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Entry title: Airports' role and operations in the international environment

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Definition: An airport is a set of facilities, that comprises of buildings, runways, apron areas, roads and space connectors, and constitute the connector between surface and air transport. An airport is planned to serve passenger, cargo and aircraft movements in its facilities.

Chapter: Airports' role and operations in the international environment

1. Airports as part of the international transport system

Airports, almost 100 years after the birth of aviation in Ohio by Wright brothers, continue connecting facilities between surface and air transport and, in some cases, being the only alternative for people's long-distance trips. Air transport allows people from all over the world to connect to other places, cultures and, eventually, opportunities through the infrastructure of over 40.000 airports that operate worldwide, 1.200 of which are international airports, and 17.370 unique city-pair routes (flights) that connect the airports among them (ATAG, 2017).

Air is the fastest and safest means of transport (Savage, 2013). Airports compete mainly with high-speed rail at medium distances (Adler et al., 2010; Dobruszkes, 2011). Internal competition among airports is also observed at a regional or interregional level (Oxera, 2017).

Through the air transport networks and the associated ground infrastructure, movements of passengers, cargo and aircrafts are served. In 2015, approximately 3,6 billion passengers moved by air, 51,2 million tonnes of freight were carried and 35% of interregional good exports were conducted by air (ATAG, 2017). According to Airports Council International (ACI), the trade association of the world's airports, a continuous rising trend is seen in the global aviation market. The transported volumes of total passenger, cargo, aircraft movements, international passenger and freight have all increased by 2,4% to 10% approximately (ACI, 2018). In 2018, the busiest day in the skies since the beginning of aviation was tracked with 202.157 flights on a single day (<https://www.flightradar24.com/>). In 2013 around 3 billion people used air transport for business and tourism needs (IATA, 2013) while it is estimated that every day 8,6 million passengers travel by air (52% to international destinations) through 99.700 flights which also carry goods of total value 17,5\$ billion (ATAG, 2017).

The distribution of traffic presents a strong concentration phenomenon as almost a fifth (17%) of the global passenger traffic (1,5 billion passengers) is served by the 20 busiest airports while as far as cargo is concerned, 43% of global movements is served by the top 20 airports. This creates high requirements in the respective airports and implies the need for harmonization

of processes around the world.

Demand has been increasing but sources claim that this is attributed to increases in the travel frequency of the passengers rather than the actual increase in the number of people traveling (Alegre, Mateo and Pou, 2009). This holds especially for modern tourism which is characterized by short and frequent stays spread throughout the year (Ferrer-Rosell, Martínez-García, and Coenders, 2014; Salmasi, Celidoni, and Procidano, 2012) and for the increasing business trips (Barros and Machado, 2010; Castillo-Manzano, Lopez-Valpuesta and Gonzalez-Laxe, 2011).

The high volumes of passengers and freight being managed within the airports form a complex environment of operations. Worldwide regulations, different development levels, distinct cultural differences and the great number of the stakeholders involved in the airport management and ownership are aspects that usually restrict operations and seamless mobility. For this reason, the need to cater for the passenger experience increases when we consider airport operations. Compared to other modes, airports invest a lot in ensuring that passengers will have a pleasant experience while they are in the airport terminal. There is evidence that happy experiences increase passenger satisfaction levels and non-aeronautical revenues (DKMA, 2014; Graham, 2014) while they strengthen both the airport's reputation (DKMA, 2014) and its position in the competitive environment and increase the chances of the airport to be chosen among other transport alternatives (Parrella (2013), Wattanacharoensil, Schuckert and Graham (2015)).

1.1 Airport typology

Airports can be categorized according to the type of traffic they serve. There are airports that are used for military purposes and airports that are used for commercial services. In some cases, there might be a simultaneous mixed use for both purposes.

Airport categorization can be done by the regions that the airports serve. Federal Aviation Administration (FAA) (2016) distinguishes airports into national, regional, local and basic according to the areas they serve (international, national, regional).

The volume of the movements that the airport serves is also used to classify airports. In the USA, FAA distinguishes primary (at least 10.000 enplanements of scheduled flights per year) and nonprimary airports and defines the following primary airport categories:

- Large primary hub (serving 1% or more of U.S. enplanements)
- Medium hub (serving between 0.25% and 1% or more of U.S. enplanements)
- Small hub (serving between 0,05% and 0,25 % or more of U.S. enplanements)
- Non-hub (serving less than 0,05% of U.S. enplanements but more than 10.000)

According to the EU standards (European Parliament, 1996), European airports are categorized based on their demand to:

- International Association points: air-ports with annual traffic of more than 5.000.000 passengers (Category 1)
- Community connecting points: airports with annual traffic of more than 1.000.000

passengers (Category 2)

- Regional access points: airports with annual traffic of more than 250.000 passengers (Category 3)
- Airports with annual traffic of more than 100.000 passengers and airports with annual traffic of less than 100.000, serving mostly domestic flights because of the limited available runway length (Category 4).

Finally the type of the demand that the airports serve can be a means of categorization. In this case airports may be characterized as hub airports (attracting many transfer movements), business airports (attracting mainly business passengers), low-cost airports (attracting low-cost airlines and passengers) and cargo airports (with a great volume of cargo movements).

2. Airports as part of the global industry

2.1 Economic impacts

The airport industry continues to be regarded as a vital part of the worldwide economy. In economic terms, 3,4% of the global GDP is supported by aviation representing aviation's total global economic impact: 2,4 \$ trillion including direct, indirect, induced and the catalytic effects of tourism (IATA, 2017). European airports hold the greatest proportion of the global airport income (38%) followed by those in Asia-Pacific (28%) and North America (22% (Airport World, 2015)).

The airport sector is profiting from public and private investments that are going to keep the world connected through fast, safe and secure transport. Ongoing and planned airport construction projects globally is worth US\$638.7 billion (Renner, 2017).

At a local level, airport and aviation development brings benefits to their regions. The connectivity that the airports provide to all the parts of the world constitute opportunities for the development of businesses around the airport. Logistic companies, business centers, hotels and heavy industry departments choose the airport surrounding areas for the location of their operations. This results into urban and economic development of these regions. For example, the development of Dubai's airport (one of the busiest airports worldwide) and the area around it (industrial development, hosting of corporate headquarters, international conferences and trade shows, tourism growth and development of a logistics and distribution hub) is highly related to Emirate airline's development (20% of Dubai's GDP) (O'Connell, 2011).

2.2 Social impacts

From a social perspective the airport industry contribute to a great extent to employment enforcement. The airport environment requires the provision of different services and generates employment opportunities: different specializations of engineers and technicians work on the infrastructure (airfield, air traffic control, safety, logistics, IT systems), statisticians and people of marketing, aircraft crew, policy makers, retail and commercial-related professions among others. It is estimated that the air transport industry supports 62,7 million jobs globally

and that airports employ directly 470.000 people for their operations and indirectly 4.602.000 for the on-airport operations such as retail, security and safety, air navigation providers among others (ATAG, 2017). An indirect impact on employment arises through the employment opportunities born by the effect that aviation has on tourism (36,3 million places) and the logistic supply chain (11,2 million places). It is also noteworthy that advancements in aviation research are estimated to bring higher profits than manufacturing: \$100 invested million generates additional GDP benefits of \$70 million year after year (ATAG, 2014).

Airports' operations are vital for remote areas with difficult or low access to other modes. Often, they are the connectors to urban environments increasing in this way social equity. Emergency cases of health care, for example, in some islands relies exclusively on the reliable and safe services of air transport. Usually these airports have difficulties to correspond to their operational costs and the state aid they receive is essential in order them to maintain their operations.

2.3 Environmental impacts

This multifunctional and large in scale role of airports inherently affect negatively their sustainability profile. However, activities forcing airport sustainability are met at an international level as general recommendations, such as ACI's Airport Carbon Accreditation program (ACI, 2009) which helps airports become certified across four levels: Mapping, Reduction, Optimization and Neutrality. Individually, several airports are adapting strategies that will enforce their sustainability profile. For example, the installation of solar panels on roofs saves energy costs and reduces the environmental impact of airports. Birmingham Airport is estimated that will save 22 tonnes of CO₂ each year through the installation of 200 solar panels (Aviation Benefits, 2017). Sustainable waste management and recycling activities inside the airport are also areas of interest for the increase of an airport's sustainability. Bioclimatic terminal design and electric vehicles reduce the electricity and fuel consumption of the airport, respectively, and promote sustainability. Finally, operational decisions such as the efforts to minimize the time required for aircraft taxiing activities represent an endeavor of airport managers to reduce aircraft emissions and improve airport's sustainability behavior.

3. Airport Planning and Operations

Airport planning, as part of transport infrastructure planning, falls in the spectrum of the relatively new field of research "Systems Engineering" and includes technical, managerial, social dimensions and their interactions (Moses, 2003) and is characterized by long lifecycles, capital-intensity, internal and external uncertainties, complex interactions and significant economic and societal impacts.

In this context, each airport serves one or more specific purposes in transport networks. It may serve international traffic by connecting airports of different countries and continents; it may connect passengers to other airports, railway stations or highways of a country and its neighboring countries or passengers moving from smaller places in the regional network to a

bigger airport. Airport planners are forced to think beyond the local environment; they need to consider the worldwide development of the airport and the airline industry.

3.1 Airport components and configurations

An airport can be separated into two key areas, the landside and the airside. The landside includes all the areas that the passengers use before their departure or after their arrival at the airport. For the departing passengers these areas comprise all the space they use since arriving at the airport until boarding on the airplane or exiting from the passenger building to stage in the transporters that transfer them to their airplanes. For the arriving passengers these areas are the places the passengers use after they arrive at the airport and disembark from the airplane, they collect their baggage and they finally exit the airport. The same areas are used by transit passengers who arrive at the airport and wait for their connecting flight. The airside entails all the areas that are used for activities related to aircrafts. Passengers in between aeronautical activities may use areas with non-aeronautical activities, the most common of which are Food and Beverage and convenience retail (grab-and-go items) that cover passenger needs and Duty Free, News, Gift and Specialty Retail that cover passenger wants. More specialized activities are offered at many airports, the number and variety of which has substantially increased over the past three decades especially in international departure terminals. This type of optional activities are crucial elements for airports because they stimulate the hedonic experience and excitement of shoppers or passengers (Ballantine, Jack and Parsons, 2010), especially when airports want to generate a high portion of their revenue from non-aeronautical means (Freathy and O'Connell, 2000; Graham, 2009). For this reason, special analysis takes place for their design with the collaboration of planners with people working on marketing and sales.

Regarding the connection of the building to the airside, different practices are met internationally. The exterior rampways which connect to jetways are mostly a European architecture which rarely appears in the US. As European terminals tend to be multi-level in order to separate passenger flows (domestic, international, transfer) the gates tend to be at different levels and hence, interior recessed ramps are used to connect the jetway to the gate area. The term "gate" often corresponds to aircraft stands at the terminal and off-pier stands on the apron too. Arriving aircrafts might be directed to fixed gates or to remote stands. In the first case the passengers are directly connected to the passenger building through "bridges" while in the second case, they need to be transferred by buses to the passenger building. Remote stands are usually used when there is no available gate or when the airline has requested so (Neuman and Atkin, 2013). Each type implies different levels of passenger involvement in the process and different service times.

From the perspective of the pattern of landside and airside connection, five configurations are commonly used to connect the airport building with the airfield: (1) linear, (2) finger piers, (3) satellites with or without finger piers, (4) midfield linear or X-shaped and (5) transporter configuration in which the building is far away from the airfield and buses or small

trains called “*people movers*” are needed to transfer the passengers from the building to the aircraft and vice versa. A successful decision over the terminal design is made considering the total airport demand, the seasonality of demand, the percentage of transit passengers, the needs of all airport users and the perspectives of the passengers, the airlines, the owners, the government and retail agents. The decided configuration affects the way that passengers are separated and move inside the airport area. Apart from the owner’s objectives, national regulations define the final choice of each airport configuration as well.

3.2 The passenger experience

Independently of the geographical position of the airport, its terminal building needs primarily to serve its users fast, safe and efficiently. Passengers, while they are in the terminal, they pass through various processes which are required for the completion of their trip (Figure 1). A passenger building accommodates functions related to passenger departure, transfer and arrival. The airport, the airlines and government agents are all involved in the execution of these processes. Departure functions include passenger and baggage check-in, immigration exit control, security screening and boarding. Transfer functions include the direction of transferring passengers to security screening and flight rebooking. Arrival processes entail immigration exit control, baggage collection and customs. Most of the control processes involve checks on passengers and baggage based on travel and passenger documents data. Passengers after checking to board, they either board directly or are transferred to the airplanes through special vehicles. Checked-in baggage goes through a separate process of successive security screenings of increasing sophistication using different technologies, until they are transferred to a central area and then through belts they arrive at the gates the corresponding flight is.

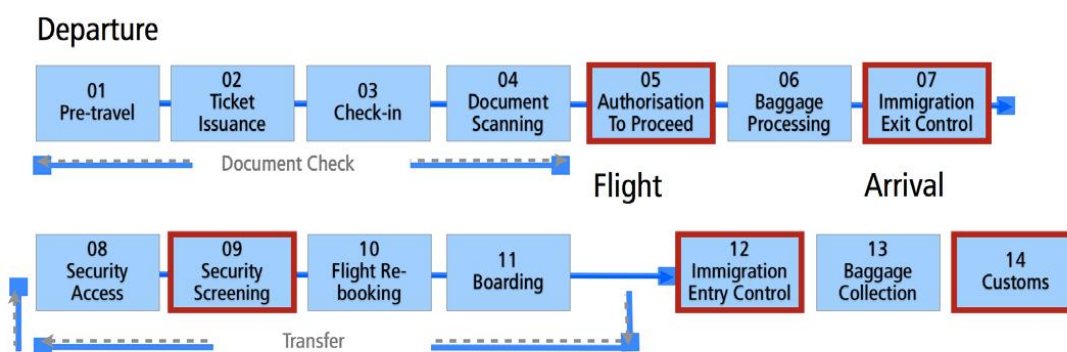


Figure 1. Schematic representation of passenger processing functions inside the passenger building (IATA, 2012)

Technological developments have always been a driving force in the complex airport environment and nowadays they concern innovations with the potential to facilitate the passenger experience in the terminal and air traffic control management. An increasing number of airports employ new devices and develop new mechanisms to support their operations. At the same time, the passengers have attained an active role in a way that enables them to affect the length of their “journey” in the airport building. Today the passengers are given the option

to choose how they will do the check-in, how they will pay and if they will compromise sharing more personal information in order to enjoy shorter security queues.

In this framework, IATA's objectives on improvements in the passenger experience are reflected in its Fast-Travel program (Figure 2) which aims to reduce costs and enhance the passenger experience and introduces process automation, an employee-free process. This initiative relies on new technologies so that it manages to bring changes to three fields:

- information sharing and process optimization by airlines, airports and government,
- introduction of more technologies and harmonization in the global landscape and
- streamlining regulatory policies throughout the journey.



Figure 2. IATA's Fast-Travel program (IATA, 2013)

From a design perspective, the airport environment should ensure a pleasant passenger experience and be harmonized with the characteristics of the region of the arriving/departing airport. Some airports have adopted this design trend. Since 2008 the passengers using Beijing International airport enjoy the view of the curving tail-like roof which resembles a Chinese dragon and red columns along the airport's central axis which refer to Chinese temples; hence, through the airport's design there is a direct reference to the Chinese culture and tradition. The use of local materials for the exterior or the interior of the airport is another expression of this design concept. Two indicative examples are Vancouver airport and Little Rock National Airport in Arkansas. Vancouver airport has rough-cut stones from the Rockies Mountains, timber, a collection from the Pacific Northwest Coast native art and a mimic of the area's waterfalls and the façade of Little Rock National Airport in Arkansas reflects the flatness of the Delta and the mountain contours among which the airport is located. Other recent projects indicate that the modernization of existing terminals takes place through power installations, open light spaces and the use of materials that last in time (eg. use of Terrazzo flooring instead of carpets) (Airport Magazine, 2014). Investments show that the many airports cater for the architectural and design aspects of their buildings in an attempt to improve the passenger experience.

3.3 Airfield and airport terminal planning

Efficient planning takes into consideration the overall environment and considers the airport master plan, land use compatibility, ground access transportation, terminal site planning,

airport security, information technology and communications, environmental protection, sustainability and business plan (ACRP, 2010). For the detailed planning process, it is important to consider the mission of the building, the balance it offers to achieve a smooth transition between its components, the level of service, passenger convenience, flexibility, security, wayfinding and terminal signage, accessibility and maintenance (ACRP, 2010).

Airport space requirements are based on the choice of the design loads which can be estimated in several ways which vary worldwide. Typically, the peak hour of the average day of the busiest month of the year is used (ACRP, 2010) for the movements of passengers and aircrafts.

The airfield of an airport usually covers 80 to 90% of the total airport area. It serves the movements of aircraft approaching, landing/departing, taxiing, parking, being maintained and connected to the building. The most important decision to make while planning this field is the number of runways, their directions and the configuration in which they will be set. FAA and ICAO have set the safety requirements for the estimation of these parameters. The mix of the types of the aircrafts that are expected to be accommodated by the airport set the requirements for the dimensions of the runway and the distances among the gates. These types of aircrafts may refer to future aircraft designs that today are not available. Another important aspect to consider is the history of wind types in the area where the runway will be located, known as the “wind rose” and the wind coverage. This information allows the planners locate the runway towards the direction that will be the most favorable for the aircrafts’ movements. When more than one runway is used at the airport, then the runways can either be located either parallel to each other, staggered or intersecting.

The building occupies around 20% of the airport’s area and accommodates the majority of movements and passenger flows. Several aviation organizations (International Air Transport Association (IATA, 2004; Airports Council International (ACI)) have reviewed the needs of the buildings and suggested some guidelines for terminal planning. For example, IATA (2004) suggests that (1) airports should be developed to operate in an efficient manner considering the safety of the users and the clients, (2) the passenger terminal building should be designed to provide an efficient and seamless flow between the landside and the airside and (3) each system of the airport should be flexible enough to accommodate future requirements in order to maintain the balance of the overall airport system.

Indicators of acceptable quality of service in distinct areas are expressed by the space availability per passenger in the busy hour and in this way, they form the provided quality of the offered services. This indicator is called “*Level of Service*” (LOS) and may concern several subsystems (departure facilities, arrival facilities, transfer facilities, people movers and bus operations and baggage handling areas). IATA published recently (2014) an updated concept of airport Level of Service (LOS) based on the time-space concept (Figure 4). This new perspective shifts the focus of the initial definition, that related LOS to $m^2/passenger$, from evaluating passenger comfort by relying merely on space to evaluating space-time service, instead, achieving in this way the inclusion of waiting time in the LOS concept. Four new levels are

proposed for the airport building: oversized, optimum, sub-optimum and under-provided. The rationale behind this change initiated from the worldwide observation of oversized terminal facilities during regular operational periods caused by the intention to provide passengers LOS A facilities and resulting to inefficient and costly infrastructure. The new base for terminal planning is a LOS defined as “optimum” which provides sufficient space to accommodate necessary functions in a comfortable environment and ensures acceptable processing and waiting times.

		SPACE		
		Overdesign Excessive or empty space	Optimum Sufficient space to accommodate necessary functions in a comfortable environment	Sub-Optimum Crowded and uncomfortable
MAXIMUM WAITING TIME	Overdesign Overprovision of resources	OVERDESIGN	Optimum	SUB-OPTIMUM ► Consider Improvements
	Optimum Acceptable processing and waiting times	Optimum	OPTIMUM	SUB-OPTIMUM ► Consider Improvements
	Sub-Optimum Unacceptable processing and waiting times	SUB-OPTIMUM ► Consider Improvements	SUB-OPTIMUM ► Consider Improvements	UNDER-PROVIDED ► Reconfigure

Figure 1. New IATA LOS concept (2014)

The queue length, the average queuing time per passenger, the average processing time per passenger, the size of queue area per passenger, the average total time in the system, the percentage of passengers who lose the flight (IATA; 2004), the expected number of users in queue and the expected waiting time, the variability of queuing time, the reliability and predictability of the system and dwell time (Neufville and Odoni, 2003) are other common factors that are used in the evaluation of quality of the services provided to the passengers inside a terminal.

Walking distances inside the terminal also matter. In principal, walking distances should be minimized; the maximum distance between any pair of processes is proposed to be 300m (IATA, 2004). In the planning process, factors such as carrying baggage, using baggage trolleys, changing levels and accessing the aircraft are considered.

Specific recommendations are given for the dimensioning of the airport areas (IATA, 2004). Check-in can be designed in a centralized form where people queue in linear or island forms, a split form (the check-in is performed in various areas of the terminal or outside (eg. Train station)) and gate check-in (check-in counters serve the passengers and their baggage just in front of the gate lounge). In most US airports the check-in agents after the passengers place their baggage on the belt, they have to lift them off the scales and move them on other belts

that transfer them to the baggage handling area while in most parts of the world, the belts where the passengers locate their baggage are connected with the belt that gathers them to the baggage area and no employee intervention is required. The check-in counters and the baggage drop-off machines are usually airline-dedicated while check-in machines might be of common use. The planning of the check-in area foresees the visit of well-wishers at the airport by adding approximately 20% of the estimated aeronautical areas for them.

Some airports have centralized and others de-centralized security processes. In de-centralized configurations the security control might be located at the gates (Singapore Changi, Kuala Lumpur International). This system is more expensive as it employs more employees and machines, it requires separation of gates to other amenities (e.g. restrooms) and is likely to decrease the time that the passengers have available for non-aeronautical activities before the gate.

Large areas are required for the accommodation of the document control of international passengers who are categorized based on their VISA type. In addition, several requirements should be satisfied in the planning process in accordance to the expectations of different agents. For example, Customs facilities should comply with legislation and the recommended practice of several agents such as national government legislation, EU directives or guidelines of aviation groups.

For the better utilization of space and minimization of it, IATA recommends shared use of open spaces for hold rooms and gates. The use of common space as gate lounge gives the flexibility to the airport to host the passengers of various aircraft types in central areas, eliminating the risk of space underuse.

4. Challenges for the future of airports

4.1 Demand levels

Demand is expected to rise and airports are called to deal efficiently with it. IATA foresees (IATA, 2014) that passenger demand will reach 7,3 billion in 2034 worldwide. The major demand influences stem from changes in living standards, population and demographics, ticket prices and availability of air travel. International agreements and changes in the global market are bound to bring changes in aviation as well (liberalization of free-trade-agreements in Asia Pacific, establishment of the ASEAN Single Aviation Market (ASEAN-SAM or ASEAN Open Skies policy). It is expected that 1,3 billion of the overall demand will correspond to the Asian market (growth rate of 5.5%) which by 2030 is expected to overtake the US market (1,2 billion passengers – growth rate 3,2%). The next strongest markets are expected to be India (266 million), Indonesia (183 million) and Brazil (170 million) but the fastest growth will most likely be seen in Africa (more specifically Central African Republic, Madagascar, Tanzania, and Burundi) and Kuwait mainly due to their rapid population growth. Europe is expected to experience the slowest growth.

A comprehensive assessment of aviation demand management allows a rigorous

estimation of the balance of tradeoffs between managing demand and increasing capacity (Ryerson and Woodburn, 2014). Forecasts predict that about 12% of the air travel demand will not be accommodated by 2035 due to a shortage of airport capacity (Eurocontrol, 2013). The mitigation of airport congestion is a challenging issue that is managed through (a) capacity investments so that the demand matches the supply, (b) new technologies in the airside that assist air traffic management, such as SESAR (Europe) and Next-Gen (USA) and improvements in resource management such as better slot allocation and resource pricing. In this context, the USA Air Traffic Control System is recently being modernized under an investment of over \$1 billion in 2015 which aims to replace the current ground-based radar surveillance system with the satellite-based surveillance system, the Next Generation Air Transportation System (NextGen) (The White House Press, 2015).

Capacity problems push for improvements in the management of airport operations as well. It is estimated that security check-in often creates long waiting lines resulting in passenger discomfort and industry costs that exceeded \$7,3 billion in 2012, while 1% of baggage worldwide was mishandled costing the airlines \$2,58 billions (IATA, 2013). Airports are called to cope with capacity constraints and adapt innovative solutions in their processes and collaborations in order to ensure smooth operations.

4.2 Demand types

The rise of low-cost carriers (LCCs) in specific regions worldwide are expected to make air travel more accessible to many people. Over the past decade LCCs revolutionized air travel in Asia; a boom of LCCs in the next decade and is expected to stimulate travel to second and third tier cities (Amadeus, 2014). Today LCCs account for 25% of the Southeast Asia market (compared to just 5% a decade ago), they provide 60% of all aircraft seats and they have generated a series of operational, infrastructure and capacity challenges for airports (Gittens, ACI as in Airport World, 2015). This leaves airport the challenge to be ready to accommodate a range of aircraft types and provide terminals that will correspond to the needs of all the kind of passengers.

Air connectivity is expected to increase with the addition of new longer-range mid-size aircrafts (IATA, 2014). Futuristic aircrafts such as the AWWA-QG Progress Eagle of 2030 are envisioned as triple-decker aircrafts with 800-passenger capacity, are energy-independent (zero carbon emissions allowed by a rear engine that would double as a wind turbine, and solar panels on the roof and wings) and offer private rooms, shops and restaurants to the “pilot class” – the equivalent of the current “business class” (CNN, 2015). The Airbus A320neo, the New Engine Option, and the Bombardier CSeries, are new services. Changes in the aircraft design are also expected; private cabins with a living room, a bathroom and a butler will be available on the upper deck of future Airbus A380s. These changes in the shape, size and capacity of aircrafts imply changes in the way that the airport will accommodate both aircraft and passenger

movements.

4.3 Provision of new technologies

Advanced technologies in airport services, baggage handling and air traffic control are expected to reduce the time needed to serve passengers and aircrafts and change the passenger experience. A growing number of passengers expect travel services that would integrate all the transportation steps from origin to destination, fast and secure experience at check-in, security and immigration checkpoints, continuous information regarding closest services and special offers at restaurants, bars and hotels (Amadeus, 2012). Simplified processes are a key passenger expectation which comes into alignment with the vision of many organizations and companies for a paperless-based airport. The fast-mobile penetration in aviation is assisting this vision. The majority of the passengers carry Smartphones, use self-service options at the airport terminal and use airline and airport applications for the preparation of their air trip. An increasing percentage of passengers is willing to allow sharing of personal data or location data and reveal information in order to enjoy streamlined operations, efficient travel, location-based advertising and personalized travel offers such as vouchers, currency-free purchases or outlet discounts (Amadeus (2012), SITA (2015)). These are trends that are demonstrating that the operations inside an airport terminal are about to change and passengers' trip is tending to become faster requiring less participation and actions by the passenger. Passengers' expectations are likely to be fulfilled with the implementation of new technologies in the airport area. Digitalization and storage of passenger biological traits, Near Field Communication Systems and i-beacons are potential technologies that can materialize the vision of the automated airport.

4.4 Market dynamics

Airports may have fixed locations but as they connect the world to the region they belong to, they attract the interest of investors worldwide. This facilitates stakeholders to acquire shares in the ownership of airports (full or partial privatizations occur). In this case the operations of the airports that belong to the same group are likely to become streamlined; the costs for the utilization of technologies may decline and this system would be expected to improve the efficiency of the corresponding group airports.

Additionally, a pattern of airport development met during the last 15 years is the operation of airports in close proximity. Among others, some city examples of this case are Paris with 3 airports serving the city, New York and Los Angeles with 4 airport and London that is served by 5 airports. These groups of airports form the "multi-airport systems" which are defined as a set of two or more significant airports that serve commercial traffic within a metropolitan region (Bonnefoy et al., 2008). As demand is growing and airports face capacity limits, these systems offer the opportunity for airport synergies, maximization of airport facility

utilization, network bottleneck limitations and stakeholder benefits.

5. Final remarks

This Chapter focused on airport development and operations. The position of the airports as nodes of air transport and the demand they capture was first described. Then the impact that the airport sector has on sustainability issues (economy, society, environment) were presented and it was shown that the sector affects significantly all the fields. Then a short description of planning and operating issues was given and was followed by the presentation of some factors that are likely to affect the way airports operate today. These challenges that appear in the airport sector can be seen as opportunities for the airports to enhance their own sustainability and the sustainable impact they can have worldwide to societies of different sizes and geographies.

References

1. Adler, N., Pels, E., Nash, C., 2010. High-speed rail and air transport competition: game engineering as tool for cost-benefit analysis. *Transp. Res. Part B* 44 (7), 812-833
2. Airport Cooperative Research Program (ACPR) (2010). Airport Passenger Terminal Planning and Design. Report No. 25. Washington D.C.: Transportation Research Board – Business Office.
3. Airports Council International (ACI) (2009). Airport Carbon Accreditation. <https://airportcarbonaccreditation.org/about.html>
4. Airports Council International (ACI) (2018). ACI Media Releases: ACI World releases preliminary 2017 world airport traffic rankings; Passenger traffic: Indian and Chinese airports major contributors to growth; Air cargo: Volumes surge at major hubs as trade wars threaten. Retrieved from: https://aci.aero/Media/ddb0b7f0-7b17-4d8a-b77f-86248a9b61e9/Qw-_Xg/News/Releases/2018/09%20April%202018/9April2018_MediaRelease_Prel_Ranking_FINAL.PDF
5. Airport Magazine (2014). <http://airportmagazine.net/>
6. Air Transport Action Group - ATAG (2014). Aviation benefits beyond borders.
7. Air Transport Action Group - ATAG (2017). Aviation benefits beyond borders.
8. Airport World (2015). Money matters. <http://www.airport-world.com/features/economics/5009-money-matters.html>
9. Alegre, J., S. Mateo, and L. Pou (2009). "Participation in Tourism Consumption and the Intensity of Participation: An Analysis of Their Socio-demographic and Economic Determinants." *Tourism Economics* 15 (3): 531–546
10. Amadeus, 2012. From chaos to collaboration - How transformative technologies will herald a new era in travel. Available at: http://www.investors.amadeus.com/media/files/english/press/2012_q1/jan12_chaos

- _to_collaboration.pdf. Latest accessed on 04.08.2014.
11. Amadeus, 2014. Shaping the future of travel in Asia Pacific - The big FOUR travel effects. Retrieved from http://www.amadeusapac.com/cmcapac/APACWhitepapers/downloads/Shaping_the_future_of_travel_in_APAC.pdf, latest accessed 21.09.2015.
 12. Aviation Benefits (2017). Retrieved from: <https://aviationbenefits.org/case-studies/birmingham-airport-powered-by-solar-energy/>
 13. Ballantine, P. W., Jack, R., & Parsons, A. G. (2010). Atmospheric cues and their effect on the hedonic retail experience. *International Journal of Retail & Distribution Management*, 38, 641-653
 14. Barros, C.P. and L.P. Machado (2010). The length of stay in tourism. *Annals of Tourism Research*, 37 (3) (2010), pp. 692–706.
 15. Bonnefoy , P., de Neufville, R. and R. J. Hansman (2008). Evolution and Development of Multi-Airport Systems: A Worldwide Perspective. *Journal of Transportation Engineering* 136(11)
 16. Castillo-Manzano, J., López-Valpuesta, L. and F. González-Laxe (2011). The effects of the LCC boom on the urban tourism fabric: the viewpoint of tourism managers. *Tourism Management*, 32 (2011), pp. 1085–1095
 17. CNN (2015a). Is this three-deck, zero-emissions super jumbo plane the future of flight? By Daisy Carrington. Published on April 21, 2015. <http://edition.cnn.com/2015/04/21/travel/progress-eagle-future-plane/index.html>
 18. de Neufville, R. and Odoni, A. (2003). *Airport Systems: Planning, Design and Management*. New York: McGraw-Hill Companies, Inc.
 19. DKMA. (2014). Why focus on improving the passenger experience? 9 great reasons to make customer service a top priority. DKMA. Retrieved from <http://www.dkma.com/en/images/downloads/customer-service/Why%20focus%20on%20the%20passenger%20experience.pdf>
 20. Dobruszkes, F., 2011. High-speed rail and air transport competition in Western Europe: a supply-oriented perspective. *Transp. Policy* 18, 870-879
 21. EuroControl, 2013. 20-year Forecast of Annual Number of IFR Flights (2012–2035). <<https://www.eurocontrol.int/articles/forecasts/>>.
 22. (1996). Article 13 of Decision No. 1692/96/EC
 23. Federal Aviation Administration (2016). Retrieved from: https://www.faa.gov/airports/planning_capacity/passenger_allcargo_stats/categories/
 24. Ferrer-Rosell, E. Martínez-García and G. Coenders. Package and no-frills air carriers as moderators of length of stay. *Tourism Management*, 42 (2014), pp. 114–122
 25. Freathy, P. and F. O'Connell (2000). *European Management Journal*, 2000, vol. 18, issue 6, 638-645.
 26. Graham, A. (2009). How important are commercial revenues to today's airports? *Journal*

- of Air Transport Management, 15, 106–111.
27. Graham, A. (2014). Managing airports: An international perspective (4th ed.). New York, NY: Routledge.
 28. International Air Transport Association IATA (2004). Airport Development Reference Manual 9th Edition, International Air Transport Association, Montreal-Geneva. ISBN 92-9195-086-6.
 29. International Air Transport Association IATA (2012). <http://www.iata.org/publications/airlines-international/december-2012/Pages/passenger-travel.aspx>
 30. International Air Transport Association. (2013). Fast travel program. Retrieved from <https://www.iata.org/whatwedo/passenger/fast-travel/Documents/Fast-Travel-Program-Strategy-V6.pdf>
 31. International Air Transport Association IATA (2014). New IATA Passenger Forecast Reveals Fast-Growing Markets of the Future. Press Release No.: 57. Date: 16 October 2014. <http://www.iata.org/pressroom/pr/pages/2014-10-16-01.aspx>
 32. International Air Transport Association IATA (2017). Factsheet, Aviation Beyond Borders. Retrieved from: <https://www.iata.org/policy/Documents/aviation-benefits-%20web.pdf>
 33. Moses, J. (2003). The Anatomy of Large Scale Systems. ESD Internal Symposium. Cambridge, MA, MIT: 17
 34. Neuman, U. M. and J.A.D. Atkin (2013). Airport Gate Assignment Considering Ground Movement. Lecture Notes in Computer Science Volume 8197, 2013, pp 184-198
 35. O'Connell, 2011. The rise of the Arabian Gulf carriers: An insight into the business model of Emirates Airline. Journal of Air Transport Management 17 (2011) 339-346.
 36. Parrella, B. C. (2013). Understanding airline and passenger choice in multi-airport regions. Airport Cooperative Research Program. Retrieved from http://onlinepubs.trb.org/onlinepubs/acrp/acrp_rpt_098.pdf
 37. Renner, J. (2017). Airport investments – it's all about finding the right balance. Retrieved from: <https://www.linkedin.com/pulse/airport-investments-its-all-finding-right-balance-jurgen-renner?articleId=6270950435259981824#comments-6270950435259981824&trk=prof-post>
 38. Ryerson, M. S. and A. Wookdburn (2014). Build Airport Capacity or Manage Flight Demand? How Regional Planners Can Lead American Aviation Into a New Frontier of Demand Management. Journal of the American Planning Association, Volume 80, Issue 2, 2014.
 39. Oxera (2017). The continuing development of airport competition in Europe. On behalf of ACI. Online source: <https://www.aeroport.fr/uploads/documents/Publication/Oxera%20Study%20The%20Continuing%20Development%20of%20Airport%20Competition%20in%20Europe.pdf>
 40. Salmasi, L., Celidoni, M. and I. Procidano (2012). Length of stay: price and income semi-

- elasticities at different destinations in Italy. *International Journal of Tourism Research*, 14 (2012), pp. 515–530
41. Savage, I. (2013). Comparing the fatality risks in United States transportation across modes and over time. *Research in Transportation Economics*, vol. 43, issue 1, 2013, p.9-22
 42. SITA (2015). SITA/ATW Passenger IT Trends Survey. The future is personal.
 43. The White House Press (2015). Department of Transportation. Retrieved from: <https://www.whitehouse.gov/sites/default/files/omb/budget/fy2015/assets/transportation.pdf>
 44. Wattanacharoensil, W., Schuckert, M and A. Graham (2015). An Airport Experience Framework from a Tourism Perspective. *Transport Reviews*, DOI: 10.1080/01441647.2015.1077287