Benchmarking Airport Productivity and the Role of Capacity Utilization
– A Study of Selected European Airports[1]

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Abstract

The importance of benchmarking studies among airports is widely acknowledged, more so with the impact of liberalization on aviation, the trend towards airport privatization and the need to improve the regulatory framework and to provide reliable information about the performance of airports. Numerous known benchmarking studies try to establish ways to measure an airports' overall performance, but contrary to financial indicators, a lack of practical operational capacity measures has been recognized and subsequently lead to this study.

This study emphasises the question of operational capacity measures as indicators of technical efficiency of airport infrastructure (runways, apron and passenger facilities) and the associated capacity utilization. Econometric methods, like the Data Envelopment Analysis (DEA) or Total Factor Productivity (TFP), are used to measure total airport productivity. We analyze how labour, capital and other physical inputs are combined into outputs, like number of passengers, number of aircraft movements or total revenues.
The importance of physical inputs for this analyses and the thorough understanding of the underlying production process are pointed out. But the currently used indicators for physical inputs (number of runways, length of runways, runway area or some other measure for runways characteristics, number of gates, number of check-in-counters, terminal area and others for passenger facility characteristics, number of parking positions and loading bridges for apron characteristics etc) eventually fall short in describing airport performance and depicting the dynamics of the airport system, especially on a day-to-day basis.
We know that from an engineering perspective, the maximum productivity of an airport system is limited by the maximum capacity, e.g. the maximum number of flights per time period, of each subsystem. Especially runways are believed to be the most crucial peace of infrastructure of an airport, and its maximum throughput capacity dictates the ultimate limit of airport productivity.

This study analyses the productivity of 58 European airports and its use of infrastructure, based on the annual and design peak hour (DPH) runway and terminal demand, ultimate and maximum declared capacity and capacity utilization. To make airports comparable regarding the capability of the airport system to serve demand., an effort has been made to isolate peer groups with similar productivity characteristics. Also a rule-of-thumb methodology for isolating an airport's DPH for benchmarking purposes has been proposed.

The ultimate runway capacities have been calculated on the basis of the Federal Aviation Administration (FAA) methodology, taking runway and airfield layout, preferential runway system, prevailing weather and visual conditions, aircraft characteristics and airport specific limitations into account. Furthermore we focus on the effect of capacity utilization on service quality, i.e. measured "aircraft delay", which sharply increases with runway capacity utilization, as airside congestion rises as saturation is approached.

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Aircraft delays have been calculated as an estimated annual total delay and as annual average delay per aircraft. Airports must be managed in such a way that an acceptable level of service quality, e.g. a maximum of four minutes delay per aircraft on average, is guaranteed for the airlines and passengers throughout the day and during common peak periods. But in reality, competing airlines schedule their flights during similar times of day, which leads to higher demand than available capacities and therefore to aircraft delays during peak hours.

In a further step delays per aircraft per hour have been calculated through SIMMOD simulation for 18 single runway airports and two parallel runway airports. Then growth scenarios have been applied to the current level of traffic, to estimate, when the ultimate runway capacity of each simulated airport is likely to be reached.

Annual and daily demand data has been obtained from EUROCONTROL for the years 2003-2007 and from Official Airline Guide (OAG) and Flightstats.com for daily traffic data during peak and off-peak periods. Furthermore data on maximum slots per hour/maximum declared runway capacity and maximum declared terminal capacity has been taken from 2003 IATA Capacity/Demand Profiles and from the national slot coordinators websites. On this basis, the relationship between the ultimate capacity for IFR and VFR flights, the maximum declared capacity and the demand is shown over the time of day. We also show the demand peaks and specifically the peak hour(s) at each airport and the relationship between annual flights, peak-hour flights, annual passengers and peak hour number of passengers, where "assumption rectangles" (Adib Kanafani 1981) have been calculated. Average numbers of seats during the peak hour at airports have been extracted from the traffic data, which included the aircraft type for each scheduled flight. With estimated and calculated seat load factors the number of seats could be translated into the number of boarded passengers for passenger facility calculations.

To have an impression of the efficient use of the runway system, capacity envelopes have been constructed for each airport, given different departure and arrival streams of aircraft. The envelope describes all maximum possible combinations of departing and arriving flights. From the simulation reports it was possible to plot cumulative flow charts, with service and demand graphs, which reveal the number of queued aircrafts and the amount of delay per flight per time of day. Also demand diagrams with the corresponding average delay per aircraft per hour of day have been plotted for all simulated airports.

As an outcome of the study we have been able to use further insight into airport operations in order to be able to find more consistent measures for an overall performance analysis. It should also be possible to use these operational measures to be able to evaluate how airports combine inputs of various kinds, financial or operational. Though demand, growth, fleet mix, scheduled flights, number of (transit) passengers could be considered beyond managerial control, the provision of an acceptable level-of-service and sufficient current and future capacity to meet demand is an essential task of airport management.
This study could be expanded into a strategic planning tools by identifying the most congested airports, which need further investment in additional capacities. Also an extension of the study is possible to monitor the effect of peak and off peak pricing capacity utilization over time.

This approach has helped us to understand better an airports operation and the production process. The accumulated operational data can now be enriched with financial and airport charges data to have a much richer overview of the whole value chain and monetary streams of the aviation site of an airport.