Airport benchmarking: a review of the current situation

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This is an electronic version of an article published in Benchmarking, 12(2), pp. 99-111, 2005. Benchmarking is available online at:

http://www.emeraldinsight.com/10.1108/14635770510593059

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A Review of the Current Situation

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Abstract

Purpose

To provide an overview of the current attitudes and practical experience of airport benchmarking.

Design/methodology/approach

A range of benchmarking studies are critiqued. The paper considers the partial performance measures which are used from an economic, operational and environmental perspective. It also investigates more complex modelling approaches which have been undertaken to gain greater insight into an airport's overall performance. In addition an assessment is made of the role of benchmarking in airport regulation.

Findings

The paper finds that benchmarking techniques have become more well established in recent years within the airport sector. However there is still some way to go in overcoming some of the problems which inhibit effective benchmarking on a truly international basis.

Research limitations/implications

The paper focuses on methodological issues and does not discuss the findings of research in this area.

Practical implications

A very useful source of information for all researchers in academia and industry who wish to use airport benchmarking techniques.

Originality/value

The paper provides a comprehensive and unique review of the benchmarking techniques currently in use for airports.

Key words

Benchmarking; Airports; Performance Measures; Regulation

Paper Type

General Review

Introduction

Benchmarking within the airport industry has only really begun to be accepted as an important management tool during the last fifteen to twenty years . Prior to this, commercial and business pressures within the airport sector were less pronounced and airports were under government ownership – at a time when benchmarking techniques were not widely used by the public sector. Moreover airport benchmarking was viewed as a particularly difficult task because of the diversity in the outputs, inputs and operational environment. These perceived difficulties only further hindered any attempt to seriously develop comparative performance measures.

However, in recent years various developments have encouraged the airport industry to change its attitude towards benchmarking. Many airports, particularly in Europe, have become very much more commercially oriented and have adopted a much more businesslike management philosophy. This transformation away from the view of airports as public utilities towards being considered as commercial enterprises has naturally led to airports seeking ways to gain insights into their operations and to improve their performance by benchmarking themselves against others. In some case commercialisation has been taken to its limits by the airports severing their links with their government owners, through some type of privatisation process. This has involved the transfer of the management of an airport, and in many cases the ownership as well, to the private sector. This movement towards privatisation in the industry has also led to the beginning stages of airport globalisation with the emergence of a few global airport companies who are operating at an increasing number of airports around the world (Graham, 2003).

A major result of these developments is that many airports no longer see their role as merely providers of infrastructure. Instead they view themselves more and more as just any other industry which requires a wide range of business competencies and skills together with the adoption of effective management and business techniques, including benchmarking. Moreover the increased airline competition brought about by deregulation and liberalisation in the USA, Europe and a growing number of other airline markets, has placed airports themselves in a much more competitive environment where they are now under greater pressure to find out about the performance of their competitors through benchmarking.

There is thus a growing recognition amongst airport operators and other organisations involved with the airport industry of the value of continuous performance appraisal and the use of benchmarking. The increasingly competitive airline industry, which is operating in a much more cost-conscious environment particularly post September 11 and other recent events, is keener than ever before to identify any airport which is being inefficiently managed or which is providing a poor quality of service. Government regulators of airports

also have a need to investigate these performance areas when establishing or reviewing the regulations which they set. Investors and bankers which are interested in airport privatisation want to use benchmarking techniques to identify possible business opportunities.

The result of these diverse interests in airport performance means that benchmarking is now needed to consider a number of different aspects of an airport's business. Lemaitre (1998) described how the measurement of airport performance can be viewed from three general management perspectives: financial ; marketing ; and the operational perspective. Her definition of financial performance included the use of traditional accounting ratios which are used in most industries, such as return on capital employed, debt: equity ratio and (for the publicly quoted companies) enterprise value and price earnings ratio, as well as more specific airport economic indicators which involve defining specific measures of airport inputs and outputs. This paper concentrates on the economic indicators since they are unique to the airport industry, unlike the financial ratios. Lemaitre defined the marketing measures as those which look at passenger satisfaction with airport services in terms of, for example, crowding, comfort and signing . These are based on passenger perception, usually using passenger surveys. By contrast operational measures, such as capacity utilisation, waiting time and queue length are indicators based on the operator's measurements of the service provided or delivered service. In this paper the marketing and operational measures are considered together as they are very closely inter-linked. In recent years the environmental perspective and the measurement of environmental good practice has also become increasingly important particularly in the key areas of noise and emission, and in terms of waste/energy management and use of public transport. Hence this area of performance monitoring is briefly considered as well.

Economic Performance Indicators

There are a number of methodological issues which need to be resolved when any economic benchmarking exercise is to be undertaken. Financial and physical measures of inputs and outputs have to be defined. As regards the financial measures, there is a particular problem related to capital inputs such as depreciation and asset values since accounting procedures vary quite considerably. This situation is clearly not unique to the airport industry but the problems tend to be more acute since some publicly owned airports adopt government or public authority accounting methods rather than commercial practices. With government-owned airports it is possible, for example, to find that the airport's land will not be considered to be an airport's asset and hence will not appear in any balance sheet. In addition views related to how assets should be depreciated differ. For example the UK airport company BAA depreciates runways for up to 100 years while Amsterdam airport uses 30 to 40 years and the French company Aeroport de Paris uses just 10 to 20 years. Ideally, the accounts of each airport

need to be adjusted to conform to a common set of rules but normally this is too difficult a task. In addition, determining a reliable physical measure of the capital input, namely the production capability or capacity of the system, is also very difficult. An airport's capacity cannot be assessed by one measure. The capacity of the runways, terminal, gates and other infrastructure all have to be considered and these can all be measured on an hourly, daily or annual basis.

The physical output of an airport can be assessed in three key ways: in terms of quantities of aircraft, passengers or freight. The use of aircraft movements or air transport movements (ATMs) is not ideal as such measures will not differentiate between different sizes and different types of aircraft but they are important when the performance of airfield operations is being considered. Some argue that the freight output is relatively unimportant since freight handling at airports is very much an airline activity and has little impact on an airport's economic performance. Some measures which are used combine these different outputs into one single aggregate measure. The Work Load Unit (WLU), which is the most popular measure, originated from the airline industry and uses a weight criteria for combining passenger and freight traffic (i.e. one WLU = one passenger or 100 kg of freight). This is clearly a very arbitrary method of linking the two outputs since the same weight of passengers and freight does not involve using the same resources, not does it generate the same revenue (Vallint, 1998). Research undertaken by the Transport Research Laboratory (TRL) has suggested the use of the airport throughput unit (ATU) which combines output measures of WLUs per ATM (i.e.average aircraft size) and WLUs (TRL, 2002a).

These various inputs and outputs, measured in both financial and physical terms, can be used to produce indicators related to cost efficiency (e.g. cost per passenger or WLU), revenue generation (e.g. revenue per passenger or WLU) and staff productivity (e.g. revenue per employee) A full list of the most popular measures is shown in Table II. In 2000, a survey of 200 of the world's largest airports was undertaken by the UK Open University and Loughborough University to investigate how airports themselves were measuring their performance (Francis et al, 2001). Some of the most popular economic measures used were found to be cost per passenger and total, aeronautical and non-aeronautical revenue per passenger whilst revenue per WLU, for example, was a much less used indicator.

The information needed for these basic performance indicators is normally available from sources in the public domain, such as individual published reports and accounts, but can be time-consuming to collate and analyse. Various ad hoc studies have been undertaken externally. Some of these have been used for the analysis of specific markets such as France (Assaily, 1989), Australia (Doganis, Graham and Lobbenberg, 1994) or to compare airport performance within Europe (Doganis, Graham and Lobbenberg, 1995). However, two annual publications now exist, one produced by TRL and one by the Air Transport Research Society (ATRS) which contain a number of these partial indicators for a

sample of airports from different regions of the world (TRL, 2002a; ATRS 2002). More detailed and disaggregate performance measures can usually only be produced internally within an airport unless airports agree to voluntarily provide additional information. Sometimes such analysis is published as is the case with the bi-annual study of airport retail revenues by URS Corporation, which looks at comparative values of indicators traditionally used by the retail industry such as sales per square metre of space and sales by location and type of outlet for an international sample of airports (URS Corporation, 2003). Another specific area where published benchmark figures exist is airport charges (for example see TRL, 2002b).

One of the major problems associated with comparing economic performance is that there is no 'typical' airport when it comes to looking at the services and facilities an airport provides. Beyond the basic operational functions, different airports have little in common. Some airport operators will provide activities such as security, air traffic control, handling, car parking, duty-free shops, cleaning and heavy maintenance, while others will contract these out. In the extreme case, terminals may also be leased as is the situation in the USA and Australia. All this will impact on both cost and revenue levels as well as labour/capital productivity. In some cases the situation may be even more complicated as the government may choose to pay for the provision of certain services, as is typically the case with the provision of policing, security or fire and rescue. This problem can be partly overcome by standardizing or normalizing the airport data so that each airport's performance is presented as if it undertook a uniform set of activities by taking into account the typical profit margins associated with each separate airport activity. Whilst there will obviously be an element of subjectivity in the assumptions which are made, a sensitivity analyses of adjusted standardized data for a sample of 29 global airports in 1999/2000 showed that, for example, total costs were not very sensitive to the assumed profitability of the various activities which required adjustments, with the exception of ground handling (National Economic Research Associates (NERA, 2001).

The annual TRL study produces adjusted data whilst the partial indicators used by ATRS are unadjusted. By looking at the relative ranking associated with one indicator (staff and other operating costs per passenger) for airports which are common to both samples, a crude assessment of the effect of the adjustments can be made (Table I). Generally the rankings are fairly similar. Some of the most notable differences exist with Frankfurt, Rome and Vienna which are all heavily involved in providing handling services. The Irish airport group Aer Rianta's adjusted ratio is quite different from the unadjusted ratio since this airport group, unlike most other airports, chooses to provide many commercial facilities itself rather than subcontracting these activities which substantially pushes up its relative actual unit costs. This has been adjusted for with the TRL data. Clearly with this airport group, it is apparent that comparisons of adjusted or unadjusted will produce very different results. Other key factors which may influence the results of benchmarking studies are airport size, since large airports

are likely to experience economies of scale, and the nature of traffic such as the share of international passengers, as these have higher costs and generate more revenues than domestic passengers. Some studies, such as the ATRS study, takes this factor into account. Others choose only to study airports of a similar size or traffic base.

Take in Table 1

Quality of Service and Operational Performance Indicators

Some of the indicators which are listed under economic performance measures such as WLU per employee, which depend purely on physical inputs and outputs, could equally well be considered as 'operational' performance indicators. Then there are other more disaggregate indicators which assess the service delivered and can cover areas such as queue length, space provision, waiting time, baggage reclaim time, and availability of lifts, excalators and trolleys. There have been some ad hoc studies which have compared some of these different indicators at airports but there is no established source which undertakes this on a regular basis.

Whilst a 'service delivered' approach can measure the reliability of equipment, it cannot tell whether consumers feel safe, assured and satisfied with their use of the equipment. Similarly a passenger's perception of the time that they have spend waiting in a queue may be very different from the actual waiting time. Qualitative measures, looking at passenger satisfaction ratings, are therefore also used. These measures enable the quality of service to be assessed through the eyes of users rather than airport management. Consumer surveys are usually undertaken to gather information for this qualitative measure, although comment cards and occasionally mystery shoppers are used as well. Typically the surveys will ask passengers about their usage of facilities and services and their opinion of them in terms of comfort, congestion, cleanliness, value for money and other aspects. BAA plc is an airport group which has been carrying out a continuous passenger satisfaction survey now for many years. Its quality of survey monitor (QSM) is based on a sample of over 60 000 passengers for the UK airports. It also uses this at its international airports such as Naples and Melbourne (Maiden, 2002). Such surveys, however, are often greeted with scepticism from the airline industry who feel that they should be undertaken by an independent body. For example, BA has voiced its concerns over the possible bias in the BAA's QSM (Competition Commission, 2002).

The international airport organisation Airports Council International (ACI) investigated operational and quality of service measurement at airports through a survey of its members (ACI, 2000). 45% of respondents said that they used delivered service measures, while 62% used passenger survey information. Both types of approaches were adopted by 32% of all the airports. Similarly the Open

University/Loughborough study found surveys were more popular, being used by 47% of respondents compared with a 34% use of delivered service measures (Francis et al, 2001).

The International Air Transport Association (IATA) undertakes an annual quality of service passenger survey for a sample of around 50 airports and over 80 000 passengers around the world (IATA, 2002a) The IATA survey is widely used within the airport and airline industries. However some airports feel that the sample size is too small, that it depends on which airlines participate in the survey and that it lacks sufficient detail. As a result, the ACI has been looking at the option of developing its own worldwide survey. IATA has also recently begun publishing an airport connectivity survey for around 100 airports which measures the airport comparative network performance and assesses the relative quality of connections (2002b).

Most comparative studies of airport quality look at quality from a passenger's point of view (Lemaitre, 1998). Lemer (1992) amongst others has argued that there should be more consideration of different measures for other users of the airport. Airline factors can include delays, runway capacity, cost of local labour force and the reliability of air traffic control as well as the quality of connections. Airport operators often prefer not to focus on the level of delays, primarily because there are many factors that lead to flights being delayed which are outside the airport operator's remit (e.g. en route air traffic control, bad weather or technical problems with the aircraft). Comparative delays figures are produced by organisations such as the UK Civil Aviation Authority (CAA) and the Association of European Airlines (AEA) (AEA, 2003). However airlines often include a contingency allowance for delays in their schedule which can mean that these published comparisons of schedule performance tend to understate the extent of the delays and are hence of only limited use.

Environmental Performance Indicators and Sustainability

The growing concern with the environmental impacts of airports has meant that an increasing number of airports are now systematically measuring their environmental effects and setting environmental targets. As yet there is no industry norm for such environmental indicators. In some cases, such as with BAA, these measures are based on the core environmental indicators of the broader Global Reporting Initiative (GRI), an official collaborating centre of the United Nations Environment Programme which has produced globally applicable sustainability reporting guidelines. Elsewhere, for example in Germany, the airport organization ADV has produced its own guidelines which certain German airports and other airports, such as Zurich airport, follow. There is, however, no central source of information, unlike with the economic and service indicators, where inter-airport comparisons are made.

Environmental performance indicators commonly relate to noise and emission pollution (e.g. population within noise contour; noise limit infringements; % aircraft on track; CO_2 & NOx emissions per pax; fixed electrical power usage), use of water and energy (e.g. spillages per atms, water/energy consumption per pax) waste treatment and recycling and public transport use (see Table II). A number of the indicators can be further disaggregated, for example, by analysing what proportion of the emissions are due to air traffic as opposed to ground power units or landside road traffic. In a growing number of cases, the environmental indicators are measured alongside other economic, social and community relation indicators such as ethnic/gender split of staff and number of complaints with an overall aim of encouraging more sustainable development. The Open University/Loughborough University study found that number of complaints was the most popular indicator used by 84% of respondents. Another commonly used measure, which was adopted by two thirds of the respondents, was the proportion of population within a specified noise contour (Francis et al, 2001).

Take in Table II

Modelling Approaches

There are a growing number of airports which are making extensive use of many of the partial performance measures which have been described above. For example BAA, like a number of other airport groups, now uses a variety of different benchmarking techniques at different levels of the organisation. At a general aggregate level, it regularly swaps data with Frankfurt, Amsterdam and Aeroport de Paris airports (Frankfurt, London, Amsterdam and Paris make up the so-called FLAP group of airports) in order to gain insight into the operations of these major European airports of comparable size to London – in spite of the fact that these airports are direct competitors (Francis et al, 2002). More specific benchmarking includes comparisons with UK construction processes in other industries in order to investigate how its own internal construction processes could be improved. Benchmarking is also used to compare rents, airport charges, and retail prices. Comparisons of quality of service are made with its own QSM and other studies. In the environmental area BAA benchmarks itself against others in the Dow Jones Sustainability index (BAA plc, 2003). Targets in many of these areas form an integral part of the senior management incentive bonus scheme.

Some of the major limitations with the partial benchmarking measures are that they tend to be very much data led and relate to areas where data is readily available, rather than where performance assessment is ideally needed (Humphreys and Francis, 2000). By definition, they only give a ‘partial’ and rather disjointed diagnosis of the situation and can be misleading if only selected indicators are chosen. This has meant that as airport benchmarking has become generally more accepted, there has also been a growing interest and need to

use econometric or mathematical modelling to gain a more thorough understanding – particularly in the area of economic and operational efficiency.

A number of different methodologies have been used (CAA, 2000; Lemaitre, 1998; NERA, 2001). Some of the major studies are listed in Table III. Parametric or statistical total factor productivity (TFP) approaches using stochastic frontier analysis and production or cost functions have been used to make an assessment, for example, of the performance of some UK airports and a sample of European airports (Tolofari et al 1990; Pels et al, 2000). The ATRS study is the most comprehensive and uses a production function to compare the performance of over 70 major international airports.

Non-parametric index number approaches such as the Tornqvist total factor productivity, have also been used. This requires the aggregation of all outputs into a weighted outputs index and all inputs into a weighted input index. The prices of the inputs and outputs are the weights which are applied to the quantities of outputs and inputs. For instance, such a technique has been used to assess the performance of major Australian airports (Prices Surveillance Authority, 1993; Hooper and Hensher, 1998).

In addition Data Envelopment Analysis (DEA) techniques have been investigated. These compare a weighted output index relative to a weighted input index similar to the non-parametric TFP measure but the key advantage of DEA is that the weights for the inputs and outputs are not pre-determined but instead are the result of the linear programming procedure. DEA is therefore often a more attractive technique than the other methods because it has less demanding data requirements. As a result it has been used more extensively to measure airport performance. For example it has been used to undertake a comparison of the performance of 25 European airports and 12 Australian airports (Graham and Tolvad, 1997), Parker (1999) used it to study the UK BAA airports, Martin and Roman (2000) chose it to study Spanish airports, whilst Gillen and Lall (1997) and Bazargan and Vasigh (2002) adopted this method to assess the efficiency of airports in the United States. Finally a multiattribute approach, which combines a number of partial performance measures as a weighted sum of inputs, has also been employed to assess airport performance (Jessop 1999).

These various methodologies all have their relative strengths and weaknesses but undoubtedly these performance studies have added to the very limited amount of knowledge which previously existed as regards comparative airport performance. However with many of these performance analyses there does appear to be a considerable amount of focus on the technical details involved with constructing the models, with less attention paid to ensuring that the optimal data is used (NERA, 2001). Perhaps a better balance could be achieved. Moreover most of the studies have tended to concentrate on the more straightforward operational aspects of airport performance. When an economic analysis has been undertaken in most cases the research has been confined to

one specific country because of the problems of obtaining detailed and comparable data for a number of different countries.

Take in Table III

The Role of Benchmarking in Airport Regulation

There are often serious concerns that airports with considerable market power will abuse this situation, particularly if the airports are privatised. This has resulted in new regulatory frameworks being established at a number of airports. Most of these have been introduced at the same time as the airports have been privatised – but not always - with Aer Rianta in Ireland being a prime example of a recently regulated public sector airport group. A price-cap regulation based on an RPI-X formula and applied just to airport charges is the most popular form of regulation which is used at airports, for example, in London, Ireland, South Africa and initially at the Australia airports. The cap is normally set by the regulator assessing the airport's own present and future cost levels, which will include consideration of any proposed investment programmes, additional costs related to improvements in the quality of service and a reasonable rate of return.

There has been some debate, particularly in the UK, as to whether industry benchmarking could have a much more active role in determining the price cap (Civil Aviation Authority, 2000). It has been argued that industry best practice could, in theory, replace an assessment of accounting costs as the basis for setting the price cap. This approach has already been used, for example, by some of the UK utility regulators. As with all regulated industries, using benchmarking in economic regulation can mean that the regulatory control is independent of any company action inappropriately influencing the key variables used in the regulatory formula, such as inflating the asset base or overestimating costs. However, the adoption of such 'regulatory benchmarking' is fraught with difficulties within the airport sector because of the extensive problems of comparability associated with such an exerciseand the subjective nature by which some of the associated problems are overcome by making adjustments. There is also a lack of general consensus as to the optimal method of benchmarking. In addition there is the more general fundamental issue that such an approach assumes that high costs are in fact the result of inefficiency whereas in reality they may be due to a number of other factors. Only a very detailed assessment of the benchmarking data may be able to identify these factors (Shuttleworth 1999).

The UK CAA undertook an industry consultation concerning regulatory benchmarking in 2001 for the regulation review of 2002 when a number of organisations expressed their concerns about adopting such an approach primarily because of the problems associated with the choice of airport sample and suitable input/output measures and the difficulties involved with taking into account factors such as ownership patterns and the operating environment.

After commissioning benchmarking studies, the CAA concluded that benchmarking can help improve the regulatory process but improvements needed to be made to the data set and quality of data before such a technique could be used in subsequent reviews (CAA, 2002).

Another area of major concern within any regulatory framework is often the quality of service. When the regulation does not formally require appropriate quality performance monitoring there may be a strong incentive for the airport operator to reduce its quality of service if it has a very restrictive price formula. When the regulatory process for the Manchester and the London airports was set up, there was no formal service monitoring requirement whereas there was for the Australian airports – albeit that it was based purely on internal performance rather than with comparisons with other airports. However the latest UK regulatory review which was completed in early 2003 resulted in the requirement for the airports to internally monitor and set targets for their service quality. Rebates will be given to the users if certain targets are not met. The quality measures are a mixture of delivered service measures and passenger survey indicators and in the future it is planned that a measure of aircraft delay will also be used (Table IV).

Take in Table IV

Conclusions

Without doubt, there have been considerable developments within the area of airport benchmarking in recent years and the sector no longer lags so much behind other industries, including airlines, in the knowledge and practical use of performance indicators. There is a growing collection of literature related to the subject and there is also evidence that many airports, particularly within Europe, are making much greater use of benchmarking techniques.

However, the fundamental difficulties associated with inter-airport comparisons (particularly from different countries) and with dealing with problems of comparability, arising largely from the diversity of inputs and outputs, still remain and have yet to be resolved effectively. Relatively few benchmarking studies have made a truly international comparison of performance. This seems to be out of line with the fact that both the airport and airline industry are becoming increasingly international or global in nature. Further research is needed. Interest in this area will undoubtedly increase with more of the industry being expected to go through the commercialisation and privatisation stages in the evolutionary cycle of the airport industry. Other organisations, such as regulatory authorities, may also help to improve the current practices in this area.

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Table I: Comparative ranking of international airports using the operating costs per passenger indicator for 99/00 (*)

Airport or Airport Group	ATRS unadjusted data	TRL adjusted data
Frankfurt	1	4
Rome	2	6
Aer Rianta	3	11
Vienna	4	8
Munich	5	1
Finnish	6	5
Hong Kong	7	2
Manchester	8	3
BAA	9	10
Amsterdam	10	9
Miami	11	7
Washington Dulles	12	15
Copenhagen	13	12
Vancouver	14	13
Singapore	15	14
Calgary	16	17
Los Angeles	17	16
Honolulu	18	18
Auckland	19	19

(*) The largest value is ranked ‘1’.
Source: TRL (2001), ATRS (2001)

Table II: Common performance indicators used at airports

Area of Performance	Performance indicator
1. ECONOMIC PERFORMANCE	
Cost efficiency	Total/operating costs per WLU Staff costs per WLU Depreciation costs per WLU
Labour productivity	WLU per employee Revenues per employee
Capital productivity	WLU/total assets Revenues/total assets Total assets per employee
Revenue generation	Revenues per WLU Aeronautical/non-aeronautical revenue per WLU
Profitability	Revenues: cost ratio Total/operating profit per WLU Total profit/total assets
2. OPERATIONAL PERFORMANCE	
Aircraft delays	% departures delayed
Equipment use	Availability of trolleys/lifts/people movers etc
Waiting time	Waiting time at check-in, security, immigration
Queue length	Queue length at check-in, security, immigration
Transfers	Minimum connecting times
Baggage delivery	Delivery time of baggage
Terminal facilities	Satisfaction with: • Cleanliness • Way finding • Flight information • Seat availability • Comfort • Crowding • Walking distances • Staff courtesy
Commercial facilities	Satisfaction with: • Range • Quality • Value for money
3. ENVIRONMENTAL PERFORMANCE	
Noise	Population within specified noise contour Number of noise limit infringements Number of engine testing rules infringements Proportion of aircraft on track
Emissions	CO_2 and NO_x emissions per passenger (and other emissions) Fixed electrical power usage
Water	Number of spillages per 1000 atms Water consumption per passenger

Waste	Waste per passenger Proportion of waste recycled Proportion of waste going to landfill sites
Energy	Energy consumption (gas, electricity, fuel) per passenger
Transport	Proportion of passengers using public transport Proportion of staff using public transport
Social policy	Ethnic origin of staff Gender split of staff
Community relations	Number of complaints Response time for complaints

Source: Author

Table III: Examples of airport efficiency studies 1990-2003

Author (s)	Date of Publication	Methodology	Coverage
Tolofari/Ashford/Caves	1990	Parametric TFP	BAA UK airports
Prices Surveillance Authority	1993	Index number TFP	6 Australian airports
Gillen/Lall	1997	DEA	US 23 airports
Hooper/Hensher	1997	Index number TFP	6 Australian airports
Graham/Holvad	1997	DEA	25 European/12 Australian airports
Parker	1999	DEA	BAA and 16 other UK airports
Adler/Berechman	2001	DEA	26 major international airports
Pels/Nijkamp/Tietveld	2000	DEA/parametric TFP	33 European airports
Sarkis	2000	DEA	44 US airports
Jessop	1999	DEA/Multiattribute assessment	32 major international airports
Martin/Roman	2001	DEA	37 Spanish airports
Martin-Cejas	2002	Parametric TFP	40 Spanish airports
Fernandes/Pacheco	2002	DEA	33 Brazilian airports
Bazargan/Vasigh	2002	DEA	45 US airports
ATRS	2002	Parametric TFP	76 major international airports

Source: Author

Table IV: Proposed service quality elements to be included in the regulation of BAA London airports

Area of Performance	CAA Proposed Performance Measure
Stand availability	% time available
Jetty availability	% time available
Pier service	% passengers pier served
Fixed electrical ground power	% time available
People movers	% time available
Transit system	% time cars available
Security queues	Waiting time<10 mins
Arrivals reclaim	% time baggage carousels available
Departure lounge seat availability	Monthly QSM score
Cleanliness	Monthly QSM score
Way-finding	Monthly QSM score
Flight information	Monthly QSM score
Aircraft delay/congestion term	To be decided

Source: CAA (2003)