BENCHMARKING FOR DESIGN OF MAJOR AIRPORTS WORLDWIDE

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ABSTRACT

This note presents for the first time the concept of benchmarking of airports from the perspective of designers and planners. Benchmarking is valuable for three reasons: it provides basic data otherwise difficult to obtain, defines world class standards for facilities, and identifies priorities for improving the physical design at individual airports. Effective benchmarking thus focuses on objective data of capacity or performance that can be measured and observed across widely different operations, rather than on data that is either subjective derived by from widely different accounting practices.

The note illustrates the approach by comparing availability of airside and landside facilities at the comparable major airports worldwide, those that handled between 12 and 26 million annual passengers, for which data were available. This initial comparison underlines the fact that airports worldwide differ enormously in the relative amount of facilities they provide, and suggests which airports might require additional investments to reach the best worldwide levels. An application of benchmarking to the México City International Airport demonstrates the usefulness of the concept.

KEYWORDS

Benchmarking, Airports, Design, Airport landside, Airport airside, Aviation passengers, Aircraft operations, México City.

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INTRODUCTION

The purpose of this note is to present the concept of benchmarking for design of airports. It is motivated by the observation, based on worldwide experience, that the persons interested in the design of airports -- that is owners, operators, airline users or community leaders -- frequently have only very limited access to data and understanding of what best practice worldwide might be. To compensate for this lack of information, designers and clients for particular airport developments routinely take whirlwind international tours which can neither give them a deep appreciation of what is possible, nor provide hard data which may be shared with all the interested parties that were unable to participate in the visits.

Designers and clients for major airport projects need access to better information on worldwide best practice. This note indicates both how this might be done, by discussion and example. The difficulties encountered in developing this first preliminary example of benchmarking of airports for design provide a basis for discussion of the concept and suggest areas of needed improvement.

BENCHMARKING CONCEPT

Benchmarking is the process of comparing the performance or capacity of any enterprise, measured in several ways, with that of the best in the industry. It is a relatively new process, that was developed to help manufacturing industries respond to international competition. With the globalization of the airport industry, through the grouping of airlines into intercontinental partners on the one hand, and the worldwide financing of airports by global investment bankers on the other, individual airports are increasingly being compared on a worldwide basis. It is time to apply benchmarking to airports.

Benchmarking is useful because it helps planners and designers identify the areas in which their organization is below the world-class standards, and thus needs improvement (Chang and Kelly, 1994). This is a critical task because organizations easily become satisfied with their own procedures, and they need to be alerted to the current global standards of performance. As expressed by Greene (1993):

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> "Benchmarking is a critical technique for making organization transformation easy. It provides the authority for change. Provoking the humility for change, it breaks the spell of an organization's excessive self-love and narcissism. Many of the major quality approaches are major changes of business assumption and behavior. Justifying such major change is hard, especially in the beginning, before intermediate results are available. Benchmarking provides justification, in spades... ".

Perhaps the best known example of benchmarking is the MIT study of the automobile manufacturing (Jones, Roos, and Womack, 1990). This in-depth analysis of the performance of automobile factories worldwide helped catalyze significant changes in production processes in North America and elsewhere, by helping managers and designers recognize what they had to do to achieve world class standards.

Benchmarking is applicable to any organizational process, whether it is a production or a service, in the private or the public sector. This initial application to major airports is designed to stimulate discussion of the process in airport planning and design.

To date, benchmarking has been applied to airports in two ways. These focus either on some measures of customer satisfaction or on economic efficiency. Neither of these is directly useful to designers.

Various organizations periodically conduct surveys of airport performance, based on subjective surveys of passengers' appreciation of such issues as "customs efficiency" or "availability of baggage trolleys" (for examples, see: Australia, 1992, 1994 and 1995). These measures are systematically inappropriate for worldwide comparisons because they are based on widely different customer perceptions of what constitutes good service. For example, a European air passenger accustomed to being required to arrive at the airport 1 to 2 hours before a flight, may find that a processing time of 30 minutes provides good service, whereas an American or Singaporean passenger used to much faster service might judge 15 minutes of processing time to be unacceptable. Thus an equivalent objective level of performance is rated quite differently across the world, and the subjective comparison is virtually meaningless.

Several groups have carried out studies aimed at comparing the economic performance of airports. Doganis et al. (1992, 1994 and 1995) have done this for the United Kingdom, Europe and Australia. Cooper and Gillen (1995) and Gillen (1996) have done something similar for California and Toronto. These reports can be interesting to investors, airport regulators and

managers of individual airports, but do not provide the basis for worldwide comparison. This is because the economic profitability of airports depends both on the division of the responsibility of services between the airport operator and the airlines or other third parties, and on locally imposed financial objectives. For example, airport authorities in the United States are not intended to be "profitable" -- they are typically expected to cover the costs of raising capital (with a ratio of coverage) and to pass on any possible profits to the aviation industry in the form of lower charges for their services -- thus no matter how efficiently these airports are operated, they would rank low on the basis of profitability. Comparisons between airports on the basis of economic performance must therefore be viewed with caution. In any case, these economic comparisons are not immediately useful for design.

Designers and owners of new airport projects typically want to know how their existing or prospective facilities compare with others. How do our facilities compare with those elsewhere? Will our new passenger building be at a world-class standard? What is the world-class standard to which we might aspire?

Benchmarking for designers should thus focus on the amount of capacity provided, on the basis that -- from the customers' point of view, more capacity (in terms of parking spaces, check-in facilities, runways) leads to better service and lower delays. For the designer aspiring to provide excellent service, the space per passenger available in the transit lounges at Singapore is about the best available and (many customers believe) sets the worldwide standard of excellence. Whether this level of capacity and service can be justified economically is an important question, of course. But the decision about what level of service to provide is different from the question of what the worldwide standards best design might be. As the purpose of benchmarking for design is to identity the best levels of design, this benchmarking focuses on capacity provided.

BENCHMARKING STEPS

The process of benchmarking involves four steps. To illustrate the approach and concurrently identify issues to be resolved in subsequent comparisons, these steps were applied to major airports worldwide. These steps and their application are discussed below (for details see Rojas Guzmán, 1995). The steps are:

1. The identification of key measures of performance or capacity;
2. The selection of comparable facilities worldwide;
3. The collection of the relevant data;
4. The analysis of the data and the consequent ranking of the facilities worldwide.

Key Measures: In benchmarking for design it is best to focus on measures of physical capacity. These can be identified relatively easily and objectively -- the number of runways or the size of the facilities is fairly evident for example, although caution must be exercised. In fact, the performance of any airport depends on both the available physical capacity and the effectiveness of the personnel. The performance of the staff is however both extremely difficult to measure in principle, and quite impractical as of now. In any case, the performance of the staff is the responsibility of the managers, not the designers.

Considering the difficulty of obtaining comparable data from all over the world, this first benchmarking of airports focused on fairly clear and simple measures of capacity. For the airside, these were:

1. The number of full-length runways;
2. The number of gate positions with and without bridges; and
3. The area of the airfield.

For the landside, the measures of capacity were:

1. The number of baggage claim devices;
2. The number of ticket counters;
3. The number of parking spaces; and
4. The landside area available.

To compare facilities fairly, the measures of capacity has to be normalized with respect to the traffic using the airport. For the airside, the number of aircraft operations for the airside defines the traffic. For landside, the number of passengers originating from a metropolitan area (which is not the same as the number of departing passengers, as the latter term includes transfers) defines the traffic for operations that involve access or egress to the airport such as check-in, parking, pick-up of bags; the total number of passengers, including the transfers who only change between aircraft, defines the traffic when considering facilities that all passengers use.

Airports benchmarked: The focus for this initial application is on major airports because they have the largest problems and are more interesting from the point of view of design. The criterion for selecting airports was their number of annual passengers, which is a good indication of the type of operations and infrastructure at an airport.

To emphasize comparability, the focus was furthermore on the fairly large group of similarly sized airports, all those worldwide which handled between 12 and 26 million passengers in 1992, the year for which the latest data was available for this application.

The ten busiest airports worldwide that each handled more than 26 million passengers in 1992 were excluded from this demonstration of benchmarking. These airports, such as Atlanta, Chicago/O'Hare or London/Heathrow, could be included in a later, more complete study beyond the scope of this note. Table 1 lists the 40 airports selected for this initial benchmarking (Airports Council International, 1992).

Data Collection: Getting detailed current information about airports is not easy. Despite worldwide personal contacts at most of these airports listed in the study, much of the data are not available. Remarkably, airports often do not have information on the items listed in the previous section readily or unambiguously available. Airport authorities were contacted and followed up by telephone and mail within North America, and by mail and fax in Europe and Asia. The process took 8 months.

The 83% response rate was reasonably high. Unfortunately, several responses did not provide appropriately detailed or current data. Moreover the data provided often omitted a number of categories of information. As a result, detailed benchmarking was appropriate for only 24 major airports.

In all cases the data reported was reviewed carefully for comparability to the data reported for other airports. As experienced practitioners recognize, many common items are reported quite differently by different airports. For example, some airports only keep track officially of the parking spaces they provide, others try to account for the number of spaces available at the airport to the traveling public, for example through third-party operators. Based on knowledge or experience at most of the airports compared, a best effort was made to ensure comparability.

Analysis and Ranking: The ranking of the airports in this preliminary benchmarking was based on the ratios of the available capacity per unit traffic for the factors for which the most data were consistently available across the airports. As additional data becomes available, other factors could be included.

Based on the best data available at the time, Tables 2 and 3 indicate the rankings for the individual elements of the airside and landside elements. For this first exercise, it is recognized that better data could be provided, and it is hoped airports will provide this information. The airport with the highest capacity in each category is ranked number 1.

Table 4 shows the overall rankings for airside, landside and the total airport. The highest measures represent the most capacity available per unit of traffic -- and thus the best from the perspective of the users. The overall rankings reflect a balance between the rankings for individual components of these categories.

For this exercise, these rankings are based on the sum of the normalized measures of capacity in each category, the normalization being taken with respect to the best in the class. Specifically the indices for ranking each airport were obtained from the formulas:

Airside Ranking = [(Runways/Op + Position/Op + Area/Op) Normalized ratios]

Landside Ranking = [(Parking Spaces/Pax + Area/Pax) Normalized ratios]

Total Ranking = [(Runways/Op + Position/Op + Area/Op + Parking Spaces/Pax + Area/Pax) Normalized ratios]

Applying these to México City, for example, one obtains using rounding of the numbers to clarify the expressions:

Airside Ranking = [9/24 + 302/668 + 8972/81061]

Landside Ranking = [203/2367 + 118/699]

Total Ranking = [9/24 + 302/668 + 8972/81061 + 203/2367 +118/699]

Once these calculations have been applied to all airports, the overall airside, landside and total airport rankings follow.

APPLICATION OF BENCHMARKING TO MÉXICO CITY

This benchmarking was used to show how designers and managers could use worldwide benchmarking to assess how their airport compares with world class airports, and to indicate the areas in which their airport falls short of international expectations and improvements might be most desirable.

México City International Airport (AICM) provides the example. Using the full set of information contained in Rojas Guzmán (1995), the relative standing of AICM was calculated for each measure of capacity. Table 5 presents the results.

The benchmarking study indicates that México City International Airport is in the last quartile of the major airports worldwide, along with the most congested facilities at New York/LaGuardia and Fukuoka. The detailed diagnostics indicate that AICM is near the bottom of the class when it comes to aircraft positions with connecting bridges; baggage claim devices; and parking spaces.

This list thus identifies the facilities that might most urgently need to be improved to bring México City International Airport up to worldwide standards.

CONCLUSIONS

Most obviously, the effort reported here indicates that benchmarking airports for design is possible and, as the example of México City illustrates, can provide useful guidance.

Benchmarking is not easy however. Data are difficult to obtain, and are often not fully comparable when available -- even for physical characteristics which one might think are obvious and easy to count or measure. More subtle characteristics of airports, while potentially more interesting, are likely to be much more problematic.

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Table 1: Major Airports Worldwide, Handling 12 to 26 Million Annual Passengers.

Region	Country	City	Data Available
America	Canada	Toronto	X
	México	México City	X
	U.S.A.	Boston	X
		Charlotte	X
		Detroit	X
		Honolulu	X
		Houston/Intercontinental	X
		Las Vegas	X
		Miami	
		Minneapolis/St. Paul	X
		New York/LaGuardia	X
		New York/Newark	X
		Orlando	X
		Philadelphia	X
		Phoenix	X
		Pittsburgh	X
		Salt Lake City	X
		Seattle	X
		St. Louis	X
		Washington/National	X
Asia	Australia	Sydney	X
	Hong Kong	Hong Kong	X
	Japan	Fukuoka	X
		Osaka	
		Sapporo	
		Tokyo/Narita	X
	Singapore	Singapore	X
	Korea	Seoul	
	Thailand	Bangkok	X
Europe	Denmark	Copenhagen	
	France	Paris/Orly	X
		Paris/de Gaulle	X
	Germany	Düsseldorf	X
	Italy	Rome	
	Netherlands	Amsterdam	X
	Spain	Madrid	X
	Sweden	Stockholm	X
	Switzerland	Zürich	X
	U.K.	London/Gatwick	X
		Manchester	

Table 2: Airside Ranking of Major Airports, Capacity per Million Annual Operations

Rank	Runways		Positions		Area	
1	Honolulu	24.39	Madrid	668.45	Orlando	81060
2	Amsterdam	19.23	Bangkok	548.87	Pittsburgh	46641
3	Salt Lake	17.75	Orlando	546.96	Salt Lake	44379
4	Detroit	17.61	Tokyo/Narita	520.66	Houston/Interc.	39301
5	Houston/Interc.	17.47	Singapore	480.00	Detroit	23592
6	Orlando	16.57	Paris/Orly	427.86	Singapore	21413
7	Boston	16.13	Düsseldorf	395.21	Charlotte	20325
8	Pittsburgh	15.44	Amsterdam	392.31	Paris/Orly	19080
9	Zürich	15.23	Pittsburgh	386.10	Madrid	15701
10	Bangkok	15.04	Houston/Interc.	358.08	Toronto	14471
11	Paris/Orly	14.93	New York/EWR	349.26	Tokyo/Narita	13884
12	Sydney	13.39	Toronto	343.14	Honolulu	13415
13	Singapore	13.33	Phoenix	325.26	Sydney	9263
14	Charlotte	12.20	Detroit	313.38	Bangkok	9105
15	Düsseldorf	11.98	México City	302.33	Zürich	9086
16	New York/EWR	11.03	Salt Lake	301.78	Düsseldorf	9072
17	Madrid	10.70	Fukuoka	291.67	Fukuoka	9010
18	Fukuoka	10.42	Boston	270.97	México City	8973
19	Toronto	9.80	New York/LGA	268.38	Seattle	8689
20	México City	9.30	Seattle	267.86	New York/EWR	8456
21	Tokyo/Narita	8.26	Honolulu	262.20	Boston	9105
22	New York/LGA	7.35	Charlotte	260.17	Amsterdam	7692
23	Seattle	7.14	Zürich	228.43	Phoenix	7031
24	Phoenix	6.92	Sydney	116.07	New York/LGA	2390

Table 3: Landside Ranking of Major Airports, Capacity per Million Annual Originating and Terminating Passengers

Rank	Parking Spaces		Area	
1	Pittsburgh	2367	Orlando	699
2	Seattle	1596	Pittsburgh	657
3	Salt Lake	1313	Houston/Interc.	446
4	Amsterdam	1297	Salt Lake	429
5	Houston/Interc.	998	Charlotte	291
6	Toronto	997	Detroit	277
7	Detroit	992	Toronto	216
8	New York/EWR	879	Madrid	167
9	Phoenix	811	Singapore	161
10	Paris/Orly	705	Paris/Orly	151
11	Madrid	702	Zürich	132
12	Charlotte	678	Seattle	129
13	New York/LGA	604	Sydney	124
14	Tokyo/Narita	587	México City	118
15	Düsseldorf	548	Düsseldorf	116
16	Boston	511	Boston	102
17	Zürich	462	Honolulu	96
18	Orlando	460	Amsterdam	94
19	Honolulu	440	New York/EWR	89
20	Sydney	375	Phoenix	86
21	Singapore	292	Tokyo/Narita	76
22	Bangkok	207	Bangkok	65
23	México City	203	Fukuoka	62
24	Fukuoka	103	New York/LGA	33

Table 4: Overall Ranking of Major Airports, Airside and Landside and Total

Rank	Airside	Landside	TOTAL
1	Orlando	Pittsburgh	Pittsburgh
2	Pittsburgh	Orlando	Orlando
3	Houston/Interc.	Salt Lake	Salt Lake
4	Salt Lake	Houston/Interc.	Houston/Interc.
5	Madrid	Seattle	Detroit
6	Honolulu	Detroit	Madrid
7	Bangkok	Toronto	Amsterdam
8	Singapore	Charlotte	Paris/Orly
9	Paris/Orly	Amsterdam	Singapore
10	Detroit	Madrid	Honolulu
11	Amsterdam	Paris/Orly	Charlotte
12	Tokyo/Narita	New York/EWR	Toronto
13	Düsseldorf	Phoenix	Bangkok
14	Boston	Düsseldorf	Seattle
15	Charlotte	Zürich	Tokyo/Narita
16	Toronto	Boston	Düsseldorf
17	New York/EWR	Tokyo/Narita	New York/EWR
18	Zürich	Singapore	Boston
19	Fukuoka	Sydney	Zürich
20	México City	Honolulu	Phoenix
21	Phoenix	New York/LGA	México City
22	Sydney	México City	Sydney
23	Seattle	Bangkok	Fukuoka
24	New York/LGA	Fukuoka	New York/LGA

Table 5 : Benchmarking Diagnostics for México City International Airport, AICM

Situation	Parameter	Airports better than AICM (%)
Landside	Ticket counters	50
	Parking spaces	96
	Area	60
	Baggage claim devices	94
Airside	Runways	73
	Positions with bridge	95
	Positions total	60
	Area	76
	Baggage claim devices	69
Overall	**Average**	**75**

Benchmarking of airports facilities and performance is not a common practice in commercial aviation. This is true among countries and also among airports located in the same country, which have different authorities in charge of operating and managing them. As a consequence, there are very few detailed comparisons of airports. In the few studies available to the general public in libraries or transportation department offices, the data is not updated and is incomplete.

* Note. For all U.S. airports, the number of operations used is that of certificated route air carriers only. In all other cases, except for the AICM, this data was not available. It was considered that general aviation and air taxis operations are not directly related with many of the airport facilities included in this study.

Formulas

Airside Ranking = Ranking [Sum individual airside normalized ratios]

Landside Ranking = Ranking [Sum individual landside normalized ratios]

Total Ranking = Ranking [Sum individual airside and landside normalized ratios]

For example: AICM

Airside Ranking = Ranking [(Runways/Op + Position/Op + Area/Op) Normalized ratios]

= Ranking [9/24 + 302/668 + 8972/81061]

Landside Ranking = Ranking [(Parking Spaces/Pax + Area/Pax) Normalized ratios]

= Ranking [203/2367 + 118/699]

Total Ranking = Ranking [(Runways/Op + Position/Op + Area/Op + Parking Spaces/Pax + Area/Pax) Normalized ratios]

= Ranking [9/24 + 302/668 + 8972/81061 + 203/2367 + 118/699]

5 IMPROVEMENTS NEEDED

As can be seen, even though this is a logical commonly used criterion to analyze data, the obtained airport ranking gives the rank of the airport in terms of the capacity of only some facilities and not the capacity or the quality of service of the whole airport. Besides that, there are many other variables that were not considered in this study.

For example: Airports handling high percentages of wide body aircraft require fewer runways to handle the same number of passengers than airports handling a mix of aircraft. In this study the type and mix of aircraft handled by each airport is not considered. In addition, car ownership per passenger is low in some countries; a low capacity of parking spaces per passenger is not

representative of the quality of service in the parking area. This is also true for airports with a high percentage of foreigner passengers.

5 CONCLUSIONS

It is a fact that better and more complete data are required to improve the soundness of this study, however, the obtained results are very useful. This study is just a brief introduction of what can be achieved with the benchmarking practice.

Even though many variables were not considered in this benchmarking study and not all the numbers used in it are precise or the most appropriate ones, the obtained final results give us a sound global guide of where each airport stands and where improvements need to be focused in order to maintain a certain level of service.