter rail services have been introduced in the past decade, most public transport trips are still on microbuses operating under low safety and environmental standards. Such vehicles accounted for over 60% of total trips on public transport in 2010 (Government of Mexico City, 2012).

The authorities aim to move towards a more sustainable and inclusive mobility system. A series of projects, mostly in the Mexico City have focused on investment in public transport, efforts to promote walking and cycling and a change in priorities for the allocation of road space in favour of non-motorised

and public transport users. The principles of sustainability and inclusiveness reflected in these projects have also been introduced into legal and planning instruments linked to mobility policy in Mexico City, with the State of Mexico to make similar changes to its legal framework.

Changes to the institutional and legal frameworks in Mexico City began in 2013, when the Ministry of Transport and Roads (SETRAVI) became the Ministry of Mobility (SEMOVI). This was followed by a new mobility law and mobility programme, as well as the reform of the fiscal code to make public and non-motorised transport projects eligible for funding through betterment charges (*contribuciones de mejoras*). Formerly, only road qualified for funding through this mechanism.

The 2014 Mobility Law shifted the focus from road management, under previous legislation, to mobility policy with a focus on "providing the necessary means to the population so that they can choose freely between different modes of transport in order to access goods, services and opportunities offered by the City" (Article 6). It also requires developers of land and property to submit a mobility assessment to SEMOVI, evaluating the impact of the proposed development project on passenger and freight transport systems and ensure that developments are in line with the Integrated Mobility Program adopted under the law for 2013-2018. This aims to achieve two core objectives: improve the travelling experience of all, regardless of mode used; maintain the current modal share of seven out of ten trips by public transport and non-motorised transport by lessening incentives for recourse to the use of private cars. Secondary legislation is pending for the establishment of a number of new institutions and instruments under the law. This includes prescription of the detailed contents of mobility assessments and specification of their precise role in decisions to grant construction permits, which falls under the authority of the Federal District's Ministry of Urban Development and Housing (SEDUVI).

Federal highways, including freeways in Mexico City, are constructed with Federal funds and Mexico City's Metro system has been built largely with Federal funds, administered by SCT. Formal development consents are not therefore required from Mexico City. Nevertheless, development requires a good degree of consensus between the authorities and the public, as well as alignment with priorities established in the metropolitan transport master plan, once this is developed.

With the State of Mexico developing mobility targets and planning objectives along similar lines to those established in the New Mobility Law and the Integral Mobility Programme for Mexico City (see Box 3 for detail on the latter) it is clear that surface transport access plans for the new airport will need to be compatible with the overall direction of policy in the ZMVM, and contribute to the attainment of established objectives for inclusive and sustainable mobility. Plans should also be co-ordinated with Federal level policy and leverage existing programmes and funds supporting urban mobility projects. The Ministry of Agricultural, Territorial and Urban Development (SEDATU) has adopted a National Sustainable Urban Mobility Strategy along similar lines to those established in Mexico City, thus facilitating alignment of surface transport access plans with local and federal policy.

In terms of financial support, the Federal Programme for Supporting Urban Mass Transport (PROTRAM), managed by the Ministry of Finance (SHCP) and part of the National Fund for Infrastructure (FONADIN), provides funds for mass transit projects. In addition, various urban-related national funds were integrated into a new infrastructure programme (Habitat) with a mobility component that will be managed with SEDATU. The new programme has an important focus on supporting infrastructure that improves conditions for cyclists and pedestrians, facilitates access to public transport and better integrates transport services with the adjacent urban environment. A range of infrastructure investments are eligible for funding by PROTRAM, including: roads to improve accessibility, connectivity and safety for pedestrians, cyclists and public transport users; other pedestrian and cycling infrastructure; intermodal transport exchange areas; and infrastructure related to public transport

accessibility (e.g. station improvements). National funds available for metropolitan areas in Mexico also include those granted through the Metropolitan Fund (Fondo Metroplitano).

Together, these funds could make a valuable contribution to advancing delivery of surface transport access plans for the new airport. A detailed review of these and other useful funding opportunities is available in a Guideline of Federal Funds for urban mobility and accessibility developed by the Institute for Transportation and Development Policy (ITDP).[15] While funds from FONADIN have already been requested by SCT for carrying out feasibility studies for some of the BRT and metro lines extensions, PROTRAM is also available for funding part of the infrastructure of the projects. PROTRAM funding would also be eligible to support redevelopment of CETRAMs, stations and station surroundings to adapt them to handling larger numbers of people, and to create a safer and more secure environment more attractive to users, including air passengers. Mexico City's Mobillity Program includes rehabilitation of station environments but the speed of implementation is limited by a shortage of funds.

Overall, the new airport projects could also provide a good opportunity for both Federal and local authorities to improve alignment of investment priorities with contemporary mobility policy principles, revisiting the share of funding available for public transport in the total national funds for mobility. PROTRAM, for instance accounts for only xx% of the total funds from the larger FONADIN programme going to transport projects, while the rest of the funds spent in this sector are destined to building road infrastructure. At local level there is also a mismatch between how funds are designated between modes and the priorities established in the New Mobility Law and the PIM. Overall investment of federal funds destined to mobility projects in the ZMVM is unbalanced. In 2014, 64% of funds was allocated to road infrastructure and 26% to public transport, whereas 64% of trips are carried on public transport.

Box 3. **Objectives and strategic axes established in the Integral Mobility Programme for Mexico City**

Through the Integral Mobility Programme (PIM), Mexico City authorities seek to fulfil two core objectives: improve the traveling experience of all users, regardless of the transport mode chosen, and maintain the current modal share, in which 7 out of 10 trips are performed in public and non-motorised transport modes, while lessening incentives for the use of private cars.

The PIM is divided into six strategic axes: i) Integrated Transport System; ii) streets for all [users]; iii) more mobility with fewer cars; iv) a culture of mobility; v) efficient distribution of goods; and vi) transport-oriented development.

The PIM proposes a diagnostic of ZMVM's current situation in each of these six strategic areas and establishes a list of short-term (2013-2015) and mid-term (2015-2018) goals. The PIM also provides for a set of indicators to monitor the achievements of SEMOVI and the other ministries and public agencies involved.

Source: OECD (2015).

The overall goals for strategic transport planning in relation to the new airport should clearly include the following two main objectives:

1. Provide for effective surface access to the airport from all parts of the Megalopolis, the airport's hinterland, through development of road, rail and metro infrastructure and extension of public transport services.
2. Contain the impacts of the new airport on road traffic congestion and air pollution through provision of high-quality public transport alternatives to transport by private car and taxi.

Seamless, reliable journeys will be important to the success of public transport in catering for air passenger journeys. Integration with the wider public transport network is important to reach a large catchment population, particularly important to workers accessing the airport. Air passengers are likely to be prepared to pay a price premium for faster, more direct services to key centres of business and tourism and this may merit investment in dedicated links as well as extension of existing transport networks.

The 322 000 people travelling to and from the current airport every day is set to grow substantially with the new airport. The potential impact of the new airport on congestion in transport services and infrastructure is clearly very large, and the opportunity to reduce air pollution by ensuring a larger share of users take public transport in the future is equally significant. The impacts on transport networks go well beyond the airport site and present challenges and opportunities for the whole regional transport system and for development of the city. The case studies presented in this report shed light on how surface access strategies can be developed to minimise negative impacts on the transport network and the local community, whilst maximizing access to the benefits of air travel for the wider population and the economy as a whole. This is the focus of government policy in the London and Copenhagen examples.

The opportunities for strategic transport planning, integrated with land use development in the metropolis as a whole include liberation of the existing airport site for redevelopment. The site provides an extraordinary opportunity for major redevelopment in the heart of the metropolis and also a convenient linear tract of land for planning future public transport links (BRT/metro) to the new airport serving also new centres of transport demand on the old airport site. Key transport links to the new airport will need to be built ahead of redevelopment of the old airport site. Strategic planning should, however, be able to anticipate a second wave of investment in relation to development of the site of the former airport and include provision for metro, BRT and rail links/extensions to the site.

4. Surface access plans for Mexico City's New International Airport

Plans for construction of the new airport

The New International Airport of Mexico City (NAICM) will be constructed on an extensive site of 4 431 hectares located in the northeast of Mexico City between Ecatepec (to the west) and Texcoco to the east. This land is property of the Federal Government and no expropriations are required. When the new airport starts operating, initially scheduled for 2020, the current airport will cease to provide services and will transfer its operations to the NAICM; the airports cannot work simultaneously due to their proximity and the perpendicular orientation of their runways. The planning and development of the new airport, including road access and public transport services, must thus be well co-ordinated in order to minimise disruption and inconvenience for passengers and freight forwarders, and avoid negative impacts on the economy and the aviation industry. In July 2016, SCT announced 21 packages of projects for the construction of the new airport. These packages are divided into three stages as follows:

1. Preliminary stage: preparatory work for the main buildings, foundations for Terminal 1, control towers and other buildings and levelling for the runways.

2. Main infrastructure: construction of the terminal building, the boarding platforms, the control tower and control centre.

3. Preparing for operations: access roads will be completed in two phases, a multimodal centre for surface transport systems will be built and car parking facilities and support buildings constructed.

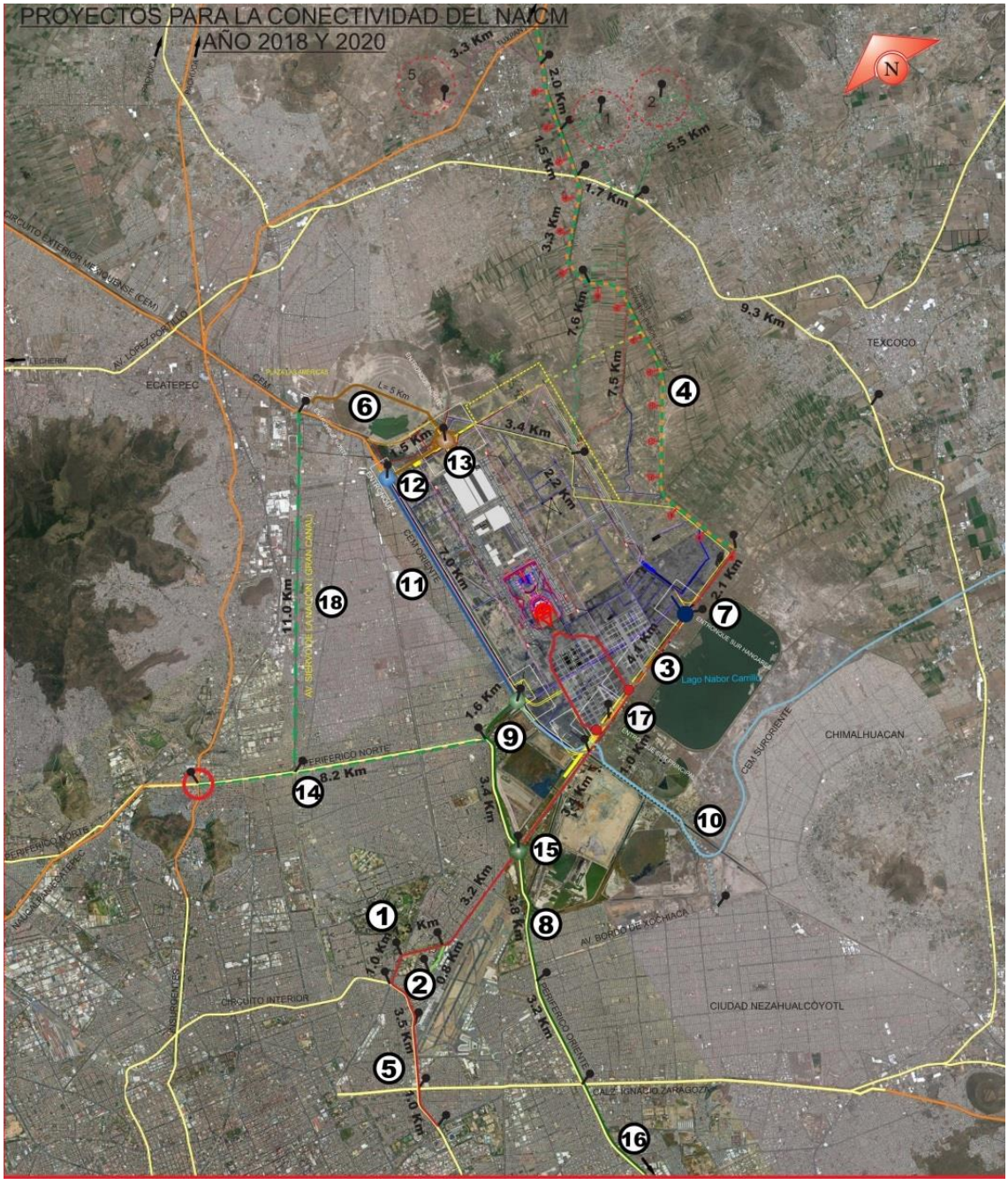
Table 16. **Planned stages for NAICM construction**

Preliminary stage	Main infrastructure	Preparing for operation
• Levelling of the land • Drainage system • Foundations of the terminal • Electric system/electrical substation • Runways (2, 3 and 6) • Control tower and control centre foundations.	• Main terminal • Fuel terminal • Boarding platforms • Fuel distribution • Air traffic control systems • Central tunnel	• Fire station • Support buildings • Road access (1st phase) • Multimodal centre for surface transport systems • Parking for employees • Operation centre • General parking • Road access (2nd phase)

Source: GACM.

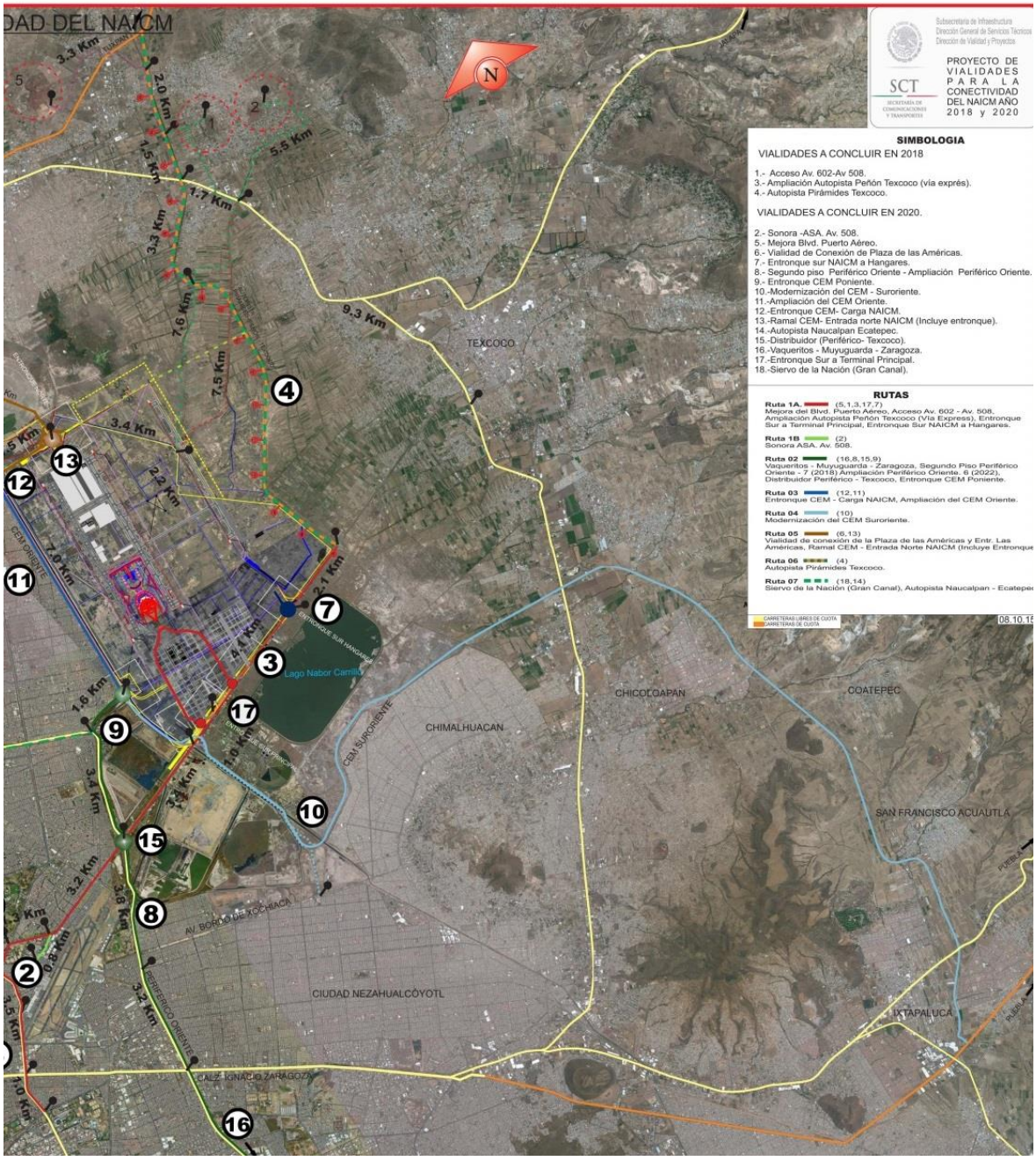
Plans for developing the road network are well advanced and SCT opened tenders for the construction of access roads in late 2016 and 2017. The plans for public transport systems are at varying stages of development and funding is still to be secured in some cases.

Figure 30. **Highway projects to provide access to the new airport**



Source*:* SCT (2015).

Figure 30. **Highway projects to provide access to the new airport (cont.)**



Source*:* SCT (2015).

Road access to the new airport

Seven routes will be developed to provide access to the new airport by road, some of the roads will be newly constructed others renewals and expansion of existing roadways. The seven routes are traced in Figure 31, which shows the north-east quadrant of the ZMVM including the northern half of Mexico City's inner ring-road motorway, the Circuito Interior (bottom left of the map). Adjacent to this, one can

see the existing airport with its two runways running north-east towards the new airport site in the centre of the map.

Route 1A (red line on the map) is the main road extension planned to provide access to the city centre, expected to be completed in 2018. This will link the inner ring-road to the existing Texcoco motorway, which runs along the new airport site's southern border. Constructing it will involve expanding the section of the ring road running past the existing airport and constructing a freeway along the alignment of the Avenida Oceania just north of the existing airport and along Avenida 602 (Via Tapo). The latter leads to the current starting point of the Texcoco motorway; a route of 20.6 km in all. In a second stage, Route 1B (short green line at ② on the map), will be completed after closure of the existing airport, with the current airport access road to be converted to a more direct freeway link, going from the inner ring-road to the extended Texcoco motorway.

Other motorway extensions include: a second floor added to the eastern peripheral (ring-road) running to the western edge of the airport site from the south (Route 2); a link from the eastern end of the airport site running north (Route 6); extension of the outer ring-road motorway (Circuito Mexiquense, highlighted in blue on the map) along the western boundary of the new airport site; upgrading of the south eastern loop of the outer ring-road, heading east from the new airport; and strengthening of the motorway network with a new north south link just to the west of the airport. A total of 141.5 km of freeways and link roads will be built to serve air passenger, commuter and freight traffic.

Plans for accessing the airport by Bus Rapid Transit

Four potential Bus Rapid Transit (BRT) lines are under consideration. The existing airport is served by Metrobus (Mexico City's BRT system) line 4, which runs in a loop around the city centre and includes an express service from the San Lázaro station to both terminals of the airport. Fares on regular services are set at the low, uniform rate for the Metrobus system (MEX 5), while the tariff for the express service to the airport is MEX 30. Vehicles on the express service are equipped with surveillance cameras and baggage space. The express service is not heavily used.

Extension of the Metro system to the new airport

Pre-feasibility assessments are underway for possible extensions to the metro system. These would be an integral part of the city's metro system, with journeys priced in the same way as on the rest of the system, in order primarily to provide access for people working at the airport,

Extension of the Metro from *Pantitlán* station to the new airport is under examination. It is as yet undecided if the new link would be a standalone line or an extension to one of the four lines that currently terminate at the station (lines 1, 5, 9 or A). *Pantitlán* is situated not far from Terminal 2 of the existing airport. Line A from the south-west serves an area from which a significant number of workers commute to the existing airport. Lines 1 and 9 serve central parts of the city on east-west axes. Both serve *Tacubaya*, a large station on the western side of the centre. Line 1 goes on to the adjacent station *Observatorio*, planned terminus of the Toluca-Mexico City railway (see below). Line 5 serves eastern and northern suburbs. Line B of the metro system runs relatively close to the site of the new airport, with several stations around 6 km from the new Terminal 1, and a branch to the new airport might be possible.

Figure 32. **Line 4 Metrobus connection to the existing airport**

Source: ITDP.

Other potential projects

Currently, the potential for an express metro or rail link is being considered; it would leave fromthe airport terminal to serve Polanco, the wealthy inner western area with a large concentration of offices and hotels, via Paseo de la Reforma, the principal avenue of Mexico City and location of company headquarters, banks and government offices. This would serve primarily air passengers and would probably require a separate funding and pricing framework from the existing metro and suburban rail network. The feasibility of a standard suburban rail link to the new airport is also under examination.

Rail track to transport construction material for the new airport

The rail freight network will be extended to facilitate logistics for the transport of construction materials for the airport and minimise the impact of truck traffic on the road network and the surrounding area. The project will help to decongest road access to the area of the NAICM.

5. Conclusions and discussion

The case studies from the UK, Korea, Australia, Denmark, Canada and the USA outlined in this report provide some useful insights for successful development of surface transport infrastructure for the The New International Airport of Mexico City . These concern the following main areas:

- the strategic transport planning framework in the Megalopolis and aspects of governance and inter-jurisdictional co-ordination
- targets for modal split to ensure compatibility with air quality objectives and contain congestion on the road network
- design of the airport terminal building and public transport stations within the airport
- choices to be made in prioritising links, including between dedicated express rail services targeting air passengers and extensions to existing metro, BRT and suburban rail systems designed to serve a full range of users
- arrangements of funding investment in surface transport links to airports.

Decisions over priorities for investment in rail, metro, BRT and bus links, and investments to improve the safety, security and accessibility of stations and interchanges are needed, rights of way and alignments for future investments that cannot be financed in the short term need to be preserved and the airport's multi-modal public transport station needs to be designed to be future-proof. Overall the development of the airport needs to be an integrated part of the process of improving strategic regional transport planning and inter-jurisdictional integration in the Valle de Mexico.

The key conclusions are as follows:

1. The surface transport access plans for the new airport will need to be compatible with the overall direction of policy in the ZMVM, and contribute to the attainment of established objectives for inclusive and sustainable mobility. The overall goals for strategic transport planning in relation to the new airport should clearly include the following two main objectives:
    - Provide for effective surface access to the airport from all parts of the Megalopolis, i.e. the whole of the airport's natural surface hinterland, through development of road, rail and metro infrastructure and extension of public transport services from its neighbouring cities.
    - Contain the impacts of the new airport on road traffic congestion and air pollution through provision of high-quality public transport alternatives to transport by private car and taxi.
2. Plans for investment in road, BRT, metro and rail infrastructure to serve the new airport under consideration by SCT, if realised to high standards, could establish surface access links to the new airport among the best in class in OECD member countries.
3. The success of public transport services in securing a large share of trips to and from the airport will depend to a significant degree on the design of the multimodal surface transport access facilities to be developed by the Airports Group. Facilities should prioritise access by public transport at the terminal, providing short, direct, step-free and unobstructed access to check in

areas and exit gates from rail platforms and bus stops. This requires locating rail and bus stations directly below or adjacent to terminals.

4. Funding is not available to initiate all of the potential public transport projects simultaneously. The next stage in strategic planning is to prioritise projects and establish an order of development.

5. Planning powers should be used to preserve alignments for investments in infrastructure for public transport that can only be made at a later stage. Future potential interconnections should be accommodated in the design of terminal and station infrastructure constructed in the first phase of investment.

6. Future integration of transport links to the new airport and to the redeveloped site of the existing airport should be planned for, as some of the facilities developed on the old site are likely to be prime destinations for air passengers and the alignment of the sites is fortuitous for connections to central Mexico City.

7. Seamless, reliable journeys will be important to the success of public transport in catering for air passenger journeys. Integration with the wider public transport network, as planned, is important to reach a large catchment population. This is particularly important for workers accessing the airport but will also determine the overall number of air passengers able to use public transport.

8. Air passengers are likely to be prepared to pay a premium price for faster, more direct services to key centres of business and tourism and this may merit investment in dedicated links as well as extension of existing transport networks. The potential for increasing the share of fare box revenue to secure funding for the planned express metro service in the first phase of development should be examined. Experience from the case studies suggests any blurring of the distinct role of an express service with standard metro provision should be avoided. It is possible to run express and stopping services with different tariffs on the same line, as is the case for example with Heathrow Express and Heathrow Connect in London, serving different combinations of air passengers, airport workers and local communities along the route.

9. Delivery of key parts of SCT's plans for BRT, metro and rail infrastructure in time for the opening of the new airport is essential to containing the negative impact of airport on air quality and congestion in the ZMVM. This argues for prioritising investment in these projects by Mexico's funding authorities.

10. The success of the airport in serving the population of the whole of the catchment area of the Megalopolis is dependent also on the quality of the road and public transport services provided. Its success in providing the business community with fast, seamless, reliable access to international markets is highly dependent on the planned express metro and rail projects. These are therefore particularly important to the potential economic benefits to be generated by the airport.

11. The long-distance bus terminal adjacent to departures and arrivals, and the high quality bus services provided at the existing airport are world class. This facility needs to be replicated in the new airport with an extended range of destinations served.

Prioritising projects

Availability of funding will inevitably require priorities to be established between the projects under consideration for public transport links to the new airport. These should be established primarily on an analysis of the needs of key user groups in terms of geographical distribution, service quality requirements and travel costs. Some of the potential projects may be determined ultimately to be of relatively little value on the basis of such analysis and be dropped or modified but for the long term the aim should be to provide a full range of viable options and develop strategic plans to preserve rights of way and anticipate future interconnections. The range of surface transport options constructed to serve Heathrow airport are outlined in Box 4 as an indication of the investment in surface transport networks to be expected to serve a major hub airport effectively in a large and crowded OECD metropolis.

Surface connectivity offering a similarly complete range of options extending the metro, BRT and bus networks should be the objective in Mexico, phasing investment according to resources available but working to plans that will enable public transport to carry a major share of trips in the longer term, as the airport expands.

Users of surface transport infrastructure accessing airports can be divided into broad groups: air passengers and accompanying people, commuters working in and around the airport, air-freight traffic, and freight and utility traffic serving the airport and associated businesses. The points of origin/destination for the majority of passengers using the airport lie in the western parts of the city. These are concentrated in the financial districts of Reforma and Polanco, in the inner western part of the city, and in Sante Fe further west, and in the wealthy suburbs north-west, west, south-west and south of the centre.

The focus of the road investments east of Mexico City around the airport site is essential but passengers accessing the airport from the western and southern areas are likely to increase congestion on ring roads used to access these areas and on routes through central areas, particularly in the south east of Mexico City. Modelling of future demand for road capacity should include attention to this dimension.

The public transport option designed to cater principally for air passengers is the express metro line running through the Paseo de la Reforma to Auditorio in Polanco. This alignment is ideal for serving the financial services and broader business community that drives a large part of the benefit to the economy of expanding airport capacity. Consideration might be given to extending this line on to Santa Fe in due course to maximise its reach to the main centres of origin and destination for air passengers. The project will entail relatively high cost as it will presumably need to be constructed underground through central parts of the city. Cost might postpone the project but charging a premium tariff for using this premium service could help ensure the project gets underway without delay.

At the same time SCT has rightly attached high priority to developing metro and BRT extensions to serve commuters to the airport and the business that will develop around it. The decision to make these extensions an integral part of the existing network, applying standard fares, is clearly vindicated by the experience in Sydney where these users were initially priced off the airport metro extension. This underlines the need for clarity over objectives of each new line and the user segments targeted (airport travellers versus airport workers versus urban regeneration), with pricing tailored accordingly.

Experience with Copenhagen Airport's metro connection underlines the value of fully integrating airport rail services into city and national rail services, with seamless station interchanges, making the service useful to a larger number of consumers. In turn, this increases the chances of consumers choosing the rail service over road access, thus reducing air pollution resulting from surface access to the airport.

The experience in Copenhagen and Sydney also underlines that it often takes longer than expected for demand on new services to reach target levels. Forecasting a speedy take up of rail services can lead to revenue shortfalls, undermining the credibility of the investment decision. It is therefore prudent to forecast and plan for a slow ramp-up in patronage.

Box 4. **Surface transport options for accessing London Heathrow Airport**

Heathrow airport contains a number of rail stations reflecting the distributed locations of its terminals and its accessibility via rail services on the Great Western Mainline (GWML from Paddington Station in London to the west of England) and the Piccadilly line of the London Underground metro system. Premium express services (Heathrow Express) and cheaper stopping services (Heathrow Connect) both operate from Paddington and are complemented by the London Underground, providing passengers with the ability to make trade-offs between fare, journey time and comfort.

Despite its proximity to the GWML, passengers coming to Heathrow Airport from the west of England must either change at Paddington or Hayes and Harlington, and those from the north, south or east of London must change in central London to access the airport via rail. By road, the airport is situated to the south and east of the M4 and M25 and is well-connected to London being approximately 15 miles from Charing Cross (the nominal centre of the city), however the M25 between junctions 13 and 15 carries over 100 000 vehicles daily and is subject to slow average speeds in peak hours. Additional road widening and other changes could reduce congestion on some key routes. Capitalising on its location close to a number of major motorways, Heathrow Airport also features the UK's busiest coach station providing extensive national coach coverage, and it is also served by a number of bus services operated as part of the Transport for London bus network.

There are a number of planned surface access infrastructure improvements from which Heathrow Airport passengers will benefit by 2030. The refurbished Piccadilly line, whilst potentially overcrowded during peak times in central sections, will provide more spacious, air-cooled trains at a higher frequency than present. Combined with Crossrail, there will be improved surface access from central London at relatively low cost to the passenger. Crossrail will link the airport directly to stations in central and east London, including the City (financial services district – Farringdon Station) and Canary Wharf (financial services centre) with a frequent stopping service. Western rail access will potentially significantly cut journey times from the west removing, for some, the need to change at Paddington or Hayes and Harlington, and High Speed 2 (a new rail line from London to the north) will improve connectivity to the north and midlands via an Old Oak Common interchange with Crossrail and Heathrow Express services to the airport.

There will, therefore, be a range of surface access modes with varying levels of speed, cost and comfort available to passengers travelling to the airport. These improvements are planned for delivery regardless of future airport expansion (some were conditions for previous terminal expansions) but will still have a beneficial effect on passenger experience on the construction of a third runway. Beyond the baseline, Southern Rail Access from Waterloo via Clapham Junction and Staines would provide an additional corridor for passengers, increasing resilience and improving access for those south of the airport.

Source: UK Airports Commission (2015).

Integration between the surface transport terminal in the airport and the network to be developed

The new airport is being designed for Aeropuertos y Servicios Auxiliares (ASA) by the architects Foster and Partners, together with Mexican partners FR-EE and NACO, to the highest ISO standard for sustainability, and includes provision for a multimodal transfer station to provide seamless access to the terminal from surface transport. The design of the terminal building "ensures short walking distances and few level changes, it is easy to navigate, and passengers will not have to use internal trains or underground tunnels" (Foster and Partners, n.d.), this should equally apply to access by bus, BRT, metro and rail platforms. The design might profit from experience in Incheon, where a relatively successful layout at its Terminal 1 is to be improved on in its new second terminal, substantially cutting distances from train platforms to check in.

Construction of the terminal will start before planning for the full range of surface transport options is complete. Close co-ordination will therefore be required between the authorities responsible for public transport – the Ministry of Transport (SCT), City of Mexico (SEMOVI) and the State of Mexico – the ASA, the Grupo Aeropuertuario of Mexico City (GACM) who will operate the airport and the consortium designing and building the airport, if the multimodal transfer station is to be adequate for the long terms needs of the airport. Lessons can be learned from London Heathrow where underground stations were built with extra platforms and onward tunnel connections ready for future expansion in order to avoid future costly retrofits. The new Mexico City Airport will eventually have a second terminal as large as the first; interconnecting surface transport infrastructure should be planned for in the design of the station and in preserving alignments for future construction.

Regional transport strategy, integrated land use and transport planning

The location of the new airport on Federal land in the State of Mexico and close to the jurisdictional border of Mexico City makes co-ordinated planning critical to the success of investment in surface access transport infrastructure. A number of initiatives will be required to overcome jurisdictional boundaries to ensure the full potential of the investments planned is realised:

- Clarity will need to be established over financial responsibilities for operating and maintaining extended metro lines between the City of Mexico, the State of Mexico and the Federal Government.
- Interchanges and the environment around metro, rail, BRT and bus stations where passenger numbers are intended to increase as a result of new services to the airport will need to be improved to create secure, accessible environments conducive to using public transport. Mexico City has a programme to upgrade metro station environments in this way but limited funds are slowing progress. Observatorio interchange station in particular is expected to become a key node in surface access infrastructure serving the new airport. The need for investment in improving the semi-informal bus station at Observatorio and refurbishing the station approaches for safety and security is already urgent. Significant investment in improving streets around other key stations such as Pantitlan and San Lazaro will also be needed. And if the Buenavista railway station is to be expanded to provide new services to the airport radical improvement to the intermodal interchange (CETRAM) will be required to cope with additional passengers and shorten the often long and tortuous transfer routes through the facility. Financing arrangements will need to be agreed between Federal and City governments.
- Bus services from the City of Mexico to the new airport should run direct to central locations and passengers should not be required to transfer at CETRAMS at the border between Mexico State and Mexico City as is the case with existing cross border routes.

Mexico City was subject to repeated air pollution alerts in 2016 following tightening of air quality limits to protect public health. NO_x emissions from road transport and the resulting photochemical smog and ozone pollution are the main problem. Emergency traffic restrictions were introduced to mitigate peak pollution episodes and better road traffic management and investment for modal shift are fundamental to improving air quality in the longer term. If the surface traffic generated by the new airport is to be compatible with efforts to cut air pollution in the megalopolis a large part will have to be carried on rail and metro and new generation BRT and buses. Investment in rail and metro is a condition for planning consent to expand airports in many cities with persistent air quality problems, including London. Credible plans for limiting air pollution are essential for stakeholder acceptance of airport expansion here and likely to become increasingly important to the population of Mexico City.

The major investments in roads around the new airport to the east of Mexico City should be effective in meeting expected traffic demand and containing congestion (which exacerbates air pollution) in this part of the territory. However, traffic can be expected to increase more widely across the road network. This may cause particular problems of exacerbated congestion during peak times on routes from the wealthier south-western suburbs of Mexico City, through central city streets as well as on the ring roads. Potential traffic demand should be modelled across the network to identify where further investment made or measures to contain traffic and encourage use of alternative modes should be taken.

Overall, development of the new airport and future redevelopment of the existing airport site provide a unique opportunity to catalyse efforts underway in the City of Mexico and the State of Mexico to improve the co-ordination of planning and operation of public transport services and better integrating land use and transport planning.

References

ACRP (2008), *Ground Access to Major Airports by Public Transportation*,Transportation Research Board, Washington, D.C.

Aeropuerto Internacional de la Ciudad de México (AICM) (2016), Historical Statistics http://www.aicm.com.mx/categoria/estadisticas (accessed 3 August 2016).

Airports Commission (2015), *Final Report*, UK Government, London.

Airports Commission (2014), *Consultation Document: Gatwick Airport Second Runway, Heathrow Airport Extended Northern Runway, Heathrow Airport North West Runway*, UK Government, London.

Airports Commission (2013a), *Guidance Document 02: Long Term Capacity Options: Sift criteria*, UK Government, London.

Airports Commission (2013b), *Interim Report*, UK Government, London.

Airports Council International, 2015 Air Traffic Statistics, http://www.aci.aero/Data-Centre/Monthly-Traffic-Data/Passenger-Summary/Year-to-date

Avinor, Annual and CSR Report (2015), Swedavia, Facts About the Airport, http://www.swedavia.com/arlanda/about-stockholm-arlanda-airport/about-stockholm-arlanda-airport/facts-about-the-airport/

Byers, S. (2001), *Hansard statement on Heathrow (Terminal 5)*, http://www.publications.parliament.uk/pa/cm200102/cmhansrd/vo011120/debtext/11120-06.htm (accessed 15 June 2015).

Civil Aviation Authority (2013), Economic Regulation at Heathrow from April 2014: Final proposals, London.

Copenhagen Airports (2015), Key Facts and Figures 2015, https://www.cph.dk/globalassets/om-cph/key-facts--figures-2015.pdf

Copenhagen Airports (n.d.), Train, https://www.cph.dk/en/parking-and-transport/bus-train-metro/train/

Crossrail (2017), Route map: Elisabeth line. Crossrail Ltd. http://www.crossrail.co.uk/route/maps/route-map

CTSEmbarq Mexico (2015), “Principios Rectores de la conectividad al NAICM”. http://masterctsmexico.com/Medios/NAICM_Principios_prensa%20V4.pdf (accessed 09 August 2016).

Danish State Railways (n.d.), Travelling to Sweden, http://www.dsb.dk/kampagner/id-kontrol/id-inspection/

Department for Communities and Local Government (2014), *Community Infrastructure Levy*, http://planningguidance.planningportal.gov.uk/blog/guidance/community-infrastructure-levy/other-developer-contributions/ (accessed 17 June 2015).

Department for Communities and Local Government (2012), *National Planning Policy Framework*, UK Government, London.

Department for Environment, Food and Rural Affairs (2010), *Noise Policy Statement for England (NPSE)*, UK Government, London.

Department for Transport (2013), *Aviation Policy Framework*, UK Government, London.

European Commission (2015), *Environmental Assessment*, http://ec.europa.eu/environment/eia/home.htm (accessed 5 June 2015).

Fender, K. (2014), "Heathrow's billion pound railway". *Modern Railways*, Vol. 71/785, pp. 52-57.

Flyvberg (2007), "Cost overruns and demand shortfalls in urban rail and other infrastructure", *Transportation Planning and Technology*, Vol. 30/1, p. 13.

Foster and Partner (n.d.), http://www.fosterandpartners.com/projects/mexico-city-international-airport/

Gaceta Official Distrito Federal (2014), Acuerdo por el que se aprueba el programa integral de movilidad 2013-2018, 15 October.

Heathrow Airport Limited (2014a), *Regulatory Accounts*, Year ended 31 March 2014.

Heathrow Airport Limited (2014b), *Sustainable Transport Plan 2014 - 2019*, Houslow.

Heathrow Airport Limited (n.d.), *Night Flights*, http://www.heathrowairport.com/static/Heathrow_Noise/Downloads/PDF/Nightflights11.pdf (accessed 15 June 2015).

Incheon Airport Railroad (2015), AREX Airport Express, http://www.arex.or.kr/ (accessed 8 September 2015).

Incheon International Airport Corporation (2015), Airport Bus Guide, http://www.cyberairport.kr/pa/en/d/3/1/1/index.jsp (accessed 9 September 2015).

Inter-city bus ticket reservation system, https://www.busterminal.or.kr/ (accessed 17 September 2015).

Kojects (n.d.), Trains. http://kojects.com/train/ (accessed 15 September 2015).

ITDP (2014), Megacentralidades: Propuesta de integración de los cetram al desarrollo urbano de la Ciudad de México, Sol Camacho Dávalos.

ITF (forthcoming), Income Inequality, Social Inclusion and Mobility, OECD Publishing, Paris.

Jacobs (2015), *Appraisal Framework Module 4, Surface Access: Demand Management Study*.

Jacobs (2014), *Appraisal Framework Module 4, Surface Access: Heathrow Airport North West Runway*.

Kojects (2015), Trains, http://kojects.com/train/ (accessed 15 September 2015).

Korea Transport Database (n.d.), http://www.ktdb.go.kr (accessed 15 September 2015).

Korea Traffic Monitoring System (n.d.), http://www.road.re.kr (accessed 9 September 2015).

KTX ticket reservation system (n.d.), http://www.letskorail.com/ (accessed 17 September 2015).

Kwon, Y. and J. Jo (2000), Ground Access to New Airport, The 7th International Conference on Air-Rail Intermodality.

Kwon, Y., S. Song, and K. Han (2012), ICN 3rd Step Landside Facility Detailed Design Surface Transportation Demand Forecast, Incheon International Airport Corporation.

Kwon, Y., J. Yoo, M. Kim, K. Kim, K. Lim, J. Jo, S. Kim, I. Moon and J. Oh (2001), ICN Surface Transportation Demand Forecast, Ministry of Construction and Transport.

Mayor of London (2015), *The London Plan*, Greater London Authority, London.

Mayor of London (2013), *Use of planning obligations in the funding of Crossrail, and the mayoral Community Infrastructure Levy: Supplementary Planning Guidance*, Greater London Authority, London.

Mayor of London (2011), *Mayor's Transport Strategy*, Greater London Authority, London.

Namu wiki (2015), Median bus lane routes. https://namu.wiki/, searching 버스중앙차로(accessed 21 October 2015).

Naver Map Service (n.d.), http://map.naver.com/ (accessed 15 September 2015).

New South Wales (NSW) Parliament (2014), *Removing or reducing station access fees at Sydney Airport*, Sydney: General Purpose Standing Committee No. 3, Report no. 29.

NSW Treasury (2005), *Contracts Summary*, http://www.treasury.nsw.gov.au/ppp/nsw_projects/projects_which_have_been_awarded/rail/new_southern_railway_stations_agreement (accessed 19 June 2015).

NSW Treasury (2005), *New Southern Railway Stations Agreement: Contracts Summary*, http://www.treasury.nsw.gov.au/ppp/nsw_projects/projects_which_have_been_awarded/rail/new_southern_railway_stations_agreement (accessed 19 June 2015).

OECD (2015), *Territorial Review of the Valle de Mexico*, OECD Publishing 2015. DOI: http://dx.doi.org/10.1787/9789264245174-en

OECD (2015), based on Government of Mexico City (2014b), *Acuerdo por el que se aprueba el Programa Integral de Movilidad 2013-2018*, Secretaria de Movilidad, Gaceta Oficial del Distrito

Federal, www.ordenjuridico.gob.mx/Documentos/Estatal/Distrito%20Federal/wo99436.pdf (accessed 15 June 2015).

Oh, J., Y. Kwon, J. Seo, H. Kim and J. Kim (1999), ICN ITS Master Plan, Public Transportation Sector, Incheon International Airport Corporation.

The Planning Inspectorate (2012), *National Policy Statements*, http://infrastructure.planningportal.gov.uk/legislation-and-advice/national-policy-statements/ (accessed 4 June 2015).

Rigsrevisionen (Danish National Audit Office) (2004), Report to the Public Accounts Committee Ørestads - and Metro project (no. 2).

Rigsrevisionen (Danish National Audit Office) (2000), Report to the Public Accounts Committee Ørestads - and Metro Project.

Secretaria de Comunicaciones y Transportes (SCT) (2016), Presentación Nuevo Aeropuerto de la Ciudad de México, http://www.aeropuerto.gob.mx/documentos/naicm-bnamericas-5th-mexico-infrastructure-summit.pdf (accessed 3 August 2016).

Secretaria de Comunicaciones y Transportes (SCT) (2014), Presentación del Proyecto Nuevo Aeropuerto Internacional de la Ciudad de México, http://www.aeropuerto.gob.mx/documentos/05092014-sct-visionintegral.pdf (accessed 3 August 2016).

Secretaria de Comunicaciones y Transportes (SCT) (2013), Programa de Inversiones en Infraestructura de Transporte y Comunicaciones 2013-2018.

SEDECO (2016), Para la Opinion de la Ciudad, http://13926-presscdn-0-69.pagely.netdna-cdn.com/wp-content/uploads/2016/03/LIBRO-PARA-LA-OPINION-DE-LA-CIUDAD.pdf

SENERMEX Ingeniería y Sistemas SA de CV y SCT (2013), "Análisis costo – beneficio del proyecto: Construir el tren interurbano México-Toluca, 1era etapa".

Seoul Metropolitan Rapid Transit Corporation (n.d.), http://www.smrt.co.kr/program/cyberStation/main.jsp (accessed 8 September 2015).

Seoul Solution (2015), Major roads. https://seoulsolution.kr/content/statistics?language=en (accessed 21 October 2015).

Sydney Airport Corporation Limited (2006), *Sydney Airport 2006 airport ground travel plan*, Sydney.

Transport Research Board (2008), TCRP Report 4: Ground Access to Major Airports by Public Transportation.

Transport Research Board (2000), TCRP Report 62: Improving Public Transportation Access to Large Airports.

UK Airports Commission (2015), Business Case and Sustainability Assessment, July.

UK Department for Transport (DfT) (2007), *Improving the Air Passenger Experience: An analysis of end-to-end journeys with a focus on Heathrow*.

Notes

1 Nuevo Aeropuerto Internacional de la Ciudad de México.

2 More information about the Airports Commission can be found at: https://www.gov.uk/government/organisations/airports-commission.

3 A "smart motorway" is a motorway where traffic management techniques, such as use of variable speed limits and hard shoulder running, are used at busy times to increase capacity.

4 The former is received as direct revenue for the Heathrow Express/Connect services, while the latter are received as remittances from London Underground to reflect passenger usage of the Piccadilly line extension (Heathrow Airport Limited, 2014a). The remainder of costs are financed by aeronautical and commercial revenues under the airport's regulated asset base model.

5 Similar development and similar location in relation to the airport and the centre of the city to the Santa Fe area of Mexico City.

6 The owners of Heathrow originally agreed to contribute GBP 180 million (in 2008 prices) to funding the project. However, this contribution was later reduced to GBP 70 million (in 2011/12 prices) as the regulator argued that Heathrow was operating close to capacity (and that this would not change for the foreseeable future) thus would not significantly benefit from extra surface access capacity (Civil Aviation Authority, 2013). Nevertheless, the regulator recognised the project would improve the speed and choice for surface access of passengers, which could partly be recovered through passenger charges.

7 In general, developers are not expected to pay for the same piece of infrastructure through Section 106 and the Community Infrastructure Levy; Crossrail is an exception (Department for Communities and Local Government, 2014).

8 Originally this surcharge was applied to all four privately run stations, but since 2011 the surcharge has only been applied only to the two airport stations, with the government providing a "shadow" surcharge to the operator.

9 Since 2013, the terms of the renegotiated 2005 agreement have meant that a large share of the station usage fee revenue has been allocated to the government rather than the Airport Link Company (50% from January 2013 and 85% since July 2014) (New South Wales Parliament, 2014).

10 Eurostat, Top 15 airports, passengers carried (embarked and disembarked), EU-28, 2014.

11 Scandinavian Airlines, SAS hubs: Copenhagen and Stockholm Airports.

12 Jensen, Tommy O, Metro undervejs(*Metro under way*), Jernbanen (5), p. 30.

13 de Laine, Metro till Lufthavnen indviet (*Metro to the airport inaugurated*), Rush hour, 29 September 2007.

14 Metroselskabet og Hovedstadens Letbane (*Metro Company and Metropolitan Light Rail)*, Metroprognosis 2008; OTM 5.0.

15 Available at: http://mexico.itdp.org/wp-content/uploads/Guia-Fondos-Federales1.pdf

International Transport Forum

Surface Access to Airports

The Case of Mexico City's New International Airport

The success of Mexico City's New International Airport will depend not least on the quality of access to the airport on the ground. This report reviews policies and planning controls for surface access at a selection of comparable airports in cities of OECD countries. It offers input for the Mexican Federal Government's plans for infrastructure investments that will serve passengers, the airport workforce and the public by ensuring convenient, reliable airport journeys; supporting business travel for a productive Mexican economy; and by maintaining within acceptable bounds the airport's impact on road congestion and related air pollution.

This report is part of the International Transport Forum's Case-Specific Policy Analysis series. These are topical studies on specific issues carried out by the ITF in agreement with local institutions.

This report was prepared in collaboration with the OECD's Directorate for Public Governance.

International Transport Forum
2 rue André Pascal
F-75775 Paris Cedex 16
T +33 (0)1 45 24 97 10
contact@itf-oecd.org
www.itf-oecd.org

Published: 10/2018 | Photo credit: NAICM