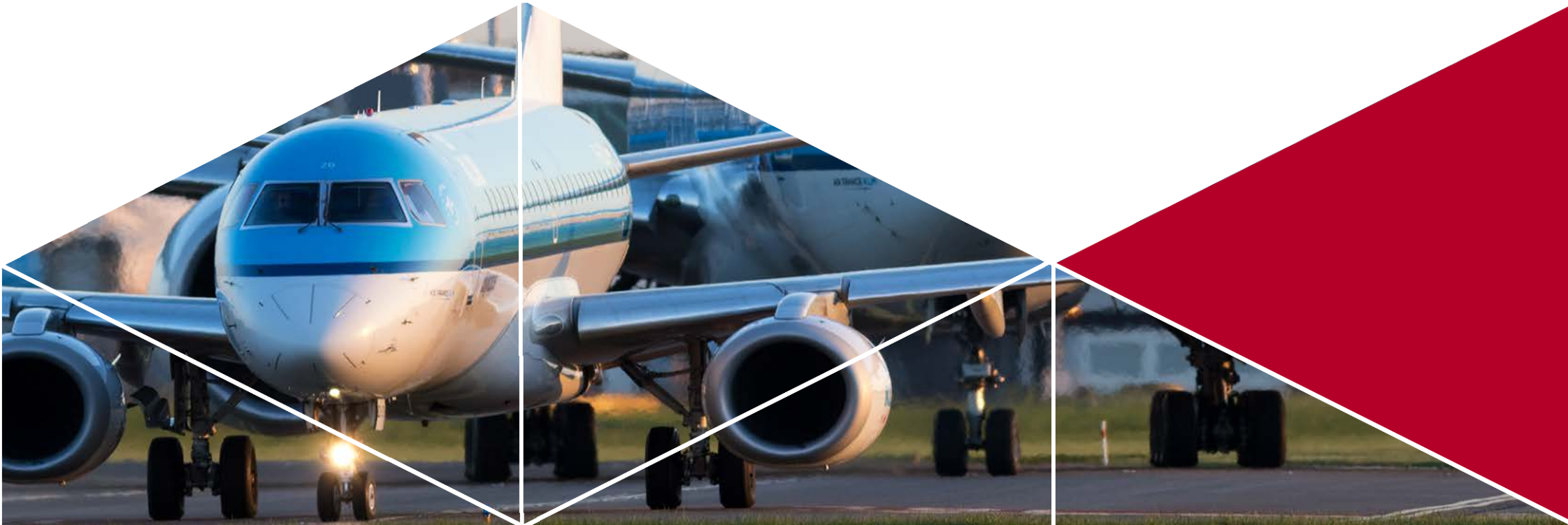
Luchtvaartfeiten.nl AviationFacts.eu

AIRPORT CAPACITY

Looking Beyond the Runway



Introduction

Air transportation is a fast-growing industry – regionally, nationally and globally. This growth has in turn created local and global impact in economic and social areas. Increasing air traffic demand now exposes the shortage of airport infrastructure capacity, which will be a crucial issue in the near future. This is especially true for mature air transport markets in the US, Europe and the Asia-Pacific regions, where airport capacity has been affected by different operational, economic and environmental constraints. These constraints have started to impede the future growth of airport and air traffic demand. As we explore constraints to airport capacity, it appears that there is not one clear definition, and that airports are constrained in different ways. This factsheet explores the different definitions of airport capacity, categorizes them in several ways, investigates the influence of airlines on the definition of airport capacity and provides examples of how we can solve these constraints.

Defined by capacity as a constraining element

Airport capacity is not a clear-cut phenomenon, with many different definitions depending on the point of view adopted (1). However, everybody agrees that airports are constrained in different ways by different types of capacity. We can categorize definitions by considering the constraining element (Figure 1), and then divide definitions into technical capacity, acceptable capacity and allowed capacity.

1. Technical capacity is defined as the maximum number of aircraft or passengers that can be accommodated in a certain period of time when there is continuous demand. It is affected by the physical constraints of the available infrastructure, such as the maximum throughput figure of a runway or the maximum number of passengers based on the limited terminal space available.

2. Acceptable capacity is the maximum number of aircraft or passengers than can be accommodated in a certain period of time, taking into account a maximum allowable delay or waiting time per step in the airport process. It is defined by the acceptable Level of Service (LoS). This applies to departing passengers and flights as well as arriving ones: waiting times at the baggage claim area is another example of how service levels determine acceptable capacity.

3. Allowed capacity is defined by regulations and legislation that balance economic importance against any nuisance that may be caused for local residents. For instance, a government or other authority might cap the annual amount of ATMs on the basis of maximum noise hindrance or gaseous emissions. No additional aircraft (or passengers) would then be allowed at an airport, even if there was physical room for expansion. For example, the Dutch government has placed a cap of 500,000 ATMs p.a. up to 2020 at Schiphol.

A capacity graph (Figure 2) illustrates the constraint categories. It depicts the quintessential behaviour of capacity in general: delays or waiting time tend to increase exponentially if demand rises and capacity becomes scarce (2).

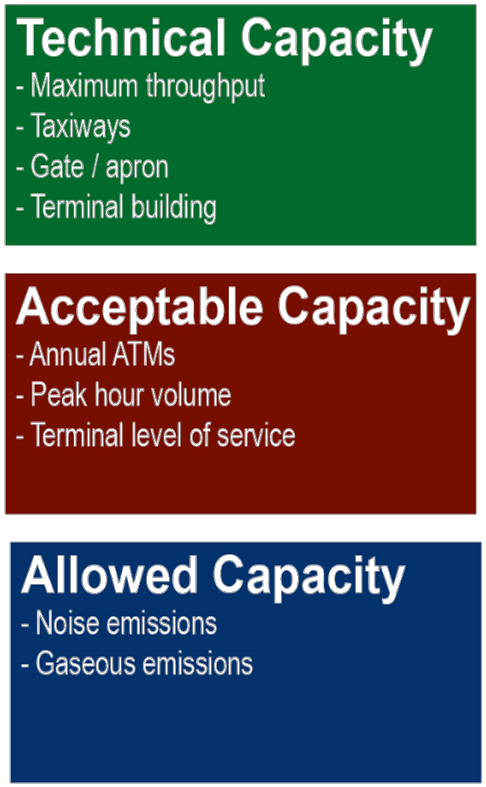


Figure 1: Capacity constraint categories.

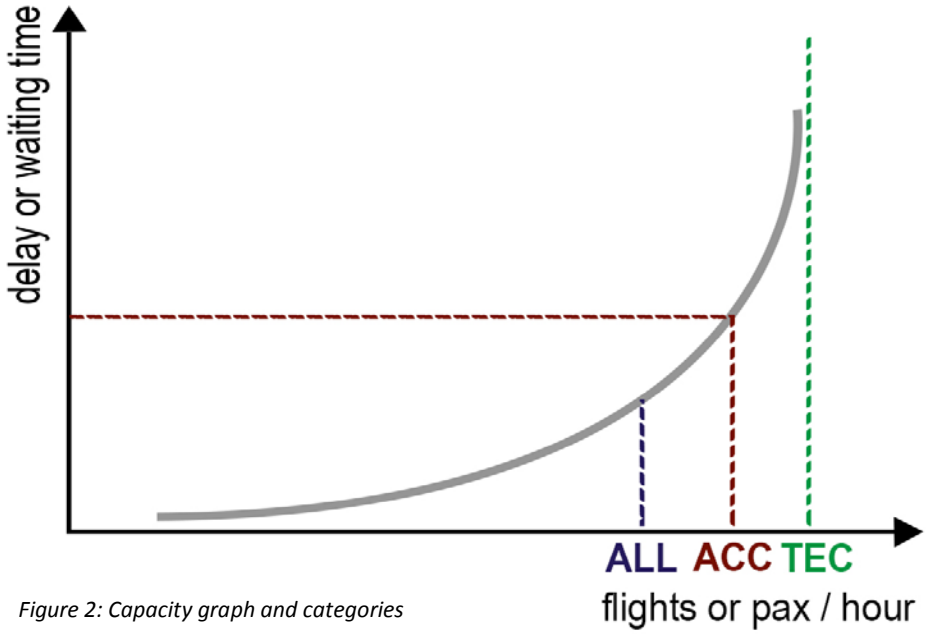


Figure 2: Capacity graph and categories

Technical capacity (TEC) is reached when no additional aircraft and/or passengers can physically be accommodated; it is marked by the green dashed line in the capacity graph. The acceptable capacity (ACC) is constrained by an acceptable level of service for peak hour passengers using the airport. The red horizontal line could be, for example, a maximum acceptable waiting time of fifteen minutes for check-in. This limits practical capacity to the number of passengers, making flights per hour short of technical capacity (3). Finally, if the government determines that a limited number of aircraft is allowed because of noise restrictions, the allowed capacity (ALL) is the limiting factor.

Note that the order of reaching technical, acceptable and allowed capacity is not fixed: there may still be room for additional flights before the allowed capacity is reached, even if this requires new infrastructure and an expansion of technical capacity.

Defined by steps in the passenger journey

Another way to define airport capacity is to look at the passenger journey at an airport.

Terminal capacity is explained in many different ways: from maximum throughput to a quality standard. According to ICAO it is the number of passengers and tonnes of cargo within a certain period of time which can be processed in the terminal building (4). IATA's terminal capacity is called Level of Service (LoS): a function of the provided space per passenger and the maximum waiting time (5). Terminal capacity is therefore mainly determined by the processing stations. When a bottleneck occurs at one processing station, other processing stations may still have ample capacity left.

After passing the terminal, the passenger arrives at the gate: the area of an airport that provides a waiting area for passengers before boarding their flight (6). The maximum gate capacity of one gate must be in accordance with the type and size of aircraft at the corresponding apron (7).

The apron is the airside area of an airport used to park aircraft. Static apron capacity is the number of stands available or the number of aircraft that can occupy the apron at any given moment. Dynamic apron capacity is the number of aircraft per hour that can be accommodated, considering the time interval between successive occupancies by two different aircraft (8). Apron capacity becomes constrained when the number and size of aprons does not match the actual number and size of aircraft using the aprons.

A queue at the taxiway will occur when the maximum runway capacity is reached. This queue will only arise in the case of maximum peak hour capacity, and not necessarily in the case of maximum annual ATMs, which is more theoretical. If maximum environmental capacity is reached at one runway, aircraft may be required to use a different runway.

This categorization can be combined with the one described previously (technical, acceptable and allowed capacity). Every single stage in the process has its own technical capacity, while the allowed capacity is a sum of the whole process (Figure 3).

Defined by Period of time

A final way to relate different capacities to each other is to sub-divide them into three time periods that describe the operational limitations of the airport: annual capacity, seasonal capacity and hourly capacity.

1. Annual capacity

Airports can be limited on an annual basis by issues such as the number of ATMs, noise hindrance and air quality. For instance, AMS has a theoretical capacity of 630,000 ATMs per year, but is in fact limited to 500,000 ATMs per year (9). Example airports of noise hindrance and their related noise abatement policies include:

- LHR, which applies noise quotas during the night,
- AMS and CDG, which use annual noise budget plans (10).

Local air quality is measured on an annual basis as well. Air quality is usually defined by the Air Quality Standards of the European Commission. Each Member State, in conjunction with their airports, closely monitors air quality related to defined quotas and tries to improve it by incentivising cleaner aircraft at the airport by levying different charges on different aircraft types (11).

2. Seasonal capacity

This type of capacity is relevant if an airport experiences seasonal concentration of traffic. The degree of seasonal concentration is likely to vary between airports, but is generally expected to be higher at smaller than larger airports.

Several factors contribute to seasonal capacity:

- Country of originating passengers,
- Traffic mix (domestic versus international services),
- Service purpose of the airport (e.g. airports that only serve holiday areas).

Ibiza Airport serves as a key example of an airport that deals with seasonal capacity fluctuations. Passenger demand is concentrated during summer months between May and October, with a peak in August. This concentration of demand is further highlighted by the fact that demand during the peak month August is 10.3 times greater than in January (12).

3. Hourly capacity

In general, each airport is constrained by a declared and operational capacity per time unit. The operational hourly capacity is defined in peak-hour operations that put the operational limitations of the airport in relation to the runway, taxiway, terminal passenger and aircraft stand capacities.

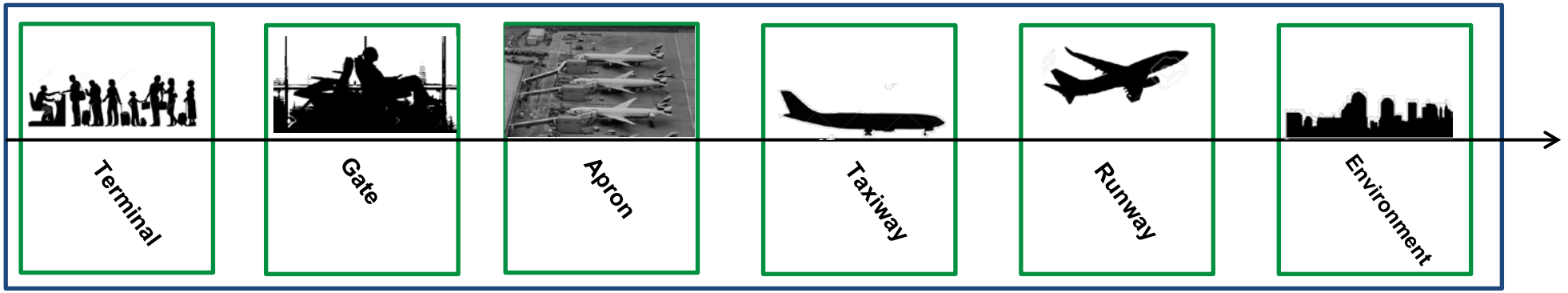


Figure 3: The influences of the different stages of the passenger journey on each other.

One frequently applied method is the peak hour volume (PHV) of an airport, which is an hourly figure that takes into account a specified level of service as well as other quality standards. This is especially relevant for hub airports, because flights are often scheduled in waves. This means that a substantial number of incoming flights has to be accommodated in a short period of time (inbound bank), followed by an outbound bank of departing flights. A variation to the PHV is the 5% PHV, which describes the number of ATMs that could be handled 95% of the time (1). This implies that capacity may be insufficient at absolute peak moments, resulting in sub-par quality standards and delays.

Conclusion

In order to resolve airport congestion in the long run, it is important to view all different constraining elements as part of the larger airport system. It must be acknowledged that the individual sub-capacities affect each other and that solving one part may shift problems to another. It is imperative to consider the airport as a whole and include all stakeholders in order to determine the most appropriate and sustainable way of mitigating congestion.

References

Introduction

P.S. Senguttuvan (2006). *Economics of the Airport Capacity System in the Growing Demand of Air Traffic – A Global View*. Retrieved from: http://ageconsearch.umn.edu/bitstream/208018/2/2006_5A_CapacitySystem_paper.pdf

1

Gelhausen, M.C., Berster, P., & Wilken D. (2013). *Do airport capacity constraints have a serious impact on the future development of air traffic?* Journal of Air Transport Management, 28. pp. 3-13. doi:10.1016/j.jairtraman.2012.12.004

2

Mujica Mota, M.A. (2015). *Capacity Development and Optimization* [lecture notes]. Amsterdam, Netherlands: Amsterdam University of Applied Sciences.

3

Wilken, D. (2014). *Course: Airport Capacity and Slot Management.* Cologne, Germany: DLR.

4

ICAO (2004). *DOC 9626: Manual of the Regulation of International Air Transport.*

5

IATA (2014). *New Level of Service Concepts*. Retrieved from: https://www.iata.org/services/consulting/Documents/Level-of-Service-Assessment-Handout.pdf

6

Transportation Research Board (2010). *Airport Passenger Terminal Planning and Design, Volume I: Guidebook.*

7

ICAO (1999). *Aerodrome Standards: Aerodrome design and operations.* Retrieved from: http://www.icao.int/safety/implementation/library/manual%20aerodrome%20stds.pdf

8

Sherry, L. (2009). *Airport Gate and Ramp Capacity.* George Mason University. Retrieved from: http://catsr.ite.gmu.edu/SYST460/Taxiway%20and%20Ramp%20Capacity%20Workbook.pdf

9

FlightGlobal (2015). *Lelystad cleared to serve as Schiphol relieve airport.* Retrieved from: www.flightglobal.com%2Fnews%2Farticles%2Flelystad-cleared-to-serve-as-schiphol-relief-airport-410983%2F&usg=AFQjCNEf4ebUonoQ6dFGYDSwGrB4eOrd4g&sig2=9gY1ckuKinWx4bYq8hc8vA.

10
Kuiper, B., Visser, H., & Heblij, S. (2011). *Efficient use of the noise budget at Schiphol airport through minimax optimization of runway allocations.* (No. 1). Virginia Beach, VA: AIAA Aviation.
11
European Commission. (2015). Air quality standards. Retrieved from: http://ec.europa.eu/environment/air/quality/standards.htm
12
Halpern, N. (2011). Measuring seasonal demand for Spanish airports: Implications for counter-seasonal strategies. *01-08-2011, 1*(1), 47-54.

Image references

Front page
Daan van der Heijden - Aviation-Photography.nl
1
Source: Author
2
Source: Author
3
Source: Author

Dutch summary

De luchtvaartindustrie is een snel groeiende sector en het aantal vluchten neemt volgens verwachtingen in de komende decennia alleen nog maar toe. Echter is de beschikbare infrastructuur in de vorm van luchthavens schaars en vormen capaciteitsproblemen een potentiële bedreiging voor het accommoderen van de toekomstige vraag naar luchttransport. Het begrip “luchthavencapaciteit” kent geen eenduidige definitie: er bestaan verschillende sub-definities afhankelijk van de manier waarop naar luchthavens gekeken wordt. Verbanden tussen de individuele definities kunnen op drie manieren worden gelegd:

1. Onderscheid tussen technische (fysieke), acceptabele en toegestane capaciteit.
2. Onderscheid aan de hand van de stappen die een reiziger op de luchthaven doorloopt.
3. Onderscheid tussen capaciteit op uur-, seizoens- en jaarbasis.

Om tot een duurzame oplossing van luchthavencongestie te komen is het belangrijk om de infrastructuur als één systeem te zien en te onderkennen dat oplossingen voor een van de capaciteitsdefinities in veel gevallen invloed hebben op andere onderdelen.

This is a Luchtvaartfeiten.nl / AviationFacts.eu publication.

Authors: J. Boonstra, J. Turkenburg & J.C. de Wit
Editorial staff: R.J. de Boer PhD, G.G.M. Boosten MSc & G.J.S. Vlaming MSc

Luchtvaartfeiten.nl is an initiative by the Aviation Academy at the Amsterdam University of Applied Sciences (HvA). Students and teachers share knowledge with politicians and the general public to ensure that discussions are based on facts.

July 2016