Adequacy of Transport Infrastructure: Airports

Working Paper

This Working Paper is the fourth in a series of Working Papers which disseminates the results of a large research project into the adequacy of Australia's transport infrastructure over the next 20 years. The assessment covers all four modes of transport - road, rail, air and sea - with the primary focus on freight.

Bureau of Transport and Communications Economics

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Adequacy of transport infrastructure
Airports

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FOREWORD

The National Transport Planning Taskforce (NTPT) was established in October 1993 by the former Minister for Transport and Communications to report on national infrastructure needs and operational improvements required to meet future demands for freight transport.

The Bureau of Transport and Communications Economics was commissioned by the NTPT to carry out assessments of the adequacy of road, rail, seaport and airport infrastructure. In doing this it has attempted to adopt a strategic multimodal orientation. A summary of the Bureau's work is given in *Building for the Job: A Strategy for Australia's Transport Network, Commissioned Work* vol. 1 produced by the NTPT.

The project was undertaken under the leadership of Mark Harvey and John Miller. Officers who contributed specific components included Johnson Amoako, Jane Brockington, Peter Collins, Glen D'Este, Bozena Dziatkowiec, Edwina Heyhoe and Chikkegowda Puttaswamy. Other officers of the BTCE, particularly Maurice Haddad, also made valuable contributions.

Details of the research undertaken for each component of the study are provided in a series of six working papers. Each paper describes the methodology used, future demand, and results of the adequacy analysis, and gives options for future research. This paper provides details of Australian airport infrastructure and details of the basis for the conclusions regarding expenditure and timing requirements.

Much of the airport adequacy work was done by Jane Brockington in conjunction with consultants Australian Construction Services. The dedication of all the Bureau staff involved, the consultants and the staff of the Federal Airports Corporation, the Civil Aviation Authority, Ansett and Qantas airlines, Ansett Air Freight, Travers Morgan and the Department of Transport who cooperated in supplying considerable information and constructive comments, has been appreciated.

Russ Reynolds
Research Manager

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December 1994

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ABSTRACT

This paper examines the adequacy of aviation infrastructure. The analysis is based on a technical assessment of theoretical capacities and volume/capacity ratios of existing infrastructure which are compared to demand projections for the period 1995–96 to 2014–15. Inadequacies are identified and the costs of projects to remedy the inadequacies are estimated.

The study concludes that investment of at least $2.8 billion is required if Australia's aviation infrastructure is to adequately service demand over the next two decades. Much of this will be provided by the private sector as a result of privatisation of the airports and/or by the airlines under the terms of their lease arrangements on terminal buildings.

It has not been possible to undertake an assessment of economic adequacy due to data limitations. One of the aims of any future study of this nature will be to advance the analysis by including an economic assessment.

KEY FINDINGS

- At present, *average* delays to aircraft at Sydney, the most congested airport, would not be considered excessive by accepted standards; however, total delays per movement during peak periods can exceed 30 minutes.
- Aviation infrastructure investment of at least $2.8 billion is likely to be required between 1995-96 and 2014-15.
- Terminal expansion accounts for 67 per cent of the total estimated expenditure needs. Of the total terminal investment, 41 per cent will be required at Kingsford Smith (Sydney) Airport (KSA).
- Required investment at KSA represents 30 per cent of estimated expenditure, while investments at Brisbane and Melbourne Tullamarine represent 26 and 18 per cent, respectively.
- *Sydney*: With the new parallel runway at KSA, theoretical runway capacity will be in the vicinity of 353 000 movements per annum. Under the primary demand forecast scenario, KSA with its parallel runway system, will be adequate over the twenty year study period. However, on the basis of alternative higher demand forecasts provided by the Department of Transport, runway capacity at KSA is likely to become inadequate between 2003-04 and 2010-11. The construction of the Sydney West Airport will increase runway capacity in the Sydney Basin by 150 000 aircraft movements per year. With this, even under the high alternative demand scenario, there will be sufficient runway capacity to accommodate regular public transport movements in the region over the study period.
- *Brisbane:* Brisbane will reach a runway demand of 230 000 movements and may therefore need a third runway around 2014-15. The lack of a curfew could lead to some deferral of this. A new international terminal is under construction and the existing international terminal could be used as a freight terminal.
- *Melbourne:* Growth of the existing international facility is physically restricted between the two domestic concourses. Relocation of the international terminal to the Federal Airports Corporation master plan site

south of the Ansett freight complex would remedy this. It would also enable domestic terminal growth into the existing international pier in a manner that could utilise wider bodied aircraft. The 230 000 aircraft movement volume will be reached by Melbourne around 2009-10 so a third runway may be required, although the absence of a curfew could enable deferral.

- *Cairns:* This airport is expected to have the fourth largest passenger throughput of the Australian airports by the end of the study period. Recently a new international terminal was constructed and the main runway extended. Further terminal expansion and international parking positions are required before 2014-15.

- *Perth:* A new international terminal has recently been completed. It can easily be extended in response to future demand growth.

- *Adelaide:* A 500 metre extension to the main runway has been proposed by the South Australian State Government and other state interests. Expansion of the domestic terminal is difficult because of its location and existing aircraft movement areas. Aerobridges would be needed to serve future wide bodied aircraft as well as more frequent B737 and A320 aircraft.

- *Canberra:* The domestic terminal has physical constraints at the Ansett terminal end due to close proximity to the north and west runways. If, at some future time the airport is granted international status, additional investment will be required.

- *Coolangatta:* The terminal is nearing its designed passenger throughput capacity. It currently has only one level. Further development could include adding a second level and air conditioning.

- *Darwin:* A new combined international/domestic terminal has recently been completed. Nevertheless, upgrade of domestic bays, further domestic parking and some extension of the international facilities is likely to be required.

CHAPTER 1 INTRODUCTION

The Bureau of Transport and Communications Economics was asked by the National Transport Planning Taskforce (NTPT) to undertake an assessment of the adequacy of transport infrastructure in Australia for the next twenty years. The NTPT's primary focus was on freight; however, passenger transport is included in the analysis since it uses the same infrastructure as freight and impacts on congestion levels.

Even though the air freight task is relatively small, airports have been accorded considerable attention because air freight tends to be high value and substantial proportions of the passengers carried are business travellers and tourists. Catering for the needs of these passengers is considered to be a matter of national economic significance.

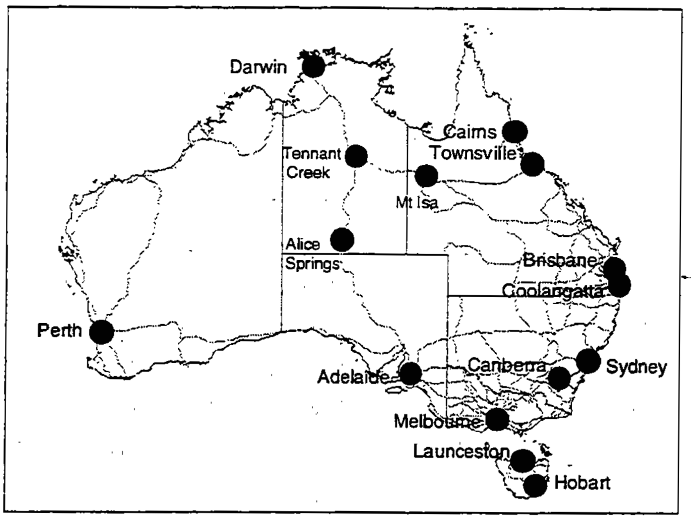
THE AIR NETWORK

To reduce the task to manageable proportions, the Bureau limited its assessment to fifteen airports which are considered to be of national strategic economic significance. The airports selected include those at capital cities as well as at important regional centres (see figure 1.1). The airports are:

- the Federal Airports Corporation (FAC) primary airports - Sydney, Melbourne, Brisbane, Adelaide and Perth;
- the FAC regional airports - Coolangatta, Canberra, Alice Springs, Tennant Creek, Darwin, Townsville, Mount Isa, Launceston and Hobart; and
- Cairns airport.

Of the 15 airports examined, five of the smaller airports, Hobart, Launceston, Townsville, Mount Isa and Tennant Creek, were eliminated from detailed assessment based on a examination of the demand forecasts. For each of these airports forecast demand is unlikely to exceed the capacity of existing infrastructure.

Airports such as Bankstown in Sydney and Essendon in Melbourne play a significant role in catering for air traffic in these cities. However, they have not



Source BTCE.

Figure 1.1 Airports examined

been examined in this study because they are not the primary regular public transport (RPT[1]) airports in their respective cities.

The Australian air transport network is of course much more than the selected airports and cities on which this study has focused. Within the time limits set for the study it was not feasible to cover the entire network in detail. However, given the strategic perspective of this study it was reasonable to assume, on the basis of previous studies by the Bureau and others, that much of the network that serves local communities and sparsely populated and remote regions is unlikely to require additional capacity to meet future demand. These parts of the network generally service traffic flows substantially below their current capacities and in some cases traffic levels are falling. However, particular airports will require capacity expansion to meet demand in growth regions or major reconstruction following natural disasters.

NEED FOR A STRATEGIC APPROACH

The strategic nature of this study needs to be emphasised. The study does make estimates of the dollar values of the investments likely to be warranted, but

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1 RPT is comprised of scheduled international, domestic and regional services.

would be a grave misrepresentation to interpret the findings as setting out a recommended investment program. The aim was not to produce a program of specific infrastructure projects and itemised costing. The techniques employed are designed to highlight areas where a full scale cost-benefit analysis would most probably indicate that investment in additional infrastructure is warranted within the twenty year period. The techniques are not substitutes for proper cost-benefit analyses but point to areas where more detailed evaluations might usefully be undertaken as well as to areas where this is not the case. The results of the study should therefore be valuable in alerting governments to parts of the national transport network infrastructure that are likely to require attention over the next twenty years and the likely magnitude of the financial resources required.

OVERVIEW OF REPORT

The analysis of the adequacy of aviation infrastructure to cope with projected demand was undertaken using a technical assessment. Unlike the road and rail modes, for aviation infrastructure the scope for undertaking an economic assessment is limited due to the inconsistencies and incomparabilities of the available delay data and difficulties in analysing benefits. A discussion of the methodology used is provided in chapter 2.

Chapter 3 provides a discussion of the aviation infrastructure examined and current levels of utilisation. The Bureau used passenger and aircraft demand forecasts, based on the FAC's demand projections which are discussed in chapter 4.

Chapter 5 presents the results of the infrastructure adequacy assessment over the next twenty years. Indicative costs of possible investment projects which would remedy identified infrastructure inadequacies are included in this chapter.

The results of the sensitivity analysis are presented in chapter 6. This chapter also provides comments on other factors likely to influence the industry over the next two decades, in order to attempt to provide a more complete picture of the industry and implications for the utilisation and provision of infrastructure.

In the final chapter the conclusions of the of the research and comments on possible directions of future research are made. In the appendices, supporting material is presented including the demand forecasts, and discussion of congestion and delays, and of the data problems confronted during the study.

CHAPTER 2 ASSESSING INFRASTRUCTURE ADEQUACY

This chapter addresses questions of the meaning of 'adequacy' of transport infrastructure and how this might be assessed. Two definitions of adequacy have been employed by the Bureau, one technical and the other economic. How the Bureau has applied these definitions to the different transport modes has been shaped by the characteristics of the modes and availability of data and models. The depth in which the Bureau has been able to analyse adequacy is therefore very uneven between modes. Even where only a limited assessment has been possible, however, it is still important to bear in mind the ideal, and this serves as the basis for subsequent discussions about future directions that might be taken in adequacy assessment work. The first part of the chapter discusses definitions of adequacy and the second part reviews some of the practical issues faced in attempting to apply these definitions.

DEFINING ADEQUACY

The concept of adequacy

'Adequacy' of transport infrastructure refers to whether or not additional investment is required in the infrastructure. The requirement to invest is a consequence of the infrastructure providing a poor level of service, such as high operating costs, long service times or unreliability. Poor service can have a variety of causes including shortages of capacity, physical deterioration and obsolescence due to changes in technology, demand, input prices or safety requirements.

Specifying just what is meant by a 'poor' level of service is not straightforward. If efficient use of resources is the objective, whether service can be considered poor and the infrastructure requires upgrading is an economic question involving a weighing up of the capital cost of investing against the benefits in terms of improved levels of service. The technique for doing this is social cost-benefit analysis. However, undertaking a cost-benefit analysis is a complex, data intensive and time consuming task. Simpler and quicker means are needed to identify investment projects where detailed assessment is likely to be warranted, and to make decisions about smaller investments where application of cost-benefit analysis techniques would not be worthwhile. The common procedure is to employ a 'rule of thumb' whereby upgrading is considered necessary when the quality of service provided by a piece of infrastructure deteriorates below some minimum acceptable level. As an example, in the aviation industry, airport runway capacity is commonly considered to be inadequate when average aircraft delays exceed four minutes per aircraft.

Technical adequacy

From the notion of 'rules of thumb' providing a rough indication of whether investment is needed, the Bureau has derived its definition of 'technical adequacy'. Transport infrastructure is deemed to be technically adequate if its physical or performance characteristics are above minimum acceptable levels. The definition can be applied either to physical or performance characteristics. Examples of physical characteristics for airports are square metres of terminal area per passenger and aircraft parking positions per aircraft movement. For performance characteristics, the minimum could be specified either in technical terms, for example, hours of delay per aircraft movement, or in cost terms, for example costs per aircraft movement of delays.

Given that infrastructure adequacy is essentially an economic question, determining the level of minimum technical standards should be done bearing in mind the standard that is likely to be warranted on economic grounds. One approach is to assume that, *on average across the country*, current standards for infrastructure of a given type are roughly right in economic terms. The physical or performance characteristics of a large number of sections of infrastructure can then be compared and those with the poorest standards deemed to be technically inadequate. Precisely where to draw the line between adequate and inadequate remains a matter for judgment. In the absence of information about economically warranted standards, natural breaks in the continuum of standards and perceptions about reasonable standards could be drawn upon.

Economic adequacy

An assessment of adequacy using a technical definition can only be regarded as providing a rough guide to whether upgrading is economically justified. A piece of infrastructure which is inadequate in the technical sense could be adequate in the economic sense if the cost of upgrading was high in relation to the benefits. Conversely, if the benefits of upgrading exceeded the costs, it would be economic to invest even where the infrastructure was technically adequate.

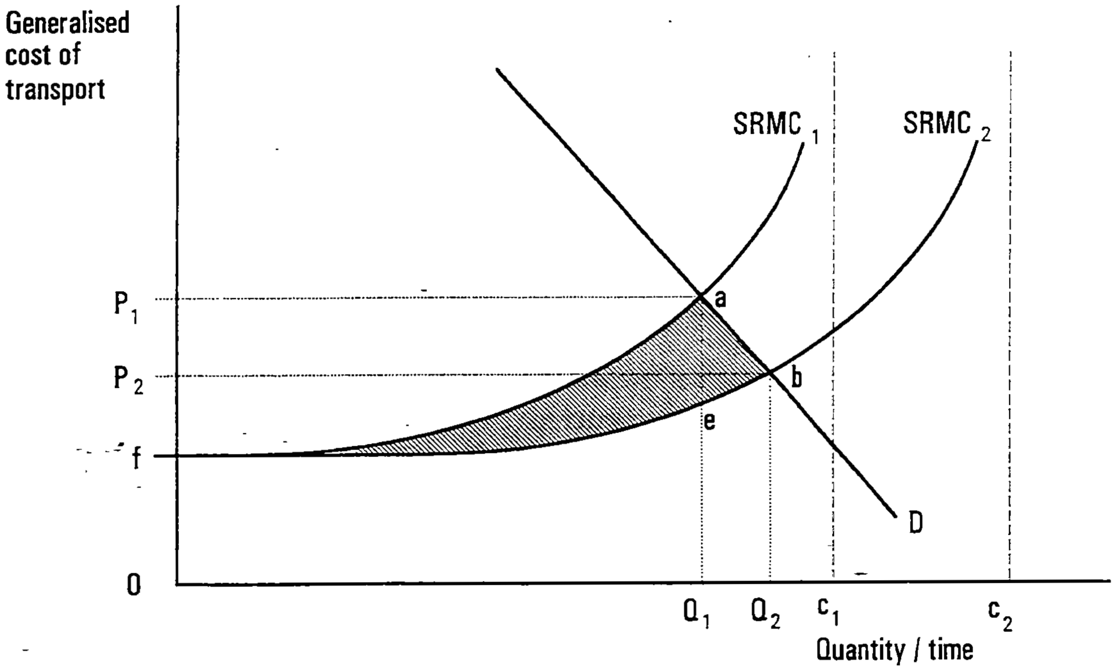

Figure 2.1 Benefits from capacity expansion

The 'economic adequacy' approach employed by the Bureau is based on social cost-benefit analysis. An investment is economically warranted at a point in time if:

1 the present value of benefits exceeds the present value of costs; *and*

2 there is no net welfare gain from delaying the investment.

The first condition is intended to ensure that the resources invested will earn at least what they could if used elsewhere in the economy and the second condition aims to ensure optimal timing. Transport infrastructure is deemed to be economically adequate at a point in time if investment to improve the level of service provided is not economically warranted.

To explain the economic concept of adequacy in more detail, figure 2.1 shows a demand curve and two 'short-run marginal social cost' (SRMC) curves for the use of a piece of infrastructure. Quantity provided or demanded per period of time is graphed on the horizontal axis and 'generalised social cost' of infrastructure use on the vertical axis. This 'generalised social cost' consists of all the costs associated with use of the infrastructure regardless of to whom they accrue. In the case of an airport runway, generalised social costs would include the costs of runway provision and maintenance, air traffic control, delays imposed on aircraft as a result of congestion including the value of passengers' time, and noise externalities imposed on people living nearby. For terminal capacity, delays to aircraft and delays and discomfort imposed on passengers arising from congestion would be important components. Valuing time and discomfort for passengers and noise externalities entails significant measurement problems which are not addressed in this conceptual discussion.

The marginal cost of infrastructure use is the cost imposed by an *additional* user. The short run refers to the time frame in which it is not possible to invest to change the infrastructure. Capital costs and fixed operating costs of infrastructure are excluded because they will not be affected in the short term by infrastructure usage. The short-run marginal social cost curve, $SRMC_1$ rises as usage rises towards maximum capacity (c_1) and operating costs, delays and unreliability increase. If the maximum capacity was increased, say to c_2 the short-run marginal cost curve would shift to the right - to $SRMC_2$.

The demand curve (*D*) shows the quantity demanded of infrastructure usage at each level of generalised cost incurred by users. Users incur their own costs plus taxes and charges associated with use of the infrastructure. To simplify the exposition, it is assumed that taxes and charges are levied in amounts such that user pays the short-run marginal social cost of the resources consumed. This is the economically optimal price. As a result of the capacity expansion, users gain from a reduction in generalised cost from P_1 to P_2 and so increase their use from Q_1 to Q_2. The net gain to society from expanding infrastructure capacity is equal to the shaded area (*abf*) in figure 2.1.[1] Clearly, the shaded area and hence the benefits from expanding capacity will be greater in size, the higher demand is in relation to capacity.

A social cost-benefit analysis would compare the capital cost of the capacity expansion with the discounted present value of gains per period time. The first condition in the above definition of economic adequacy requires that the latter exceed the former before capacity could be considered inadequate.

If infrastructure could be expanded in finely divisible amounts, one would keep on adding to capacity as long as the present value of benefits from one dollar's worth of additional expenditure on capacity exceeded one dollar. In practice, however, capacity can often only be expanded in sizeable lumps. In many cases this is due to economies of scale in construction as it is cheaper to reach a given capacity level with one large capital work than to do so via a series of smaller investments increasing capacity in steps. In other cases, this is attributable to technical characteristics; for example, the number of runways capable of handling aircraft above a given size must be an integer.

1 The area between the two SRMC curves from *0* to Q_1 (*aef*) represents the saving in costs on existing throughput. The area from Q_1 to Q_2 (*abe*) is the gain to society associated with the generated demand. It is the difference between the gain to users represented by the height of the demand curve and the social cost of meeting the additional demand represented by the height of the $SRMC_2$ curve.

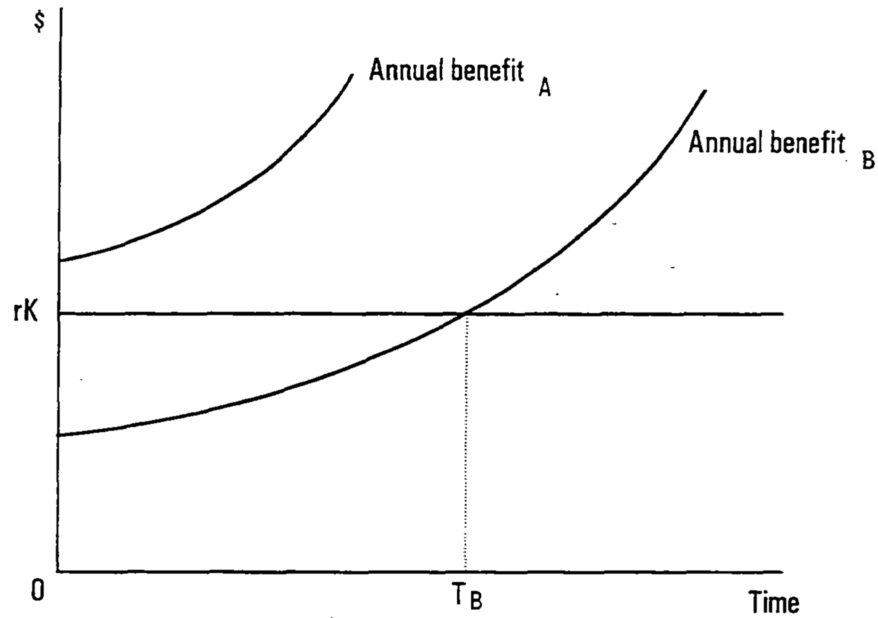

Figure 2.2 Optimal timing of investments

The optimal time to invest

Although capacity may be lumpy, the time at which to invest is divisible. This leads to the second condition in the definition of economic adequacy, which ensures optimal timing. Even when the present value of benefits exceeds costs, it may still be preferable to delay an investment. Assuming that the upgrade will be permanent, if the investment project was delayed by one year, society would forgo the benefits from the project for that year. As an offset, society could gain by investing the funds required for one year elsewhere and could earn interest. Assuming perfect capital markets, so that the interest rate equals the discount rate, which in turn equals the opportunity cost of capital, society would gain *rK*, where *r* is the discount rate and *K* the capital cost of investment. Hence an investment would be better delayed so long as $B(t) < rK$, where $B(t)$ is the benefits in year *t*.[2] If demand is growing over time, annual benefits will grow as well, so the time will eventually be reached when investment is warranted. This illustrated in figure 2.2. Time is graphed on the horizontal axis and annual benefits and costs on the vertical axis. Two annual benefit curves are shown along with the value of *rK*. The annual benefit curves have been drawn as rising at an increasing rate because, as the demand curve in figure 2.1

2 This condition is sometimes expressed as: a project should be delayed if the 'first year rate of return' is below the discount rate, that is, $\frac{B(1)}{K} < r$.

moves rightward over time, the distance between the $SRMC_1$ and $SRMC_2$ curves increases. If the annual benefit curve labelled *A* applied, the investment would be warranted immediately. In this case, the optimal time to invest occurred in the past. In the case of the *B* curve, it would be better to delay the investment until time T_B.[3]

In order to explore some of the relationships, it is assumed that annual benefits are growing at a constant rate over time, that is, $b(1+g)^t$ where *b* is the benefit in year zero from undertaking the investment and *g* is the annual growth rate in benefits.[4] Substituting the formula for annual benefit into the optimal timing condition, the optimal time to invest is $\frac{ln(rK/b)}{ln(1+g)}$. From this it can be seen that a higher discount rate and capital cost will delay the optimum time while higher benefits and growth in benefits will bring it forward.

The benefit-cost ratio (BCR) (the present value of benefits divided by the present value of capital costs) from the investment under the assumption that

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3 It is assumed that the benefit function is continuous and monotonically increasing. With investment occurring at time *T* and continuous compounding, the net present value of benefits and costs is: $NPV = \int_T^{\infty} B(t)e^{-rt}dt - Ke^{-rT}$. This equation must be differentiated with respect to *T* and set equal to zero to obtain the optimum time to invest: $\frac{dNPV}{dT} = -B(T)e^{-rT} + rKe^{-rT} = 0$; which reduces to: $B(T) = rK$. The second order condition for a maximum is that, in the region of the optimum: $-e^{-rt}\frac{dB}{dt} < 0$ which holds if $\frac{dB}{dt} > 0$. Thus the annual gain from implementing the project must be growing over time. The optimal timing condition derived here assumes that the project has an infinite life. There may be periodic maintenance costs and replacement costs which occur at definite times following initial construction. Deferral of the initial investment also defers these. NPV could then be expressed as:

$$NPV = \int_T^{\infty} B(t)e^{-rt}dt - Ke^{-rT} - k_1e^{-r(T+x_1)} - k_2e^{-r(T+x_2)} - \ldots - k_ne^{-r(T+x_n)}$$

where the *k*'s are periodic maintenance of replacement expenditures each one occurring *x* years after time *T*. The optimum timing condition then becomes: $B(T) = r\left(K + k_1e^{-rx_1} + k_2e^{-rx_2} + \ldots + k_ne^{-rx_n}\right)$. Thus one could use the simple optimal timing condition derived previously but augment *K* by an amount equal to the present value of these periodic maintenance and replacement costs. For maintenance costs which occur every year and are the same for each, it is simpler to reduce annual benefits by the amount.

4 If the demand curve shifts rightward at a constant growth rate, benefits from infrastructure expansion will in fact rise faster because the gap between marginal costs with and without the investment rises as figure 2.1 shows.

benefits grow at a constant rate is $\frac{b(1+g)^T}{K[r-\ln(1+g)]}$, where T is the time of implementation. Thus the BCR grows over time at the growth rate. If the investment is undertaken at the optimal time, the formula for the BCR reduces to $\frac{1}{1-\ln(1+g)/r}$. The b and K terms drop out of the equation altogether. From this equation it can be seen that with a positive growth rate and optimal timing, the BCR can never lie below one. A project having a BCR below one would, with optimal timing, be delayed into the future, by which time its BCR would have risen above one. At the optimal time, how far the BCR lies above one will depend on the size of the growth rate relative to the discount rate. If the project has its optimal time in the past as illustrated by the annual benefit curve *A* in figure 2.2, the BCR will be higher still, depending on how late the project is. Application of the optimal timing criterion to identify investment projects and timings therefore means that BCRs will be above one, and significantly so where growth rates in benefits are high relative to the discount rate and where there is already substantial under-investment.

Non-capacity expanding investments

The SRMC curves in figure 2.1 were drawn such that the investment shifts the SRMC curve to the right. Short-run marginal costs at low outputs remain unchanged. The improvements in service levels eventuate because there is more capacity to handle any given volume of demand. Some investments will shift the SRMC curve downward as well as or instead of to the right. An example would be an investment to save on variable maintenance costs. Even if there is no congestion whatsoever the principles for assessing whether the investment is warranted and estimating the optimal time are the same. In terms of figure 2.1, the demand curve would pass through the flat parts of the SRMC curves. The annual benefit would still be measured by the area bounded by the two SRMC curves and the demand curve.

Non-optimal pricing

To simplify the exposition, it was assumed in the discussion of figure 2.1 that taxes and charges were levied in the amounts such that users always paid the short-run marginal social cost. This is the optimum pricing rule to achieve economic efficiency because the marginal user, that is, the user on the borderline in deciding whether or not to use infrastructure, is faced with the full cost he or she imposes on society. In practice, prices will never perfectly reflect marginal costs and may be quite different. Where prices differ from marginal costs, measurement of benefits from infrastructure upgrading will be more complicated than just the shaded area in figure 2.1.[5] If prices are above marginal costs, infrastructure will be underutilised compared with the most efficient level, and less investment will be required. Conversely, if infrastructure is underpriced, there will be more congestion than the most efficient level and additional investment will be required.

APPLYING THE DEFINITIONS

The extent to which the Bureau has been able to apply the definitions of technical and economic adequacy to each mode of transport in the adequacy assessments described in the present series of working papers has depended on the availability of data and the availability of models to forecast future levels of service as demand grows and infrastructure is upgraded.

Demand projections

The present study aims to assess adequacy over the 20 year period 1995-96 to 2014-15 inclusive. Demand projections over this period are therefore an important first step and this is the subject of a later chapter. Data on recent levels of utilisation are vital for making demand projections, and some forecasting techniques also require time series data.

As demand rises towards capacity, levels of service will fall, which will choke off some of the demand. Investment in new capacity can have the opposite effect, stimulating demand. In order to keep the effects of demand growth, that is, rightward movement of the demand curve, separate from effects of congestion on demand, that is, movements along the demand curve, it has been assumed when making the demand projections that service levels provided by the infrastructure remain unchanged. Figure 2.3 illustrates this. A demand curve is shown moving rightward over five time periods. The price level *P* represents the generalised cost at time 1 when the demand curve is at D_1. Over time, as demand grows, if the generalised cost remained at *P*, quantity demanded would follow the series of *Q's* along the horizontal axis. This would be the quantities the demand projections aim to estimate. If changes in service levels were taken into account, the quantities would be found at the intersections of the demand and cost curves.

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5 Benefits in the form of increased willingness-to-pay would be measured with reference to the demand curve and actual generalised costs incurred including taxes and charges. Benefits in the form of net cost savings would be measured as the areas under the marginal social cost curves.

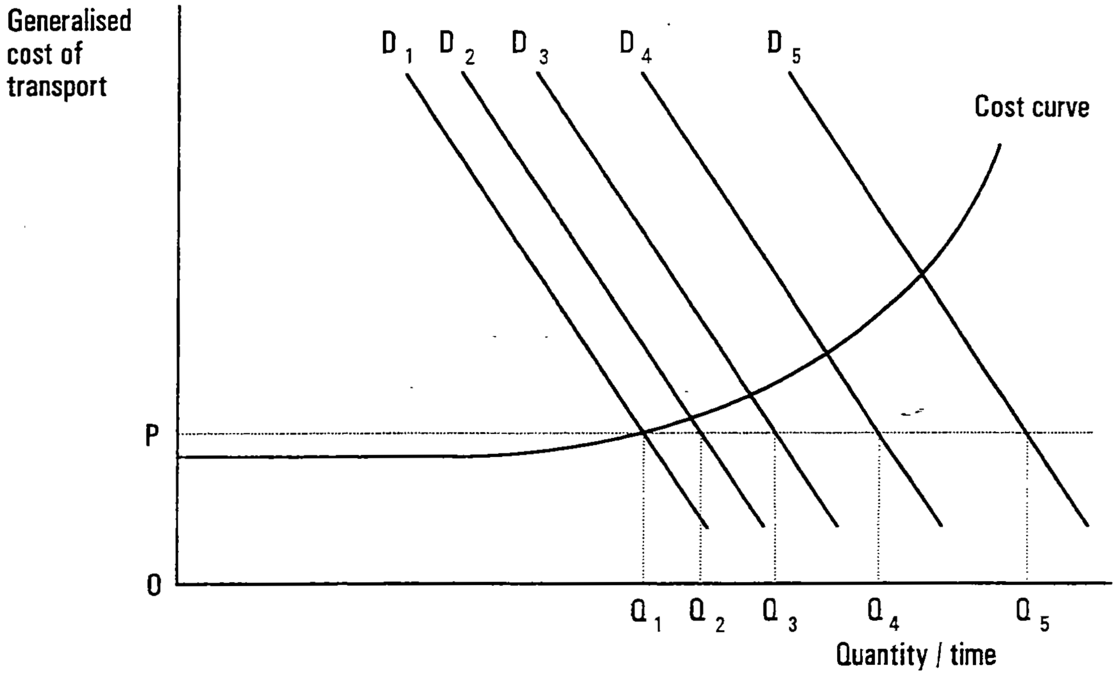

Figure 2.3 Quantity of transport demanded at a constant level of service

Data requirements

An essential component of the research has been a comprehensive program of data collection on the infrastructure being studied. The difficulties encountered by the Bureau in this part of the work have uncovered major deficiencies that exist in knowledge about the physical and performance characteristics and the usage of transport infrastructure in Australia.

Technical assessments

The basic data required are some physical characteristics of each individual piece of infrastructure and details on levels of utilisation. With this information a technical assessment can be carried out by comparing the physical characteristics of each section of infrastructure against predetermined standards or against one another to highlight the worst infrastructure. Utilisation data are essential where physical characteristics are expressed per unit of throughput, for example, square metres of terminal area per passenger. It might be useful to consider the results of the technical assessment alongside data on utilisation, because a piece of infrastructure of low standard but poor utilisation may not be inadequate in the economic sense.

A more sophisticated form of technical assessment is based on performance characteristics such as delays, times taken, reliability or operating costs. This requires either data on current service levels or a model which will estimate them. A model normally requires much more detailed data on physical characteristics and utilisation than would be needed for a technical assessment of physical characteristics. Projection of future service levels if forecast demand was to be loaded onto existing infrastructure would also require modelling.

A technical assessment may be employed to identify investment projects and, if the projects can be costed, estimates of the costs of likely future investment needs can be derived. The investments identified would be those which would bring the level of service up to a specified level. This has been the approach followed in the airports assessment. It is based on the assumption that the current levels of service provided by airports across the country are, on average, at the right levels. Simple models are derived relating infrastructure needs to demand using regression analysis.

Closely associated with the the concepts of capacity, congestion and demand is the issue of delays. Congestion is the build-up of aircraft that occurs as demand outstrips capacity and queues form (TRB 1990).

In the consideration of the adequacy of airport infrastructure, delays are an important indicator of performance of both airlines and airports. As such, they are an useful tool in determining the efficiency of airline operations and airport management procedures, and the adequacy of airport infrastructure in coping with demand.

The capacity of an airport is the 'maximum number of aircraft operations that can be accommodated during an hour when there is a continuous demand for service' (BTE 1982, p 5). The USA Transportation Research Board (TRB 1990) defines capacity as the throughput of an airport. While an airport will have a maximum technical, or theoretical, capacity, its practical, or actual, capacity will almost always be below this level. This is due to the fact that capacity is dependent on the runway configuration, air traffic control and safety rules (for example separation standards), the mix of movements and aircraft, and the weather conditions.

As a result of these factors, it is difficult to directly determine airport capacity. The TRB (1990) suggested capacity could be inferred by comparing actual throughput with actual demand for an given period of time (usually an hour). When capacity is reached delays are incurred as queues of aircraft waiting to be serviced form.

Table 2.1 outlines the Civil Aviation Authority's (CAA) runway movement ranges for various operating conditions, which are largely determined by weather conditions. Included are scenarios for the existing cross runway system as well as scenarios for the parallel runway system and associated technology as it is phased in.

TABLE 2.1 RUNWAY MOVEMENT RATES AT KSA

Runway(s) in use	*Movements per hour*
Single runway - IFR	30 to 36
Single runway - VFR	36 to 40
Two runways - IFR	40 to 44
Two runways - no SIMOPS	44 to 48
Two runways - VFR, SIMOPS (Runway 16 departures, Runways 16 and 07 or 25 arrivals)	48 to 60
Two runways - VFR, SIMOPS (Runways 25 or 07 departures, Runways 25 or 07 and 34 arrivals)	60 to 65
Phase 1 parallel runways - existing tower	50 to 55
Phase 2 parallel runways - new tower, VFR	60 to 65
Phase 3 parallel runways - new tower, PARM	80+

IFR Instrument flight rules
VFR Visual flight rules
SIMOPS Simultaneous runway operations[7]
PARM Parallel Approach Runway Monitor

Note The runway numbers indicate the direction of operations; for example, runway 07 departures means take-offs made to the east on the E/W cross wind runway.

Source Air Traffic Services, CAA, Sydney (1994).

Clearly, there is a wide range of runway capacities which apply to KSA under various conditions. The CAA predicts that once the parallel runway, the new air traffic control tower and the Parallel Approach Radar Monitor (PARM) are commissioned, operations will be restricted to the east-west runway only when cross winds exceed 25 knots, which is expected to occur only 1.25 per cent of the time.[6]

Economic assessments

A problem with moving from a technical to an economic definition of adequacy is that economic adequacy cannot be assessed without specifying how the infrastructure is to be upgraded in order to estimate the costs and benefits of doing so. If alternative ways of achieving the same service improvement are available, all alternatives need to be analysed and compared. As already noted, the technical assessment can assist in identifying projects.

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[6] The parallel runway was commissioned on 8 November. The CAA expects the new tower to be commissioned in early March 1995 and the PARM by December 1995.

[7] SIMOPS was introduced by Air Traffic Services at KSA in 1983 to improve the aircraft movement rate during the peak periods. Under SIMOPS procedures simultaneous take-offs or landings can occur on the cross runways within existing separation criteria. SIMOPS are only applied to domestic and Qantas international movements and used in good weather conditions. The CAA estimates that SIMOPS improves KSA's capacity by approximately 30 per cent (to 46 to 60 movements per hour).

In the present strategic exercise, full scale cost-benefit assessments of potential infrastructure investments are not feasible. The economic assessment work undertaken must necessarily be rudimentary in nature and so only provides a broad guide as to whether investments are warranted. If the data and models are available to predict levels of service provided by infrastructure such as would be required for a technical assessment of performance characteristics, a basic economic analysis is possible provided some additional information requirements are met. These additional requirements include capital costs of investment projects and data on operating costs, including values of time and reliability where these are major benefits from investment projects.

CONCLUSION

The approach to assessing infrastructure adequacy outlined above offers great flexibility in terms of the depth of analysis, and this is essential given the variations in degrees of data availability and ease of modelling between the modes. At the lowest level is the technical review of the physical characteristics of infrastructure. The next level is a technical assessment of adequacy based on current and projected infrastructure performance in terms of service levels. This has the advantage that it can formally incorporate demand projections. In some cases, by using the technical assessment to identify potential projects and estimating the costs of these projects, it has been possible to forecast future investment needs. Finally, if it is possible to specify investment projects and estimate costs and benefits, there is the economic assessment. This too may be undertaken in varying degrees of depth ranging from a 'back of the envelope' calculation to a major cost-benefit study. The study described in the present series of working papers, with its strategic focus, would not aim to go beyond cost-benefit studies at a rudimentary level.

CHAPTER 3 CURRENT INFRASTRUCTURE AND LEVELS OF UTILISATION

INFRASTRUCTURE ASSESSED

An airport is made up of a number of interdependent systems - the airspace, the runway/taxiway system, the apron/parking areas, the passenger and freight terminals, and the land transport interface. Within a number of these systems exists micro-systems, for example, within passenger terminals there are check-in counters, baggage handling systems, and customs, immigration and quarantine processing systems. Given the strategic nature of this study and the short time frame involved, our analysis has abstracted from these micro-systems and focused only on the major systems.

Details of the major infrastructure components for the airports studied are listed in table 3.1. Clearly, Sydney is the largest airport in terms of each of the infrastructure components described in the table, followed by Melbourne and Brisbane. The infrastructure available at Melbourne and Brisbane is largely comparable, the basic difference being the slightly larger domestic facilities available at Melbourne.

As mentioned in Chapter 1, airports such as Bankstown in Sydney, Moorabbin and Essendon in Melbourne, and Archerfield in Brisbane have not been included in the assessment. The rationale for excluding these airports is that despite playing a significantly role in catering for air traffic, they are not the primary RPT airports in their respective cities.

CURRENT UTILISATION

The following section describes current levels of traffic using the existing aviation infrastructure at each airport. The discussion is based on actual

TABLE 3.1 AIRPORT INFRASTRUCTURE, 1992-93

Airport	*Runways lengths & width (m)*	*International terminal areas*[a] *('000 sqm)*	*Domestic terminal areas*[a] *('000 sqm)*	*Parking positions international*[b]	*Parking positions domestic*[b]	*Aerobridge international*[c]	*Aerobridge domestic*[c]
Sydney	3962x45, 2400x45,[d] 2530x45	142	75	22	41	20	35
Melbourne	3657x45, 2286x45	62[d]	65	12	31	12	27
Brisbane	3560x45, 1760x30	62[e]	64	12	20	8	14
Adelaide	2528x45, 1652x45	6.9	16.5	2	12	1	0
Perth	3444x45, 2163x45, 1595x23	38.8	26	6	12	5	6
Darwin	3354x60, 1524x30	15.5	15	2	8	1	2
Cairns	3197x45, 925xna	15	10.7	5	11	0	3
Hobart	2251x45	3	2.8	1	6	0	0
Canberra	2683x45, 1679x45	na	8.5	na	6	na	4
Coolangatta	2042x45, 612x18	na	11.3	na	9	na	0
Townsville	2438x45, 1100x30	–	10[f]	2	5	0	0
Launceston	1981x45, 700x30, 500x30	na	3.4	na	1	na	0
Alice Springs	2438x45, 1029x18, 113x18	na	4.5	na	10	na	0
Tennant Creek	1959x45, 1349x45, 1032x18	na	0.225	na	1	na	0
Mount Isa	2560x45, 914x30	na	–	na	4	na	0

na Not applicable
– Not available

a. Terminal total area - the gross floor space of the terminal buildings (with no differentiation between the various uses of the area).

b. Parking positions - the total number of apron stands for RPT aircraft (excluding free stands used by regional RPT aircraft). These figure do not include GA apron areas.

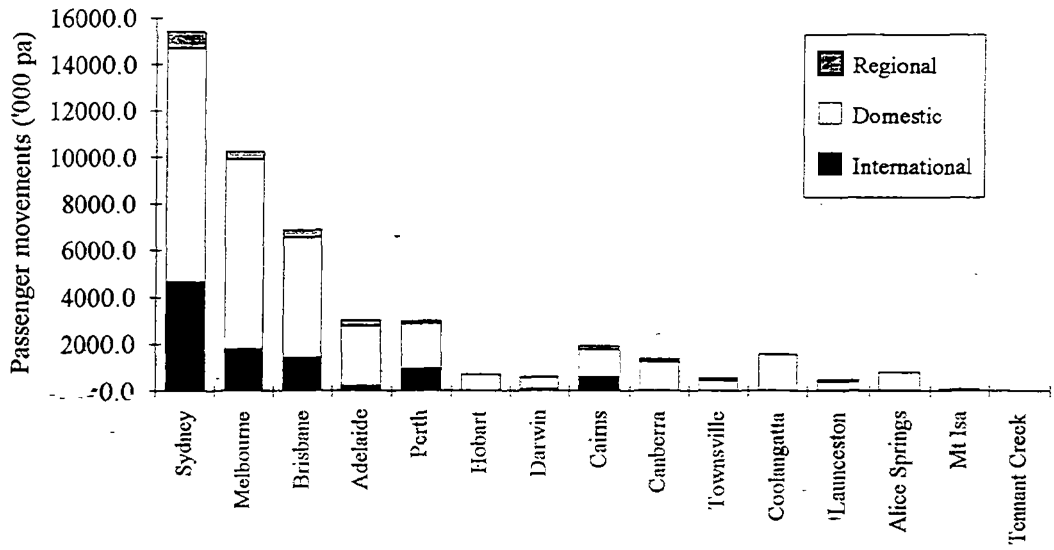
c. Aerobridges - the number of terminal gate positions to which passenger access is through an elevated, covered walkway.

d. Includes infrastructure projects which are currently under construction and are expected to be completed during 1994-95 (ie the KSA parallel runway development and the further development of Sky Plaza at Tullamarine).

e. Includes infrastructure projects which are expected to be completed during 1995-96 (ie the New International Terminal Building development at Brisbane).

f. Combined total international and domestic terminal area.

Sources BTCE compilation; FAC (1993b).



Source DoT (1994).

Figure 3.1 Passenger movements by airport, 1992-93

numbers of passenger and aircraft movements,[1] and air cargo tonnages for 1992-93, which are collected by the Department of Transport (DoT 1994).

Passenger movements

Actual passenger movements and the mix of passengers is shown in figure 3.1 for each airport examined in the study for 1992-93. Clearly, Sydney had the highest total passenger throughput in 1992-93 of 15.5M passengers, representing one-third of aggregate total passenger movements at the 15 airports. Melbourne recorded the next highest number of passengers for the year, 10.3M or 22 per cent of total passenger movements.

The largest number of international movements[2] occurred at Sydney, Melbourne and Brisbane. International passenger throughput at these airports represented 48, 18 and 15 per cent of the market, respectively.

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1 An aircraft movement refers to a landing or a take-off. Therefore, each service provided by an airline will generate two movements, a take-off from the airport of departure and a landing at the destination airport.

2 An international movement refers to a service with one trip-end outside Australia. A domestic movement refers to all services within Australia on the two domestic carriers, Ansett and Qantas. Domestic services are mostly interstate movements. Regional movements refer to all other services within Australia on RPT carriers, for example, Eastern Australia Airlines and Ansett Western Australia. Regional services tend to be intrastate movements.

TABLE 3.2 PASSENGER MIX IN 1992-93
(per cent)

Passenger type	Sydney	Melbourne	Brisbane	All airports
International	30	17	21	21
Domestic	65	79	75	74
Regional	5	5	5	5
Total	100	100	100	100

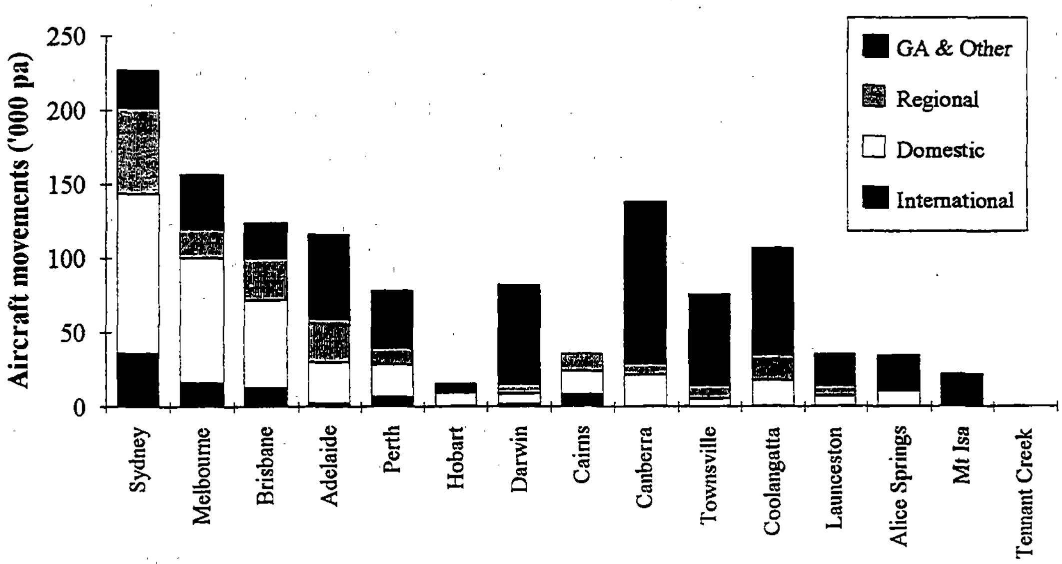
Source DoT (1994).

Similarly, for domestic passenger movements, Sydney, Melbourne and Brisbane recorded the largest throughput volumes. Sydney attracted almost one-third of all domestic passengers, while Melbourne captured close to a quarter of the market.

Table 3.2 presents the passenger mix for the largest three airports in terms of passenger throughput and the aggregate mix for all airports for 1992-93.

Aircraft movements

Based on the discussion of passenger movements in the previous section for 1992-93, it is not surprising that the greatest number of aircraft movements in total, for international movements and domestic movements occurred at Sydney, Melbourne and Brisbane (see figure 3.2).



Source DoT (1994).

Figure 3.2 Aircraft movements by airport, 1992-93

43 per cent of all international movements and 27 per cent of domestic movements in Australia occurred at Sydney. Sydney also recorded the highest number of regional aircraft movements for the year, followed by Adelaide.

For many of the smaller airports general aviation (GA) and Other[3] aircraft account for the vast majority of total aircraft movements. The greatest number of GA and Other movements in 1992-93 were recorded at Canberra, Coolangatta and Darwin.

Table 3.3 presents the aircraft mix for, Sydney, Melbourne and Brisbane, as well as the aggregate mix for all airports in 1992-93.

TABLE 3.3 AIRCRAFT MIX IN 1992-93

0(per cent)

Aircraft movement type	*Sydney*	*Melbourne*	*Brisbane*	*All airports*
International	16	10	10	7
Domestic	47	54	48	32
Regional	26	13	23	17
GA and Other	11	23	19	45
Total[a]	100	100	100	100

a. Columns may not add exactly due to rounding.

Source DoT (1994).

International aircraft accounted for almost one-quarter of total aircraft movements at Cairns in 1992-93, with domestic and regional movements accounting for 43 and 33 per cent, respectively. However, GA and Other figures are not available for Cairns, therefore, these percentages represent the mix of scheduled RPT services only.

Air cargo

Approximately 722 000 tonnes of air cargo were moved into, out of and within Australia in 1992-93, of which, international cargo represented more than 60 per cent (DoT 1994).

As 90 per cent of air cargo is carried in RPT services, it is not surprising that Sydney recorded the highest level of air cargo throughput in that year (320 000 tonnes or 44 per cent of all air cargo), followed by Melbourne and Brisbane (figure 3.3).

More than half of all international air cargo volumes moved through Sydney, while Melbourne attracted the largest market share of the domestic market.

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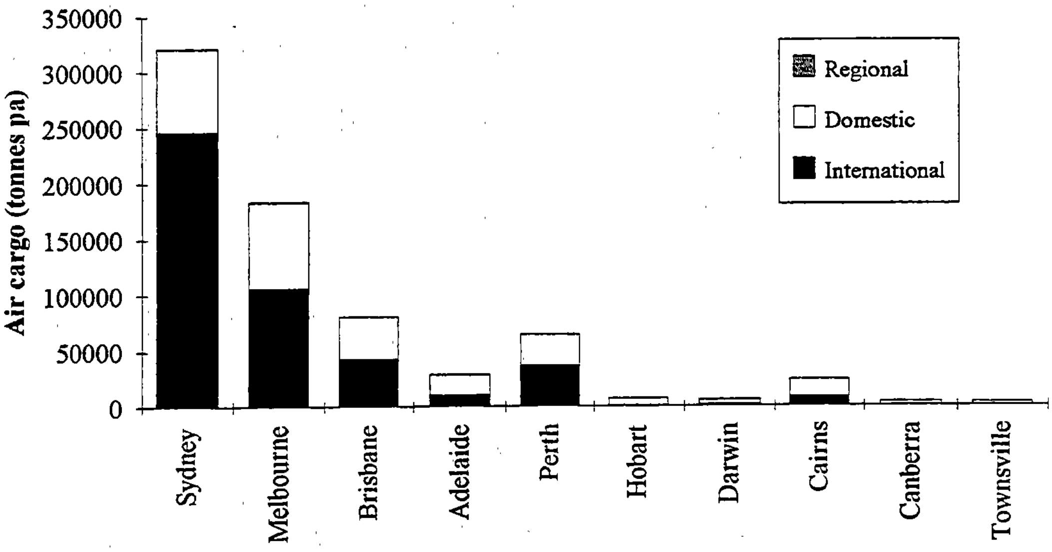
3 Other aircraft movements include charter and military movements.



Source DoT (1994)

Figure 3.3 Air cargo volumes by airport, 1992-93

Regional cargo volumes represented less than one per cent of total air cargo, of which the majority moved through Darwin and Perth.

Table 3.4 presents the mix of air cargo at the three largest airports by volume in 1992-93. The table clearly shows the dominance of international cargo volumes as a proportion of total air cargo throughput in Australia.

TABLE 3.4 AIR CARGO MIX IN 1992-93
(per cent)

Air cargo type	*Sydney*	*Melbourne*	*Brisbane*	*All airports*
International	77	58	53	62
Domestic	23	42	47	38
Regional	<1	<1	<1	<1
Total[a]	100	100	100	100

a. Columns may not add exactly due to rounding.
Source DoT (1994).

CHAPTER 4 FUTURE DEMAND

The passenger and aircraft movement demand forecasts are based on the forecasts produced by the FAC in 1993. Consultants, Travers Morgan, interpolated and extrapolated these figures to cover the desired study period. Similarly, Travers Morgan produced the air cargo forecasts in mid-1994, on the basis of the correlation between aircraft movements and freight volumes over the last decade, and the Department of Transport historical air cargo series. The demand forecasts used in the sensitivity analysis are based on forecasts for Sydney produced by the Department of Transport.

PASSENGER AND AIRCRAFT MOVEMENTS

Methodology

The demand projections for passenger and aircraft movements are based on the FAC's *Australasian Airport Forecasts, 1992-2012*, which were released in June 1993 (FAC 1993a). The FAC reviews traffic forecasts annually and prepared updated forecasts in 1994. However, as a result of the Government announcement of its intention to privatise the FAC airports, the FAC has not publicly released its 1994 forecasts. The FAC (1993a) figures are thus the last publicly available forecasts for all the airports examined and form the basis of the analysis. A summary of the forecasts is presented in tables in appendix I.

The FAC commissioned the British Airports Authority (BAA) to produce the international forecasts and Tourism Futures to produce the domestic forecasts. The FAC figures include actual figures for the last available year (1991-92), forecasts for the subsequent five years (1992-93 to 1996-97 inclusive) and forecasts for fifteen years at five year intervals (2001-02, 2006-07 and 2011-12).

Forecasts are provided for the FAC's 22 airports as well as for Cairns and three major New Zealand airports. Forecasts of international, domestic and regional passenger and aircraft movements are given by airport. GA movements are also given by airport (except for Cairns). Three forecast scenario's are presented relating to low, central (most likely) and high growth predictions. Short-run and long-run forecasts are presented for international and domestic traffic.

The underlying assumptions for the international forecasts are as follows:

- Australia's recovery from recession expected through 1992-93 has been delayed by approximately 9 months;
- the North American economies are strengthening, the UK showing signs of a gradual recovery, but Japan and Europe in a recessionary downwards phase;
- long term growth in the Japanese economy will continue to outstrip that of Europe and North America. Japanese growth is likely to be outstripped by growth in some of the recently industrialised Asian economies, for example Taiwan and Korea, and some of the predominantly primary producer economies such as Thailand and Indonesia;
- the outlook for the New Zealand economy is good;
- in the short to medium term there is expected to be little upward pressure on air fares and more intense competition. In the longer term there is likely to be upwards pressure on real air fares as the consolidation of airlines into alliances occurs and some of the weaker airlines are forced out of the market; and
- the liberalisation of the trans-Tasman aviation market is not expected to further reduce fares in the short run, but will lead to traffic being spread amongst a wider range of airports in the longer term.

The underlying assumptions for the domestic forecasts are as follows:

- in the short to medium term fares will increase at a rate 2 per cent less than inflation and by 0.5 per cent less than inflation in the longer term;
- the high scenario forecasts assume additional ad hoc entry into the Australian market (for example by Air New Zealand);
- an aggressive, competitive market exists;
- no significant increase in fuel prices or significant fluctuations in currency exchange rates;
- a reduction in domestic add-on to international fares (large due to alliances developing between international and domestic carriers); and
- GDP to grow at 3 per cent per annum on average throughout the 1990s, with a slow down in the mid 1990s due to capacity constraints in the economy (based on BIS Shrapnel 1992, *Long Term Forecasts: Australia 1992-2002*).

The assumptions underlying the regional forecasts are similar to those for the domestic forecasts with the additional assumption of a marginal increase in the projected number of passengers per movement to 10.9 by 2011-12. Similarly, for GA the most important assumptions for the forecasts are those relating to the expected growth in the economy.

The central FAC (1993a) forecasts for the 14 FAC airports examined and Cairns airport were interpolated between years and extrapolated for the last three years of the study period by, Travers Morgan.

There are several short comings with the FAC (1993a) forecasts. The forecasts were undertaken before the announcement of the year 2000 Olympic Games in Sydney and as such do not account for the impact of the Games on demand. Forecasts of GA movements for Cairns are not available. The FAC forecasts were prepared in January 1993. Since that time the economy has grown at a slower rate than anticipated by the forecasters, and the airline Compass II has collapsed (FAC 1993a).

Alternative forecasts for Sydney (more specifically the Sydney Basin ie KSA and Sydney West Airport (SWA)) have been produced by the Aviation Statistics Branch within the Department of Transport (AVSTATS), which have been devised to take account of the impact of the 2000 Olympics and the accelerated development of SWA. These figures form the basis of the sensitivity analysis undertaken.

Currently, alternative forecasts for the other major airports around the country are unavailable. As such, the flow-on effects from the higher alternative Sydney forecasts to other airports can not be accounted for. In lieu of a network forecasting model to take account of the flow-on effects and network interactions, we have made pro-rata adjustments to the FAC (1993a) forecasts for Melbourne, Brisbane, Perth and Cairns based on the increase in the growth rates for Sydney. These figures have then been used to perform a sensitivity analysis for the four airports. Further discussion of the sensitivity forecasts and analysis is included in chapter 6.

Forecasts

Table 4.1 presents summary details of the projected growth in demand for air passengers movements, aircraft movements and air cargo volumes, 1995-96 to 2014-15. A more detailed examination of the forecasts by market segment follows a brief overview of the forecasts based on this table.

Passenger movements for all airports are forecast to grow at 3.7 per cent per annum to total 113M in 2014-15. International passenger movements are expected to be the fastest growing segment (5.2 per cent per annum).

It is assumed that aircraft movements increase less than proportionately with forecast passenger movements. Airlines can satisfy demand growth either by increasing the frequency of services and/or by using larger aircraft. By increasing the frequency of services, airlines contribute to greater congestion, delays and associated costs. Use of larger aircraft causes aircraft movements to

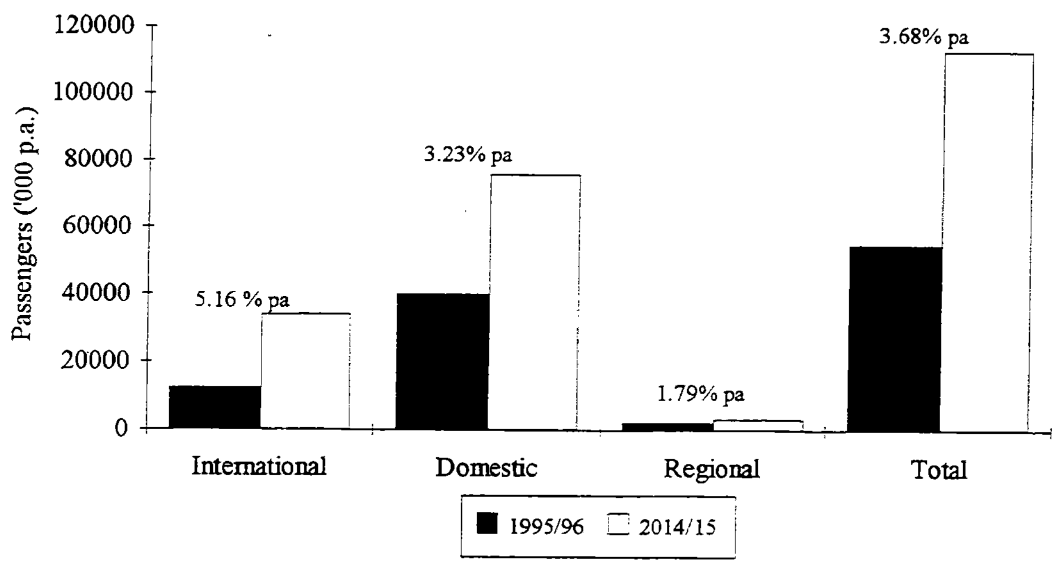
TABLE 4.1 SUMMARY TABLE : PASSENGER AND AIRCRAFT MOVEMENT, AND AIR CARGO DEMAND FORECASTS, 1995-96 TO 2014-15

	Passengers				*Aircraft*				*Air cargo*			
	1995-96 ('000s)	*2014-15 ('000s)*	*% change 1995-96 to 2014-15*	*% change per annum*	*1995-96 ('000s)*	*2014-15 ('000s)*	*% change 1995-96 to 2014-15*	*% change per annum*	*1995-96 ('000s tonnes pa)*	*2014-15 ('000s tonnes pa)*	*% change 1995-96 to 2014-15*	*% change per annum*
Sydney Basin[a]	17 900	36 800	105.0	3.7	236	345	46.2	1.9	354.3	581.0	64.0	2.5
Melbourne	11 800	21 800	84.5	3.1	165	255	54.5	2.2	200.4	324.4	61.9	2.4
Brisbane	8 400	19 300	130.3	4.3	139	232	66.6	2.6	94.9	186.1	96.1	3.4
Cairns	2 900	9 000	209.6	5.8	47	98	108.4	3.7	17.5	47.2	169.5	5.1
Perth	3 700	7 800	111.3	3.8	85	124	45.8	1.9	73.6	153.3	108.1	3.7
Adelaide	3 400	5 100	52.4	2.1	122	163	33.8	1.5	32.0	51.8	61.9	2.4
Coolangatta	1 800	4 700	155.0	4.8	109	199	82.1	3.0	na	na	na	na
Canberra	1 600	2 400	46.2	1.9	148	199	33.7	1.5	4.2	6.0	43.7	1.8
Alice Springs	760	2 000	163.0	5.0	35	67	88.5	3.2	na	na	na	na
Darwin	700	1 600	133.3	4.3	84	127	52.3	2.1	6.0	11.2	87.5	3.2
Hobart	750	1 100	49.9	2.0	15	20	31.2	1.4	7.0	7.6	9.5	0.5
Townsville	500	780	51.6	2.1	83	107	29.8	1.3	na	na	na	na
Launceston	480	500	4.6	0.2	37	38	1.8	0.1	na	na	na	na
Mount Isa	51	53	3.9	0.2	20	23	17.2	0.8	na	na	na	na
Tennant Creek	1	1	0.0	0.0	0.2	0.2	0.0	0.0	na	na	na	na
Total[b]	54 800	113 000	106.0	3.7	1 326	1 997	50.6	2.1	789.8	1 368.5	73.3	2.8

a. RPT forecasts for the Sydney Basin (KSA and SWA) plus general aviation forecasts for KSA. Separate forecasts for SWA are currently not available.

b. Totals may not add exactly due to rounding.

Source FAC forecasts (1993a) interpolated and extrapolated by Travers Morgan for BTCE.



Note: The figures above the columns are the average annual growth rates for the period.

Source FAC (1993)

Figure 4.1 Forecast passenger movements and growth rates, 1995-96 to 2014-15

grow less than proportionately with passenger movements. Airlines have to determine the optimum trade-off between the economies of scale from larger aircraft and the value of greater service frequency in the market for time sensitive passengers. Similarly, it is assumed that average passenger loadings per movement will increase, thereby contributing to less than proportional growth in aircraft movements.

Aircraft movements are forecast to grow at 2 per cent per annum, to reach 2M in 2014-15. Again, the international sector of the market is expected be the fastest growing segment (3.5 per cent).

Overall, Sydney is expected to remain the largest aviation market in 2014-15 in terms of passenger throughput, aircraft movements and air cargo. Cairns is expected to experience the greatest overall growth in passengers, and in particular, international passengers, and aircraft movements. On the basis of these figures, by 2014-15, Cairns is expected to become the fourth busiest airport in the country in terms of passenger numbers, behind Sydney, Melbourne and Brisbane. It is primarily passenger demand rather than freight demand which is driving infrastructure needs.

Passenger movements

Figure 4.1 shows the projected passenger movements and growth rates for the aggregate of the 15 airports over the period 1995-96 to 2014-15. The total passenger throughput for the airports examined is expected to grow strongly over the study period at 3.68 per cent per annum. The international component of total throughput is expected to exhibit the strongest growth. In 2014-15, 34M international, 76M domestic and 3M regional passengers are expected to travel to/from and within Australia.

Table 4.2 shows the aggregate mix of passenger traffic for the 15 airports for the beginning and the end of the study period. Clearly, domestic passengers continue to be the largest component of passenger traffic over the period although as a proportion of total passenger movements they decline over the period, while the proportion of international passengers rises.

TABLE 4.2 FORECAST PASSENGER MIX 1995-96 AND 2014-15

(per cent)

Year	*International*	*Domestic*	*Regional*	*Total*
1995-96	23	73	4	100
2014-15	30	67	3	100

Source FAC (1993a).

International passengers

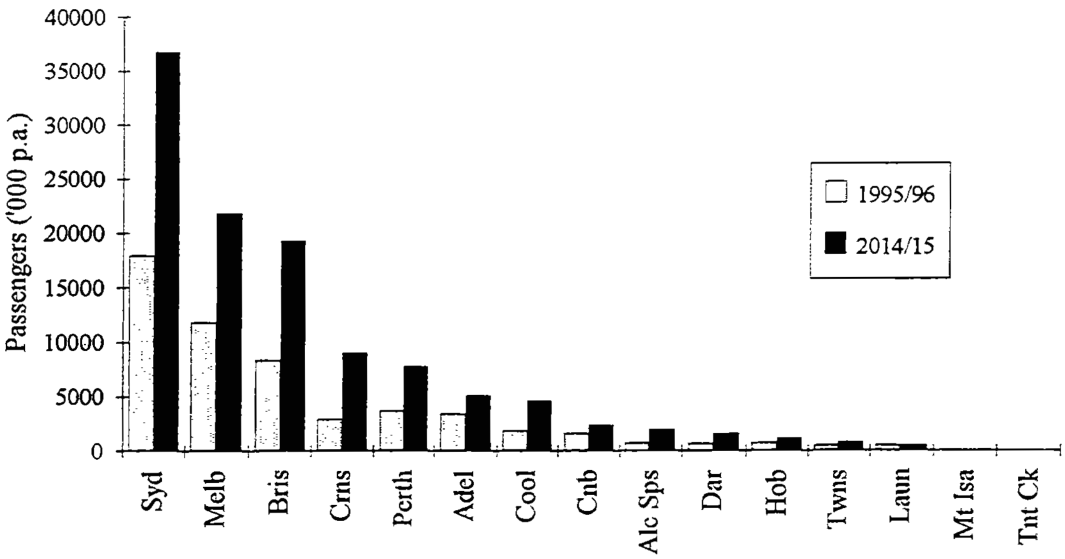
Sydney is expected to remain Australia's largest gateway for international passengers. It is forecast that 13.9M international passengers will enter/depart Australia through Sydney by 2014-15 (4.56 per cent per annum). In 1995-96 more than 45 per cent of all international passengers are expected to move through Sydney. This figure is expected to fall to approximately 40 per cent by 2014-15 as gateways such as Cairns attract a larger proportion of the market.

Over the period Brisbane is expected to replace Melbourne as the second largest international airport in the country (tables I.1, I.2 and I.3). Brisbane's market share remains constant over the period at 16 per cent, while Melbourne's share slips from 18 per cent to 15 per cent.

Cairns is expected to exhibit the strongest growth of international passengers of all the international gateways (at 8.45 per cent per annum). Numbers are expected to reach 4.4M in 2014-15. It is anticipated Cairns will capture 13 per cent of the market at the end of the period, making it the fourth largest gateway in the country.

Domestic passengers

Sydney, Melbourne and Brisbane, respectively, are expected to remain the largest markets in terms of domestic passengers over the study period (with a combined market share in 2014-15 of almost 70 per cent) (tables I.1, I.2 and I.3).



Source FAC (1993a)
Figure 4.2 Forecast passenger movements by airport, 1995-96 and 2014-15

Over the study period domestic passenger numbers at Sydney are expected to grow at 3.28 per cent per annum. It is estimated that 22.1M passengers will move through Sydney in 2014-15.

Alice Springs is expected to exhibit the strongest growth in domestic passenger numbers between 1995-96 and 2014-15. Passenger traffic is expected to grow from 755 000 to almost 2M per year (4.95 per cent per annum). This represents less than 3 per cent of the total domestic market at the end of the study period.

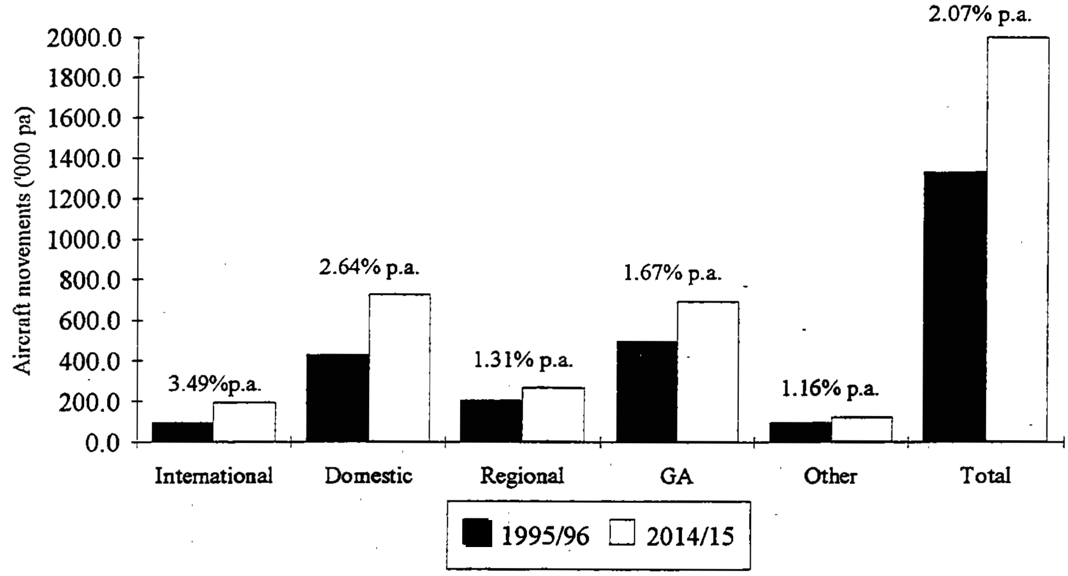
Brisbane, Cairns and Coolangatta are all expected to experience growth in domestic passenger throughput of at least 4 per cent per annum over the period.

Regional passengers

Sydney, Melbourne and Adelaide are expected to continue to be the largest markets in terms of regional passengers over the study period, although growth in regional passengers is expected to be slow at these airports. Growth in regional passenger numbers is expected to be the strongest at Alice Springs (5.7 per cent per annum). Growth in excess of 2 per cent per annum is also predicted for Coolangatta, Brisbane, Cairns and Canberra.

Total passenger movements

Figure 4.2 shows the forecast levels of passenger movements by airport for 1995-96 and 2014-15. Clearly, Sydney, Melbourne and Brisbane show the largest increases in total passenger throughput over the study and remain the



Note: The figures above the columns are the average annual growth rates for the period.

Source FAC (1993a)

Figure 4.3 Forecast aircraft movements and growth rates, 1995-96 to 2014-15

three busiest airports in the country. In terms of overall market share at the end of the period, Sydney is expected to attract 33 per cent of all passengers (or 37M), with Melbourne and Brisbane capturing 19 and 17 per cent, respectively. Cairns will overtake Perth and Adelaide to become the four busiest airport in terms of total passengers, capturing 8 per cent of the total passenger market.

An examination of the passenger traffic mix over the study period reveals that the most significant changes in the mix occur at airports such as Perth, Cairns and Darwin were strong international markets are emerging. Over the study period, international passengers at Perth and Cairns airports increases from approximately one-third to almost 50 per cent of total passengers. International passengers in 2014-15 are expected to have grown to 36 per cent of all passenger traffic through Darwin. The proportion of international passengers to total traffic at Sydney, Melbourne, Brisbane and Adelaide is also expected to increase over the period, but by smaller magnitudes.

Aircraft movements

Figure 4.3 presents the forecast of aircraft movements for 1995-96 and 2014-15 and the associated growth rates, for the 15 airports in aggregate. The international sector of the market is expected show the strongest growth. The total number of aircraft movements at the 15 airports in 2014-15 is expected to equal 2M, comprised of 194 000 international, 725 000 domestic, 268 000 regional and 810 000 GA and Other movements (tables I.3, I.4 and I.5).

TABLE 4.3 FORECAST AIRCRAFT MIX, 1995-96 AND 2014-15
(per cent)

Year	*International*	*Domestic*	*Regional*	*GA*	*Other*[a]	*Total*
1995-96	7	32	16	38	7	100
2014-15	10	36	13	35	6	100

a. Includes charter and military movements.
Source FAC (1993a).

Table 4.3 shows that the mix of traffic is expected to change only slightly over the study period.

International aircraft movements

Sydney is expected to remain Australia's largest international gateway in terms of aircraft movements over the period of the study. International aircraft movements at Sydney are expected to reach 66 500 by 2014-15. Over the study period the proportion of total international traffic through Sydney is expected to fall from 42 per cent to 34 per cent. This is consistent with the international passenger forecasts outlined in the previous section.

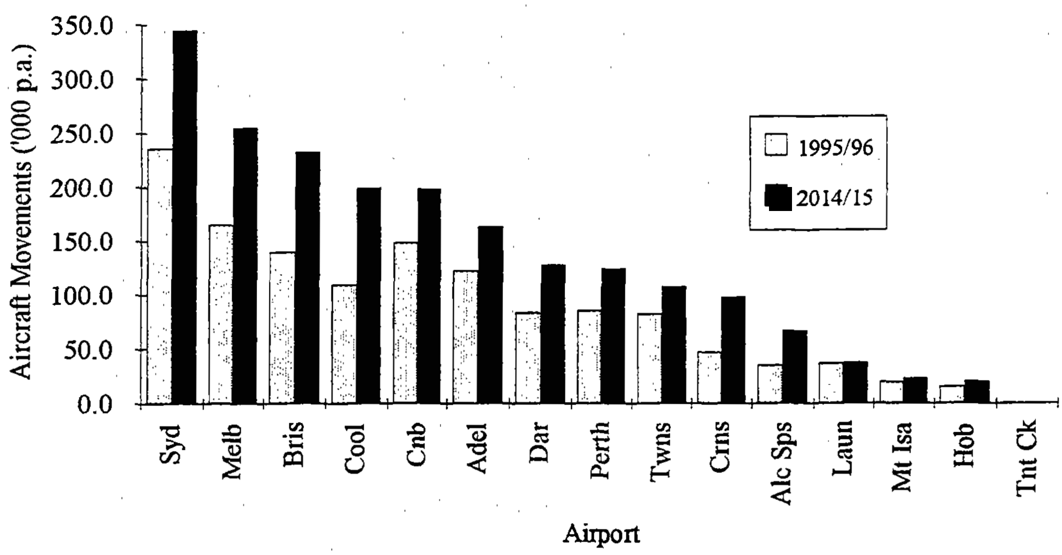
The highest average annual growth for international movements between 1995-96 and 2014-15 is forecast for Cairns (5.97 per cent). This strong growth results in Cairns passing Melbourne and Brisbane as the second largest international gateway in terms of aircraft movements in the country by 2014-15 (with a market share of 20 per cent).

Strong growth is also forecast for international aircraft movements at Darwin and Perth (4.66 and 4.29 per cent, respectively).

Domestic aircraft movements

The forecasts indicate that almost two-thirds of domestic aircraft movements will occur at Sydney, Melbourne and Brisbane in both 1995-96 and 2014-15. Over the period the market shares of Sydney and Melbourne are expected to decline marginally while Brisbane's share is expected increase.

Alice Springs is expected to experience the strongest growth in domestic movements over the period (5.15 per cent). Growth at Alice Springs is from a low base, and as such domestic movements in 2014-15 represent less than 5 per cent of total domestic movements. Growth in domestic aircraft movements is forecast to exceed 3 per cent at Coolangatta, Cairns, Brisbane and Darwin.



Source FAC (1993a)

Figure 4.4 Forecast levels of aircraft movements by airport, 1995-96 and 2014-15

Regional aircraft movements

Sydney, Brisbane and Adelaide are expected to have the highest number of regional aircraft movements over the study period. Regional traffic is not expected to grow significantly at these airports. Overall, growth in regional traffic at the 15 airports is expected to be low, with only Brisbane forecast to grow at more than 2 per cent over the period.

GA and Other aircraft movements

Canberra and Coolangatta are forecast to have the largest number of GA and Other aircraft movements in both 1995-96 and 2014-15. The forecasts estimate that GA and Other movements at these two airports combined will total approximately 300 000 in 2014-15, representing more than 36 per cent of the total GA and Other market. Growth in GA and Other aircraft movements of at least 2 per cent per annum is expected at Coolangatta, Melbourne and Alice Springs.

Total aircraft movements

Overall, the forecasts predict Sydney will remain the busiest Australian airport in terms of total aircraft movements over the study period. It is estimated that total aircraft movements at Sydney in 2014-15 will equal 345 000 movements or 17 per cent of total aircraft movements in the country. Figure 4.4 presents forecast levels of total aircraft movements by airport for 1995-96 and 2014-15. Melbourne and Brisbane remain the second and third busiest airports in the country, with Coolangatta and Canberra the fourth and fifth busiest, respectively, due to the high numbers of GA and Other movements. Cairns is forecast to experience the strongest growth in total movements amongst the airports (3.22 per cent per annum), with Alice Springs and Coolangatta also to experience growth in excess of 3 per cent per annum.

An examination of the forecasts indicate that there will be few significant changes in the mix of aircraft movements at the 15 airports over the study period. International traffic will increase as a proportion of total movements at all seven international gateways, particularly Cairns where international movements are expected to reach 40 per cent of all movements by 2014-15. Regional traffic is expected to decline at all airports over the period, while GA and Other movements will continue to account for the majority of aircraft movements at the regional airports and Darwin.

Overall, growth in total passenger movements (3.68 per cent per annum) is expected to exceed growth in total aircraft movements (2.07 per cent per annum) over the study period.

AIR CARGO

Methodology

Air cargo is made up of two components, air freight and mail, both of which were forecast separately. Due to data limitations air cargo forecasts could only be produced for nine of the airports: Sydney, Melbourne, Brisbane, Adelaide, Perth, Hobart, Darwin, Cairns and Canberra. Initially, forecasts of air cargo were made based on a historical series collected by the Department of Transport. The freight data available are incomplete due to a high degree of non-reporting of freight volumes by RPT carriers and the total non-reporting of volumes carried in dedicated freight services. The average annual growth rates for air cargo for each airport over the period 1982-83 to 1992-93 were calculated. The growth rates were then applied to the last year of the Department of Transport series and cargo tonnages were extrapolated to the year 2014-15. These simple linear projections produced some anomalies between airports, which required another forecasting method to overcome.

Regressions were run on RPT aircraft movements and air freight data, and RPT aircraft movements and mail data, for each airport. They revealed a good linear correlation between these variables for most airports. The coefficient of determination (R^2) was calculated for each airport and the results are presented in table 4.4. R^2 represents the proportion of variation in air freight and mail volumes which is explained by variations in aircraft movements. The higher the value of R^2, the greater the explanatory power of aircraft movements (that

TABLE 4.4 LINEAR CORRELATION BETWEEN AIRCRAFT MOVEMENTS AND AIR CARGO TONNAGES, 1982-83 TO 1992-93

(coefficient of determination R^2)

	International		Domestic	
Airport	*Freight*	*Mail*	*Freight*	*Mail*
Sydney	0.98	0.61	0.59	0.91
Melbourne	0.95	0.93	0.47	0.82
Brisbane	0.86	0.85	0.55	0.91
Adelaide	0.93	0.89	0.64	0.36*
Perth	0.86	0.78	0.30*	0.71
Hobart	0.62	0.06*	0.00*	0.05*
Darwin	0.81	0.80	0.59	0.04*
Cairns	0.97	0.76	0.03*	0.75
Canberra	NA	NA	0.62	NA

* The correlation is not statistically significant
NA Not applicable

Source Travers Morgan for BTCE (based on AVSTATS data).

is, the stronger the relationship between aircraft movements and freight and mail volumes).

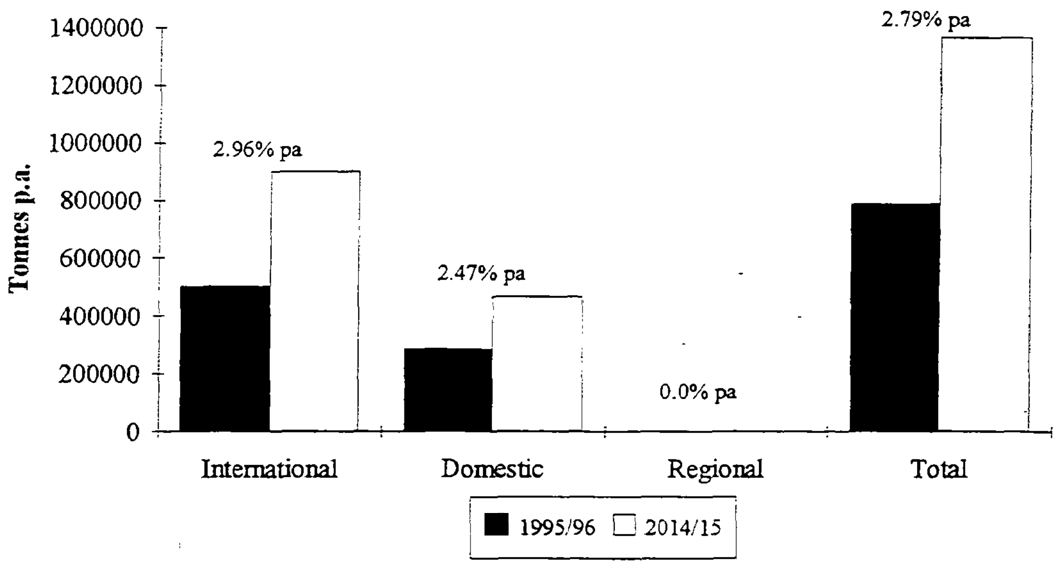
On the basis of the strength of these relationships, international and domestic freight and mail is assumed to grow in direct proportion to aircraft movements. In some instances the correlation was not sufficiently high to provide a statistically significant relationship. For these, the forecasts are based on linear trends as described above. Zero growth has been assumed for all regional freight and mail from 1992-93 onwards. The air cargo forecasts are included in appendix I.

As would be expected, there are strong correlations between air cargo tonnages and aircraft movements as approximately 90 per cent of total air freight is carried in RPT movements. Despite the data limitations mentioned previously, AVSTATS examined the forecasts, and believes the tonnages predicted are within likely bounds.

Forecasts

As mentioned previously, the analysis of air cargo is hampered by incomplete data. The figures on which the analysis is based only represent part of the total volume of air freight carried into/out of and within Australia.

Figure 4.5 shows the forecast levels of air cargo and the growth rates for the aggregate of the 15 airports examined over the study period (1995-96 to 2014-15). Air cargo volumes are expected to grow by an average of 2.79 per cent per annum. International cargo represents the largest component of total air



Note: The Figures above the columns are the average annual growth rates for the period.

Source Travers Morgan for BTCE (based on DoT 1994)

Figure 4.5 Forecast air cargo levels and growth rates, 1995-96 to 2014-15

cargo throughout the period and is expected to experience the strongest growth.

In 2014-15 aggregate air cargo volumes are expected to total 1.37M tonnes, made up of 900 500 tonnes of international cargo, 467 000 tonnes of domestic cargo and 980 tonnes of regional cargo (see tables I.8, I.9 and I.10).

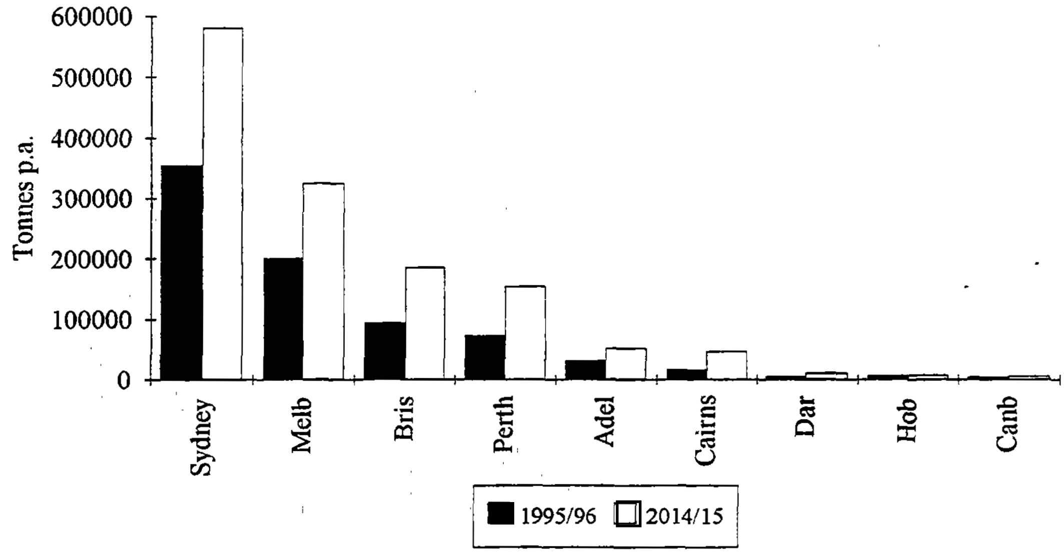
The mix of air cargo is expected to remain relatively stable over the study period. International freight represents the largest component of air cargo, growing slightly over the period (61 to 63 per cent). Domestic freight is the second largest component, representing 30 per cent of total air cargo in 1995-96 and 28 per cent in 2014-15. Regional freight and regional mail represent less than 1 per cent of the total.

Total air cargo

Sydney is expected to have the largest throughput of total air cargo in terms of tonnes per annum, in 1995-96 and 2014-15, followed by Melbourne (see figure 4.6). Cairns is forecast to experience the strongest growth in total air cargo over the period of 5.08 per cent per annum.

International freight

The largest volumes of international freight over the study period are forecast to move through Sydney. International freight of 259 000 tonnes is forecast to pass through Sydney in 1995-96, growing to 425 000 tonnes in 2014-15



Source Travers Morgan for BTCE (based on DoT 1994)

Figure 4.6 Forecast air cargo volumes by airport, 1995-96 and 2014-15

(representing growth of 2.51 per cent per annum). Sydney's market share of the total Australian international freight market is expected to decrease over the period from 54 per cent in 1995-96 to 49 per cent in 2014-15, while gateways such as Perth and Cairns are expected to attract a larger proportion of the market.

Melbourne is forecast to have the second highest throughput for international freight volumes, with international freight volumes expected to total 182 000 tonnes in 2014-15. The strongest growth in international freight volumes is forecast for Cairns (5.97 per cent per annum) and Perth (4.29 per cent per annum).

Domestic freight

Melbourne is forecast to have the highest domestic freight throughput in 1995-96 of more than 72 000 tonnes, representing 30 per cent of the market. While domestic freight volumes through Sydney in 1995-96 are expected to total more than 70 000. Over the study period domestic freight growth at Sydney (2.48 per cent per annum) is expected to outstrip that for Melbourne (2.23 per cent per annum), with freight volumes at Sydney forecast to exceed those at Melbourne by the end of the period.

As with international freight, the strongest growth in domestic freight volumes over the period is expected to occur at Cairns (3.29 per cent per annum), with Brisbane and Darwin also forecast to experience growth in excess of 3 per cent over the study period.

Regional freight

The only regional freight volume of any significance is expected to be through Darwin, 254 tonnes per annum in both 1995-96 and 2014-15, which represents 4.7 and 2.4 per cent of total freight through the airport at the beginning and the end of the study period.

Total air freight mix

Table 4.5 presents the forecast mix of aggregate air freight volumes for 1995-96 and 2014-15. Overall, the figures indicate little change in the mix of air freight over the period. In 1995-96 and 2014-15, international freight volumes are expected to represent more than 50 per cent of total freight volumes at Sydney, Melbourne, Brisbane, Perth and Cairns. International freight as a proportion of total freight at Adelaide is expected to increase from 40 per cent in 1995-96 to 50 per cent in 2014-15.

TABLE 4.5 FORECAST AIR FREIGHT MIX, 1995-96 AND 2014-15
(per cent)

Year	*International*	*Domestic*	*Regional*	*Total*
1995-96	67	33	–	100
2014-15	69	31	–	100

– Less than one per cent

Source Travers Morgan for BTCE (based on DoT 1994)

Domestic freight as a proportion of total air freight is expected to remain relatively stable for most airports. The notable exceptions are Adelaide and Cairns, where the proportion of domestic freight to total freight is forecast to decline at both airports by approximately 10 per cent over the period (to 50 per cent and 24 per cent, respectively).

CHAPTER 5 AIRPORT INFRASTRUCTURE ADEQUACY

As the FAC has invested approximately $1.3B in infrastructure over the past six years, including infrastructure currently under construction, and based on anecdotal evidence, the initial expectation was that infrastructure inadequacies would not be a significant issue at the majority of Australian airports, with the notable exception being Kingsford Smith (Sydney) Airport (KSA). However, the results of the analysis revealed a very different picture. It was found that at ten of the 15 airports examined, significant infrastructure investment was identified as required between 1995-96 and 2014-15 to accommodate forecast demand.

METHODOLOGY

Five of the airports selected for assessment, Hobart, Launceston, Tennant Creek, Townsville and Mount Isa, were not assessed in detail because projected demand is unlikely to exceed the capacity of the existing infrastructure. Only a technical assessment of adequacy has been possible for airports. A model of delays would be a major input to a cost-benefit analysis which would be necessary for a full economic assessment. An economic assessment has not been possible as detailed and comparable data on delays needed to enable the development of a model of delays was not available. Modelling delays is a difficult task as it requires extremely detailed information on delays and the causes of delays. It also requires valuing the delays, which in itself is a complex task.

Operational and regulatory environment assumptions

The capacity of aviation infrastructure is constrained by safety requirements and the operational policies of the Civil Aviation Authority (CAA), FAC, Customs, Immigration, the airlines, trade unions and the regulatory policies of the Department of Transport. We have assumed that the existing operational policy environment remains unchanged during the period of the study, and have assessed the technical adequacy of airports within this environment.

An example of the rationale for this assumption is the waterfront reform which has taken place over the last decade. The productivity gains which have been achieved on the waterfront through changes to work practices and the impact of changes, could not reasonably have been expected, let alone modelled, in the operational environment which existed a decade ago. Similarly, there are too many discretionary operational factors which potentially affect the efficiency of an airport system to be able to predict what will happen over the next two decades with any degree of certainty, within the scope and time frame of this study, although any changes would be expected to be considerably less dramatic for airports than experienced on the waterfront.

Data and plans were collected by the BTCE and Australian Construction Services (ACS) from the FAC, the CAA, Qantas, Ansett Australia, Ansett Air Freight and the ACS archives. The airports were prioritized on the basis of industry knowledge and the growth projections provided. The level of detail of the resulting analysis varies according to the size of each airport and the level of investment required to accommodate demand in the study period.

The identifying of investment needs has been undertaken largely by comparing design capacities for the various infrastructure components with forecast demand and the use of volume to capacity ratios. Based on historical and cross-section data, the following relationships were examined:

- aircraft movements per annum and passengers per annum;
- international terminal areas and international passengers per annum;
- domestic terminal areas and domestic passengers per annum;
- runways and aircraft movements per annum;
- taxiways and aircraft movements per annum;
- taxiways and passengers per annum;
- aircraft parking positions and aircraft movements per annum; and
- aircraft parking positions and passenger movements per annum.

For most of the relationships above, simple mathematical relationships do not exist, and therefore, could not be used in the assessment and forecasting procedure. However, it was decided that the relationship between terminal areas and annual passengers for both domestic and international operations was robust and would be used to determine investment requirements.

Actual terminal areas and annual passenger movements for international terminals at KSA, Melbourne, Brisbane, Adelaide, Perth, Darwin and Cairns, were plotted for two or three selected years. Two relationships emerged. Perth (1994-95) and Sydney (1992-93) and Brisbane (1995-96), when the New Brisbane International Terminal is commissioned, will represent terminals which have characteristics of high space per passenger ratios and thus room for expansion.

A line drawn through those terminal plotting points on a log-log plot represents a size to be aimed for at the time of commissioning an upgrade (see figure 5.1).

On the other hand, a line (of equal slope) drawn between the plotting points of Melbourne (1992-93), and the old Brisbane terminal (1994-95) represent terminals working at capacity (the current Brisbane terminal is considered to be over taxed).

Two lines were then estimated from the log-log relationships, as shown in Figure 5.1:

$$A_{IN} = 0.03\ P_{IN}$$

where A_{IN} is the predicted (new) terminal area at the time of commissioning an expansion and P_{IN} is the predicted annual international passenger movements in the expansion year:

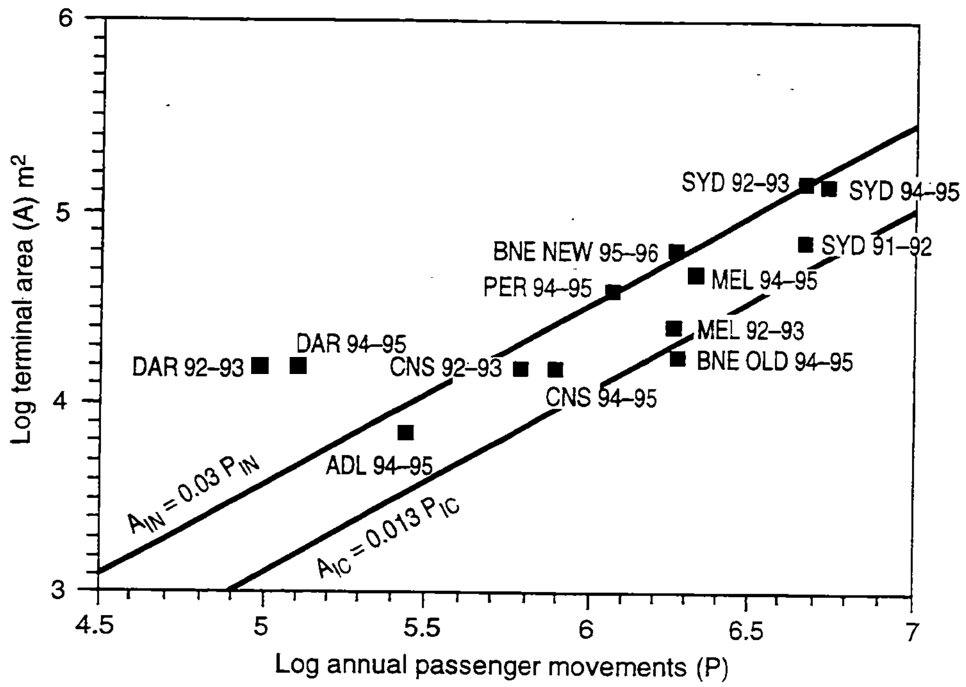
$$A_{IC} = 0.013\ P_{IC}$$

where A_{IC} is the area of a terminal, working at maximum capacity under predicted annual international passenger movements of P_{IC} for a given year.

Alternatively, the second equation above can then be re-written:

$$P_{IC} = A_{IN}/0.013$$

to indicate the annual passenger capacity of an existing terminal size A_{IN}.



Source ACS for BTCE.

Figure 5.1 International Terminals - Curve Fitting

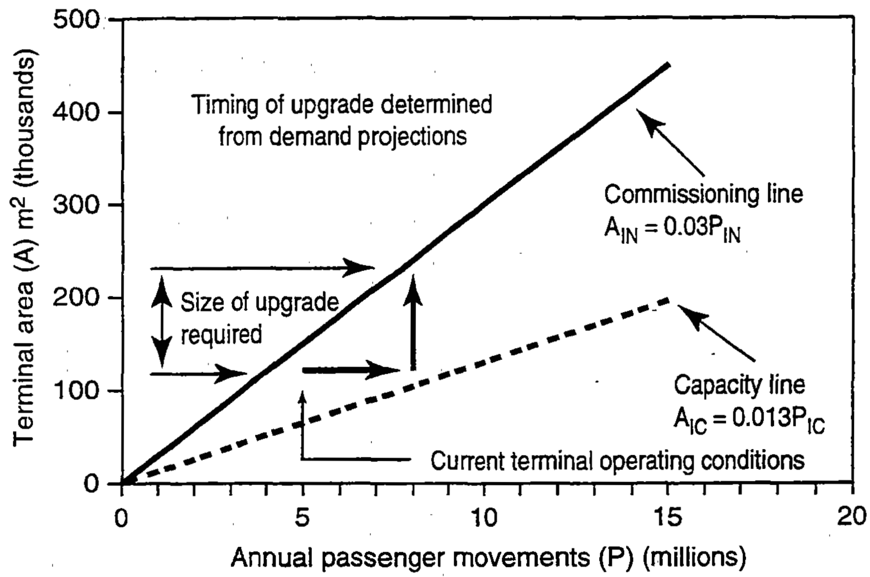


Figure 5.2 International terminals - terminal expansion forecasting 'envelope'

The next step is to refer to demand curves to assess the timing at which an upgrade is needed. The derived lines, which create a development 'envelope', are shown in figure 5.2.

In practice, two relationships were used to judge the upgrading needed;

- the relationship between terminal area and passenger movements; and
- the relationship between parking positions and passenger movements.

The parking position relationship, applied with judgement, is the trigger to the timing of an upgrade. It shows when a practical number of extra positions is required. Depending on the existing number of parking positions, this extra number may be small (1 to 2) or large (4 to 8). In turn, this may require a small terminal extension (aerobridges and/or walkways, and small forward lounges) or a large extension such as a new public concourse, additional shopping facilities and so on.

The same approach was used to develop relationships for predicting domestic terminal requirements. Again an 'envelope' was developed, although in determining the size and timing of terminal expansions an 'average' line was estimated and used which lies between the upper and lower bounds of the envelope. The adopted relationship is:

- $A_D = 0.005P_D^{1.025}$

Where A_D is the calculated domestic terminal area and P_D is the forecast annual number of domestic movements.

The graphs for the domestic terminals are similar to those above for the international terminals and have not been included here.

In determining the need and timing for development of third runways at major airports, a benchmark of 230 000 movements per annum was applied to the forecast annual aircraft movements. This figure represents the level of operations at KSA in 1994-95, the year of the upgrade to a parallel runway system. In using the Sydney benchmark, it is implicitly assumed that the mix of aircraft and the peak periods at the other airports are similar to those at KSA.

To predict aircraft parking positions the initial response was to develop a relationships between terminal size and annual passenger numbers, and between parking positions and aircraft movements. As the study progressed, it became apparent that good mathematical correlations existed in both cases, but it was convenient to use one independent variable, and this was chosen to be annual passenger movements.

As a check, the predicted number of parking positions on the basis of aircraft movements and passenger movements were compared, for forecast aircraft movements and passenger movements for a particular future year. It was found that for Sydney in the year 2009, with approximately 20 million domestic passenger movements, and 230 000 domestic aircraft movements, the predicted number of parking positions were:

- based on aircraft movements 61
- based on passenger movements 66

While it would seem more intuitive to use the parking positions to aircraft movements relationship, the study outcomes should not be significantly different, as seen by the above comparison.

Again, actual parking positions and passenger movements for international and domestic operations for the airports for selected years were graphed on log-log plots. Regressions were run to determine the mathematical relationships. The lines adopted are:

- international parking positions: $N_I = 0.0009P_I^{0.65}$; and
- domestic parking positions: $N_D = 0.000025P_D^{0.88}$.

Where N_I is the number of international parking positions, P_I is the number of international passengers per annum, N_D is the number of domestic parking positions, and P_D is the number of domestic passengers per annum.

From the derived relationships between terminal areas and annual passenger movements, and parking positions and annual passenger movements, the future terminal areas and numbers of parking positions were determined against the projected demand.

Subtraction of the existing terminal areas, and parking position numbers gave the additional works required during the study period. Judgement was used, depending on whether existing aprons or terminals could be extended, or whether extra new works, or even complete new facilities might be required.

In determining apron spaces the areas required to manoeuvre, park, service, push out, and turn each of the following types of aircraft were calculated from data held by ACS:

- B747 - 400;
- B767 - International;
- B767 - Domestic;
- A300 - Domestic;
- B727;
- A320;
- B737;
- BAE146;
- F28; and
- F50.

Unit costs of constructing high strength pavement, fuelling points, etc, for each type of aircraft position were estimated for each airport location from data held by ACS.

The future fleet mix for both international and domestic operations at each airport under evaluation was then judged, and the required additional number of positions allocated aircraft types accordingly. The apron costs were then estimated.

Taxiway improvements were judged from the numbers of aircraft movements, parking positions (number and location) and other operational considerations for each airport.

Using the relationships described in the previous paragraphs, future infrastructure needs were estimated by extrapolating on the basis of forecast passenger and aircraft movements. When inadequacies were identified, the costs of undertaking proposed investments was estimated, based on knowledge of similar actual investments, obtained from records held by ACS, the FAC, the Cairns Port Authority, Qantas and Ansett.

Investments in additional terminal area, gates, aerobridges and apron parking positions are best undertaken in relatively small increments. It is also far more practical for the work to be done in small increments for a variety of reasons:

- small incremental stages of work minimise the impact on daily operations;
- the designs can more accurately address the contemporary user needs;
- the latest technologies in passenger processing can be utilised; and

- financing can be managed more effectively.

The methodology employed for predicting future investment needs, of linear extrapolation with demand forecasts, allows for the identification of incremental projects.

Relying on these relationships to project future infrastructure requirements implicitly assumes that the current level of service provided by existing infrastructure is the appropriate level. Most of the analysis undertaken in this study focuses on annual measures of activity, demand and capacity of aviation infrastructure. This approach provides some useful insights into the overall level of infrastructure utilisation and inadequacies. However, it assumes that the time distribution of demand is similar for all airports and ignores the particular peak[1] characteristics of traffic at different airports. At the major airports examined there are well defined peaks during the day. Typically these peaks occur between 7 am and 10 am in the morning and 5 pm and 8 pm in the evening. It is during these peak periods that airport infrastructure is placed under greatest strain and demand may exceed capacity. Similarly, the methodology assumes that the mix of traffic is the same for all airports and does not change over time.

The infrastructure needs identified and project costs estimated represent the likely lower bound of necessary investment, and do not reflect the total investment in the aviation industry which is likely to occur to the year 2014-15. This is primarily due to the non-inclusionary nature of the estimates. The report provides some comment on a number of issues which have not been costed. These include:

- the provision of surface access to airports;
- the provision of car parking;
- speciality needs to accommodate events such as the Sydney Olympics, and
- the likely development of freight facilities.

Similarly, the estimates for terminal and apron developments do not allow for the costs of providing additional services to existing sites. The cost of demolition and relocation of facilities already occupying, for example, a future terminal and apron development site, have also not been costed.

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[1] Peaking occurs for several reasons:

- there will always be times of the day which are more attractive to passengers;
- airlines schedule parallel services;
- curfews and the availability off connecting flights can result in limited windows during which international flights can depart/arrive, and
- airlines aim to minimise turn around times and maximise the utilisation of their aircraft fleet.

The adopted methodology identifies future investment needs on the basis of past investment practices. Therefore, the analysis does not take account of factors such as changes in the investment decision environment, the ability to raise funds in the capital markets, or technical progress.

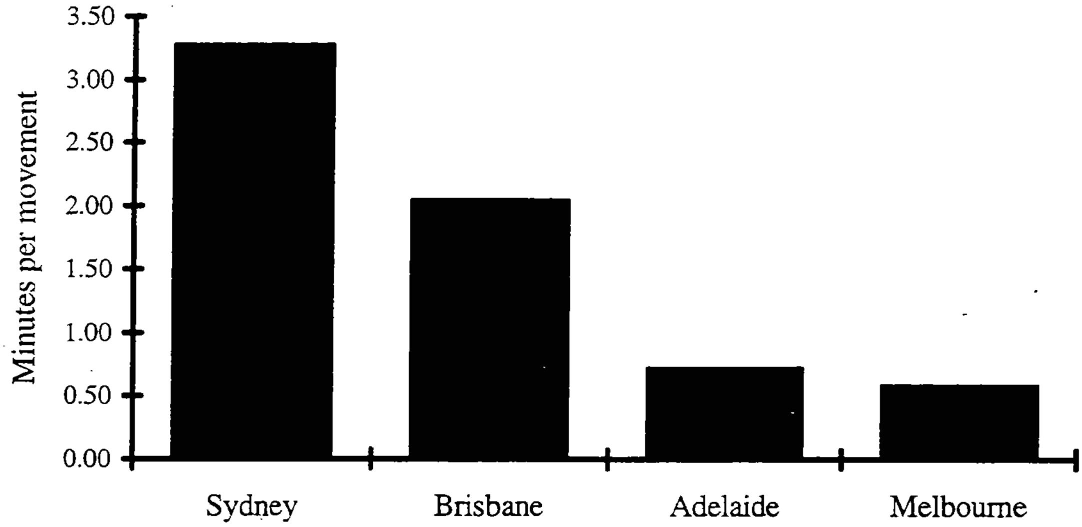
Sydney and Melbourne are examples of airports where demand growth significantly outstripped infrastructure investment prior to 1988. On the other hand, recent international terminal developments at Brisbane and Perth are clear examples of overprovision of capacity. The international terminals at Hobart and Townsville provide examples of overprovision of capacity, where markets have not developed in the manner expected at the time the investment decisions were made, or have been overtaken by other destinations.

RUNWAY CAPACITY AND AIRCRAFT DELAYS

If runway capacity is inadequate, aircraft will experience excessive delays. Delays are therefore the primary indicator of the level of service provided by runways. However, it is difficult to obtain complete and consistent measures of total delays and infrastructure delays. As the industry regulator, the CAA collects delay data for the major Australian airports. The CAA defines delay as the difference between the standard time required for take-off or landing with no air traffic intervention and the actual time taken (CAA, pers. comm. 1994). For an arriving aircraft, a delay is recorded when the actual touchdown time is different from the estimated touchdown time (that is. wheels on the tarmac) with no intervention. A delay is recorded for a departing aircraft between the time the aircraft is pushed back from a gate (or given approval to commence taxiing if it is standing on the tarmac) to becoming airborne, compared with a standard unimpeded taxi time calculated for the given parking position and runway intersection combination used. Clearly, this measure does not represent total delays arising from aviation activity. For example, delays arising from holding aircraft on the ground at gates do not appear in the CAA's delay measure.

Figure 5.3 shows the average total delays per movement as recorded by the CAA's measure of delay.

The four airports shown in the figure are the CAA flow controlled (managed) airports. Detailed records of this nature are not currently kept for other airports. Average delays per movement at KSA (3.28 minutes) are significantly greater than those experienced at Brisbane (2.05 minutes), Adelaide (0.73 minutes) and Melbourne (0.59 minutes). However, the 3.28 minutes recorded for Sydney, is below the benchmark of 4 minutes per movement which is generally accepted within the industry as an acceptable level of average delay.



Source BTCE from CAA Flow Management Database (1994)
Figure 5.3 Average total delays per movement, May 1993 to April 1994

It should be recognised that while, on average, delays at Sydney may be considered acceptable against the benchmark, measures of average delays do not reveal the magnitude of delays and congestion experienced during peak periods. The CAA average arrival delay for the worst 30 arrival hours at KSA in the year May 1993 to April 1994, peaked in August 1993 at 21 minutes, while the average departure delay for the worst 30 departure hours for the same period peaked at 14 minutes in June 1993.

Appendix II contains a more detailed discussion of airport congestion and delays. It also provides some more detailed insights into the delay performance of the four flow controlled airports.

FORECAST INVESTMENT NEEDS

As mentioned previously, demand at Hobart, Launceston, Townsville, Mount Isa and Tennant Creek airports is unlikely to exceed capacity.

Table 5.1 presents the projected demands for each of those locations during the study period.

Each of these airports has a two runway system. The main runway serves RPT aircraft, while the secondary, or cross wind, runway predominantly serves GA aircraft.

A complete set of demand figures was not available for all these locations. However, it was possible to make some careful judged extrapolations to determine that, except for Townsville, they did not achieve the levels of aircraft

TABLE 5.1 SUMMARY INFORMATION ON AIRPORTS EXCLUDED FROM DETAILED ANALYSIS

Airport	*Max annual passenger movements ('000 p.a.)* 1992-93	2014-15	*Existing terminal area ('000 m²)*	*Current capacity of existing areas ('000 pax p.a.)*	*Max annual aircraft movements ('000 p.a.)* 1992-93	2014-15
Hobart	718.0	1 123.0	5.8[c]	1 500.0	14.4	20.2
Launceston	466.0	730.0[a]	3.4	800.0	37.1	53.5[a]
Townsville	556.0	1 100.0[b]	10.0	2 000.0	61.1	120.0[b]
Mount Isa	83.5	162.0[b]	na	na	8.2	16.5[b]
Tennant Creek	Not available	(Note, permanent airport staff = 1 groundsman)				

na Not available

pax Passengers

a. Pro-rated as per Hobart.

b. Pro-rated as per Darwin (approx).

c. Domestic 2800 sqm and international 3000 sqm.

Source ACS derivation for BTCE.

movements projected for Alice Springs (66 000 movements in year 2014-15), and Coolangatta (198 600 movements in year 2014-15). In the following sections, it is shown that both Alice Springs and Coolangatta airports have sufficient capacity under the existing airfield configuration to satisfy demands to the end of the study period. Therefore, no significant works are likely to be required to the airfields. Also, none of the airports except Hobart is a terminating RPT airport.

With respect to the adequacy of terminals, Townsville and Hobart each has an international terminal which will readily accommodate any expansion required during the study period.

There is some suggestion that Hobart has the potential to increase air freight volumes, especially in the export of live sea foods. Assessment of this is beyond the scope of this report, except to say that any dedicated freight operations should be able to be accommodated by the existing runway and taxiway system.

Aggregate investment summary

Table 5.2 shows the estimated airport investment needs. The total for the 20 year study period is at least $2.8B. Spending on terminal expansion is 67 per cent of the total and far outweighs spending on tarmac infrastructure. Some 30 per cent of the total expenditure is at Sydney airport, and terminal expansion accounts for most of this. The $2.8B estimate of total airport investment requirements represents a lower bound, as air freight and aircraft maintenance facilities, and roads and car parks have not been assessed. At Sydney West

Airport (SWA) costs of infrastructure other than the runway and platform for the terminal are also excluded.

TABLE 5.2 AIRPORT INVESTMENT SUMMARY: 1995-96 TO 2014-15

($ millions)

	Apron parking positions	*Bay upgrade for W/B aircraft*	*Runway upgrade*	*Taxiway upgrade*	*Terminal expansion*	*Third runway development*	*Total cost*
Sydney-KSA	63	-	-	13	770	-	846
Sydney-SWA	na	na	120[a]	na	na	-	120
Brisbane	39	-	110	1	280	300	730
Melbourne	35	-	30	8	363	90	526
Cairns	30	-	-	6	220	-	256
Perth	18	-	-	10	105	-	133
Adelaide	10	-	20	4	75	-	109
Canberra	3	-	15	7	35	-	60
Coolangatta	4	-	-	-	40	-	44
Darwin	4	1	-	-	8	-	13
Alice Springs	-	1	-	-	-	-	1
Total	206	2	295	49	1 896	390	2838

na Not available

a. The cost of constructing the 2900m runway and the platform for terminal development is estimated at $120M. No estimates are available for the other infrastructure.

Source Australian Construction Services (ACS) consultants (1994).

Findings for individual airports are summarised in the following sections. The airports are presented in descending order of the value of total required investment, except for SWA which is placed with KSA for convenience.

Kingsford Smith (Sydney) Airport

It has been assessed that in order to meet the demands of Sydney Kingsford Smith Airport (KSA) to the year 2014-15, investments totalling $846M (August 1994 prices) will be required, to keep pace with the forecast passenger and aircraft movement growth.[2] This is 30 per cent of the total expenditure identified for all airports.

Sydney KSA is Australia's principal airport, with current and projected demands of the order of 40 per cent greater than the next busiest airport,

[2] This figure is in addition to the $243M spent on the parallel runway at KSA which was commissioned on 8 November 1994, and excludes the cost of the new air traffic control tower ($15.2M) and the Parallel Approach Radar Monitor (PARM) ($14.9M) both of which will be commissioned at KSA within the next twelve months, and associated developments and equipment installations ($5.8M) (CAA, pers. comm. 1994).

Melbourne's Tullamarine. During the study period, the share of total Australian aviation traffic handled by Sydney KSA will decrease, but even after twenty years, it will still handle approximately 30 per cent of the total movements at the top ten major Australian airports. Its share of international traffic to and from Australia will fall, but it will still be the largest international gateway in Australia.

In practical terms, due to the importance of KSA, this means that events at Sydney KSA often affect airports all around the country. This is frequently the situation with delays. Delays at airports such as Maroochydore and Darwin can often be sourced back to causes at Sydney (Ansett, pers. comm. 1994; Qantas, pers. comm. 1994). Investments in improvements at Sydney KSA can therefore deliver benefits of value to locations beyond Sydney.

Sydney KSA is currently operating at about 230 000 aircraft movements per annum, close to the capacity of the existing two runway system. The opening of the new parallel runway provides a theoretical capacity in the vicinity of 353 000 aircraft movements annually. On the basis of the FAC (1993a) demand forecasts, aircraft movements will approach this level in the final year of the study period.

In addition to the potential capacity constraints which are discussed in the sensitivity analysis (see chapter 6), Sydney KSA is likely to suffer increasing environmental complaints about noise pollution, and about increasing surface transport congestion. The cost of compensating noise-affect residents has been estimated at \$183M[3] (Hon. Laurie Brereton MP, News Release, 1 November 1994). Indications are that the aviation industry will have to recover these costs from the airport users. These costs are not included in the estimates in this report.

Sydney KSA will have sufficient airfield capacity to cope with demand related to the 2000 Sydney Olympics but the current terminal processing rate of 3400 passengers per hour will have to be increased to 5450 passengers per hour. While the study has not identified these works on a FAC program, they are necessary. An expenditure of about \$120M in 1998-99 and 1999-2000 has been estimated for four additional aircraft parking positions and 40 000 m2 of extra international terminal space to be provided in preparation for the Games. Prior to year 2000, \$62M will need to be spent on additional domestic terminals and parking positions.

A summary of the envisaged works forecast is shown in table 5.3.

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3 The compensation estimate includes \$40M for property acquisitions, and \$143M for insulating buildings and administrative costs.

The works listed in table 5.3 do not include the relocation of the Qantas maintenance hangar from the eastern side of the airport to the western side of the north-south runway. Nor does it include the relocation of the domestic and international freight complexes from the north side of the east-west runway to the south. Both of these relocations are illustrated in some of the FAC master plans examined.[4]

TABLE 5.3 IDENTIFIED INVESTMENT AT KSA, 1995-96 TO 2014-15

Year	*Identified investment*	*Cost ($M)*
1995-96	None	-
1996-97	4 domestic parking positions, 10 000 m^2 domestic terminal extension	30.0
1997-98	4 domestic parking positions, 10 000 m^2 domestic terminal extension	30.0
1998-99	500 m domestic taxiways	2.5
1999-00	4 international parking positions, 40 000 m^2 international terminal extension	120
	500 m taxiway (prior to Olympics)	
2000-01	4 domestic parking positions, 15 000 m^2 domestic terminal extension	42.5
2001-02	4 domestic parking positions, 15 000 m^2 domestic terminal extension	45.0
	4 international parking positions, 40 000 m^2 international terminal extension	114.0
2002-03 to 2004-05	None	-
2005-06	4 domestic parking positions, 10 000m2 domestic terminal extension	31.0
	500 m domestic taxiways	
2006-07	4 domestic parking positions, 10 000 m^2 domestic terminal extension	30.0
	500 m domestic taxiways	
2007-08 to 2009-10	None	-
2010-11	10 international parking positions, 110 000 m^2 international terminal extension	312.0
2011-12	10 domestic parking positions, 30 000 m^2 domestic terminal extension	89.5
2012-13 to 2014-15	None	-
Total		846.0

Source ACS estimates for BTCE.

4 The FAC has developed masterplans for most of the airports it operates. A masterplan presents the foreseen ultimate development of the airport and are updated periodically. The plans do not include times for addition developments.

It is worth noting that the relocation of domestic and international freight from north of the east-west runway to the south may mean that both facilities would be accessed from General Holmes Drive which would place increased pressure on this already congested road.

No cost estimates have been provided for the growth of passenger car parking or internal road modification. It is not clear where FAC have masterplanned the increased car parking.

With respect to timing of the works, the table illustrates a possible scenario which delivers facilities at times to meet demands. This scenario does result in 'lumpy' expenditures for this airport. This becomes particularly significant in a post-privatisation environment if an owner only owns a single airport. Where a number of airports are owned by a single entity, cross-subsidisation of investments between airports allows a smoothing of an investment expenditures over time.

Sydney West Airport

The Federal Government announced on 4 May 1994 that it would accelerate the development of the new Sydney West Airport at Badgery's Creek by arranging for the construction of a 2900 m runway, capable of handling B747 aircraft, with a completion date of 1998-99. This would enable B747 operations, on this curfew-free airport, to fly direct to Honolulu, Tokyo, Hong Kong, Bangkok and Singapore.

Reports issuing from the September 1994 Australian Labour Party (ALP) Conference indicate that the Government plans to accelerate the development of this airport to full commercial use at a cost of $120M. This will provide an opportunity to share aircraft traffic between Sydney KSA and Sydney West airports, particularly during the Olympic Games in the year 2000.

In conjunction with the New South Wales (NSW) Government, the Federal Government is planning high quality transport links between KSA and KSA airports and a 'Joint Task Force' has been established to plan the transport links between airports. This is discussed further in chapter 6.

Brisbane

As Brisbane is the most recently designed major airport in Australia, its masterplanning is still current and accurate, incremental growth is very much part of the airport design. It is a simple task to incrementally expand facilities on this airport, in balance with passenger demand.

The expenditure proposed for Brisbane is generally for linear expansion of existing domestic terminals and the same for the new international terminal. It was the intention of the Government in 1975 that the current international terminal be used for as a freight terminal when the permanent international terminal is constructed on this masterplanned site. The new international terminal is under construction and this option is still available.

The first upgrade of the domestic terminal (1998-99) could be for addition terminal space and aerobridges, generally associated with the existing 'incomplete' central satellite.

Brisbane Airport is estimated to reach 230 000 aircraft movements per year in 2014-15. It is assumed that an aircraft mix similar to Sydney would apply at Brisbane. It may then be necessary for Brisbane to introduce a parallel runway in approximately 2014-15 (see table 5.3). This would be at a cost of $300M. The non-curfewed operation may allow some deferral of this development. Prior to this, it would be necessary to upgrade and extend the existing cross-wind runway. This has been allowed for in the late 1990s - initially to widen the strip to 45 m and extend on land, then to extend it into Moreton Bay. This project would be subject to considerable environmental scrutiny.

A summary of the works is in table 5.3.

Melbourne

Melbourne has been the subject of a major study of public review, *The Melbourne Airport Strategy*, conducted by FAC in the late 1980s (FAC 1990b). The study concluded, in September 1990, that the ultimate development should be along the lines of two wide spaced (2000 m approximately) runways in the east-west direction and two intermediate spaced (1311 m) runways in the north-south direction. Terminal development would be to the east of the easternmost north-south runway, between the wide spaced east-west runways. Other developments such as aircraft maintenance and freight would be in the same zones, but further to the south.

There is a strong case for relocating the international terminal operations to the south of the existing Ansett freight complex. Currently the international pier is situated between the domestic terminals. This position physically restricts the future development of the terminal. If the terminal were relocated it would allow the expansion of the international facilities and at the same time allow the domestic terminals to expand into the existing international pier. This option has been costed as an alternative at $386M, providing 140 000 m^2 terminal space and 22 B747 parking positions. This cost is not included in the base figures. By comparison, the proposed international terminal upgrades allowed for in the estimates amount to $247M (table 5.5). The estimates also allow for an extension

TABLE 5.4 IDENTIFIED INVESTMENT AT BRISBANE AIRPORT, 1995-96 TO 2014-15

Year	*Identified investment*	*Cost ($ million)*
1995-96 to 1996-97	None	-
1997-98	Widen and upgrade cross-wind runway	40.0
1998-99	Provide 6 domestic parking positions, 6 000 m^2 domestic terminal extension	14.0
1999-00	Extend cross-wind runway	30.0
2000-01		40.0
2001-02	Provide 3 international parking positions, 18 000 m^2 international terminal extension	
2002-03 to 2003-04	None	-
2004-05	Provide 4 domestic parking positions, 12 000 m^2 domestic terminal extension	32.0
2005-06	Provide 4 domestic parking positions, 12 000 m^2 domestic terminal extension	31.0
2006-07 to 2008-09	None	-
2009-10	Commence 65 000 m^2 international terminal extensions	98.0
2010-11	Complete 65 000 m^2 international terminal with 7 parking positions and new taxiway	59.0
2011-12	None	-
2012-13	Provide 5 domestic parking positions, 13 000 m^2 domestic terminal extension	185.0
2013-14	Commence construction of third runway	
2014-15	Provide 6 domestic parking positions, complete construction of third runway	155.0
Total		730.0

Source ACS estimates for BTCE.

to the east-west runway and a second north-south runway of 2400 m prior to the turn of the century.

FAC is currently upgrading the international terminal. Stage 1, Sky Plaza retail centre and general improvements, was completed in 1993 at a cost of $56M. Work valued at $120M for the Stage 2, satellite extension is currently under way. As well as providing a total of 14 wide bodied aircraft parking positions with aerobridges it will upgrade the departure hall, increase check-in counters to 70, and double the passenger handling capacity to 1200 per hour in each direction, sufficient to accommodate demand to the end of the century. These expenditure figures are not included in the estimates as they have already been committed. A further expansion of the international terminal and additional parking spaces in 2001-02 have been included in the estimates. Prior to undertaking this expansion, a decision should logically be made about building an alternative terminal.

TABLE 5.5 IDENTIFIED INVESTMENT AT MELBOURNE AIRPORT, 1995-96 TO 2014-15

Year	Identified investment	Cost ($ million)
1995-96 to 1996-97	None	-
1997-98	Provide 3 domestic parking positions, 8 000 m^2 domestic terminal extension	19.5
	Extend existing EW runway by 500 m	30.0
1998-99	Provide 3 domestic parking positions, 7 000 m^2 domestic terminal extension	20.0
	Provide 500 m domestic taxiway	
1999-00 to 2000-01	None	-
2001-02	Provide 4 international B747 parking positions, 65 000 m^2 international terminal extension	158.0
2002-03	Provide 5 domestic parking positions, 15 000 m^2 domestic terminal extension	36.0
2003-04	Provide 5 domestic parking positions, 15 000 m^2 domestic terminal extension	39.0
2004-05 to 2006-07	None	-
2007-08	Provide 4 international B747 parking positions, 35 000 m^2 international terminal extension	89.0
2008-09	Construct third runway	90.0
	Provide 5 domestic parking positions, 7 000 m^2 domestic terminal extension	18.5
2009-10	Provide 5 domestic parking positions, 8 000 m^2 domestic terminal extension, 1000 m taxiway	26.0
2010-11 to 2014-15	None	-
Total		526.0

Source ACS estimates for BTCE.

A summary of the works is in table 5.5.

Cairns

Cairns Port Authority, operator of Cairns Airport, has developed new terminals and runways since taking over the airport and has attracted considerable overseas traffic through successful marketing.

This North Queensland airport serves traffic from Japan, Singapore, Hong Kong and the west coast of the USA. This development has been at the expense of traffic through Townsville International Airport.

Currently Cairns is running sixth in terms of passenger throughput. However, as previously noted, Cairns is expected to have the fourth highest passenger throughput by 2014-15, behind Sydney, Melbourne and Brisbane.

TABLE 5.6 IDENTIFIED INVESTMENT AT CAIRNS AIRPORT, 1995-96 TO 2014-15

Year	*Identified investment*	*Cost ($ million)*
1995-96	Provide 10 000 m^2 domestic terminal extension	26.0
1996-97	Provide 3 international parking positions, 15 000 m^2 international terminal extension	39.0
1997-98 to 1999-00	None	-
2000-01	Provide 4 international parking positions, 20 000 m^2 international terminal extension, 1300 m taxiways	59.0
2001-02 to 2004-05	None	-
2005-06	Provide 8 international parking positions, 40 000 m^2 international terminal extension	103.0
2006-07 to 2007-08	None	-
2008-09	Provide 11 500 m^2 terminal extension	29.0
2009-10 to 2014-15	None	-
Total		256.0

Source ACS estimates for BTCE

Recently, the Cairns Port Authority designed and constructed a new international terminal separate from the domestic terminal, and extended the main runway.

The estimates (totalling $256M) provide for a balanced growth of domestic and international facilities consistent with the demand projections and complementary with the Port Authority master plan of the airport to year 2014-15.

A summary of the works is in table 5.6.

Perth

Perth completed its new international terminal in the mid-1980s. Since then it has operated well below its capacity. It is a relatively easy terminal to extend on either end and the estimates for its forecast growth recognise these factors. Perth's domestic terminal is expected to develop through the site originally occupied by the old international terminal. Table 5.7 summarises the investments identified for Perth Airport.

Both domestic airlines have commenced their respective developments of the FAC-allocated sites and it is anticipated that horizontal expansion at each end of the existing site will be undertaken.

TABLE 5.7 IDENTIFIED INVESTMENT AT PERTH AIRPORT, 1995-96 TO 2014-15

Year	*Identified investment*	*Cost ($ million)*
1995-96	None	-
1996-97	Provide 2 international parking positions, 12 000 m^2 international terminal extension	30.0
1997-98	Provide 2 domestic parking positions Construct 1500 m taxiway for international terminal	8.0
1998-99 to 2004-05	None	-
2005-06	Construct 600 m taxiways	3.0
2006-07	Provide 2 domestic parking positions, 2 000 m^2 domestic terminal extension	7.0
2007-08	Provide 5 international parking positions, 30 000 m^2 international terminal extension	75.0
2008-09 to 2012-13	None	-
2013-14	Provide 2 domestic parking positions, 3 000 m^2 domestic terminal extension	10.0
2014-15	None	-
Total		133.0

Source ACS estimates for BTCE.

It is worth noting that Perth Airport has a good opportunity for on-ground expansion of existing car parking at both domestic and international terminals.

Adelaide

When the 2014-15 annual passenger forecasts for Adelaide are compared with Sydney (36M), Melbourne (22M), and Brisbane (19M), Adelaide at 5 million annual passenger throughput has an expenditure proposal of $109M which is approximately proportional to the demand statistics. This is in the same range as the amounts ($100M) quoted in the press following the ALP Conference deliberations on privatisation in September, 1994.

The international terminal is easily expanded with no immediate constraints in adjacent facilities and therefore presents no problem to either horizontal or two level expansion. Additional parking positions and terminal space have been allowed for in 1997-98, at a cost of $27M. Press reports indicate that a new international terminal is under consideration, but this has not been separately costed. Table 5.8 presents details of the investment identified for Adelaide

The domestic terminal at Adelaide is not a particularly easy terminal to expand because of its current location and the existing aircraft movement area. However, provision is made for the introduction of domestic aerobridges, especially to service the future wide-bodied aircraft, as well as the more

TABLE 5.8 IDENTIFIED INVESTMENT AT ADELAIDE AIRPORT, 1995-96 TO 2014-15

Year	*Identified investment*	*Cost ($ million)*
1995-96	None	-
1996-97	Extend main runway by 500 m	20.0
1997-98	Provide 3 international parking positions, 10 000 m^2 international terminal extension	27.0
1998-99	None	-
1999-00	Provide additional taxiway works	4.0
2000-01	Provide 3 domestic parking positions, 13 500 m^2 domestic terminal extension	38.0
2001-02 to 2011-12	None	-
2012-13	Provide 10 000 m^2 international terminal extension	20.0
201314 to 2014-15	None	-
Total		109.0

Source ACS estimates for BTCE.

frequent B737 and A320 aircraft. This work is required by the end of the decade.

A 500m extension to the main runway has been proposed by the South Australian State Government and other state interests. This item is in the project costings at $20M. This does not allow for indirect costs associated with road relocation, or possible compensation for impact on an adjacent golf course.

Canberra

The estimates provide for growth of the current domestic terminal. Canberra domestic terminal has physical restraints on the Ansett terminal end due to close proximity of taxiways on the north and east.

If at some time in the future the airport is granted international status, additional investment will be required.

A summary of investment is provided in table 5.9.

Coolangatta

Table 5.10 presents a summary of the investment identified for Coolangatta.

The estimates allow for horizontal expansion of the existing terminal and aircraft parking positions. Coolangatta is a single level terminal which is nearing its designed passenger capacity. Further development should consider a two level expansion and terminal air conditioning.

TABLE 5.9 IDENTIFIED INVESTMENT AT CANBERRA AIRPORT, 1995-96 TO 2014-15

Year	*Identified investment*	*Cost ($ million)*
1995-96	None	-
1996-97	Provide 2 domestic parking positions	8.0
1997-98 to 2002-03	None	-
2003-04	Provide 2 domestic parking positions, 13 500 m^2 domestic terminal extension	36.0
2004-05 to 2010-11	None	-
2011-12	Extend south end of runway by 450 m	15.0
2012-13	Provide 2 domestic parking positions	1.0
2012-14 to 2014-15	None	-
Total		60.0

Source ACS estimates for BTCE.

TABLE 5.10 IDENTIFIED INVESTMENT AT COOLANGATTA AIRPORT, 1995-96 TO 2014-15

Year	*Identified investment*	*Cost ($ million)*
1995-96 to 1997-98	None	-
1998-99	Provide 5 domestic parking positions, 10 000 m^2 terminal extensions	22.0
1999-000 to 2007-08	None	-
2007-08	Provide 6 domestic parking positions, 10 000 m^2 terminal extensions	22.0
2008-09 to 2014-15	None	-
Total		44.0

Source ACS estimates for BTCE.

Darwin

Darwin has recently completed a new combined international and domestic terminal. This provides maximum flexibility at an airport which has a relatively low passenger throughput. That is, there is no conflict between domestic and international daily schedules and passenger flow can use the common user aerobridges and be directed through to international or domestic gate lounges.

The forecast traffic growth over the twenty year period has been masterplanned and our estimates reflect the simplicity with which both domestic and international facilities can be expanded.

A summary of the works is in table 5.11.

TABLE 5.11 IDENTIFIED INVESTMENT AT DARWIN AIRPORT, 1995-96 TO 2014-15

Year	*Identified investment*	*Cost ($ million)*
1995-96	None	-
1996-97	Upgrade 2 existing domestic bays to take wide bodied aircraft	1.0
1997-98 to 2010-11	*None*	
2011-12	Provide 2 domestic parking positions	12.0
	7 500 m^2 international terminal extension	
2012-13 to 2014	None	-
Total		13.0

Source ACS estimates for BTCE.

TABLE 5.12 IDENTIFIED INVESTMENT AT ALICE SPRINGS AIRPORT, 1995-96 TO 2014-15

Year	*Identified investment*	*Cost ($ million)*
1995-96	None	-
1996-97	Upgrade 2 domestic bays to wide bodied bays	1.0
1997-98 to 2014-15	None	-
Total		1.0

Source ACS estimates for BTCE.

Alice Springs

Activity at Alice Springs airport is highly atypical. Each day aircraft 'hub' at Alice Springs over a two hour period daily when flights from north to south and east to west of the continent cross. This means that for a couple of hours each day the airport operates at near capacity, but for the remainder of the time has excess capacity.

The terminal has recently been upgraded and the size is sufficient to accommodate the passenger demands forecast for the study period. Allowance has been made to upgrade two narrow bodied parking positions to accommodate wide bodied aircraft (see table 5.12).

The airfield has sufficient capacity for the relatively small numbers of aircraft predicted to use it.

Air freight developments

The freight activities of airlines are focused on moving freight, not storing it at airports (Qantas, pers. comm. 1994). Typically, the freight forwarding agent prepares consignments for loading onto aircraft in a manner specified by the airline at a site away from the airport. The agent then delivers the goods to the airline freight terminals at an exact time to suit aircraft departure. The airline allows only sufficient time to transfer the goods from the freight terminal to the departing aircraft for immediate departure.

More than 90 per cent of all air freight is transported in the hold of RPT aircraft. This space is air conditioned, not refrigerated. Should the goods for transfer be of a perishable nature, the consignment must be packed in a manner to ensure its protection en route.

Minimum storage is provided for by the airline for weather protection of the goods between the freight agent and its loading onto the first available flight. The same practice is followed for air freight items inbound.

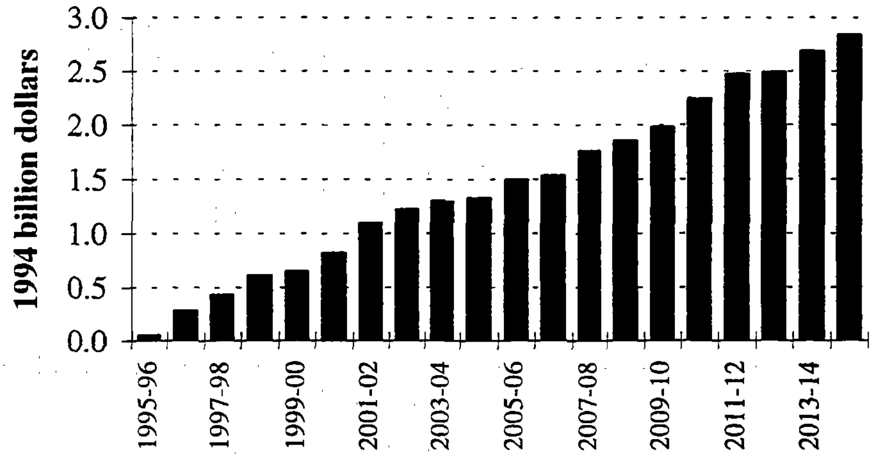
Australia, with a population of 17 million, has a relatively small demand for goods to be air freighted. The volumes of cargo currently carried in the holds of domestic passenger and international passenger services satisfies the majority of air cargo demand.

It is noted that FAC have plans to develop 'Freight Cities' where all aspects of freight handling will be incorporated into one zone, at all of the major airports. These have not been included in the costings of this report. Private operation may impact on these plans.

This brief discussion does not provide a basis for concluding where, and in what volumes, investment in freight infrastructure will be required over the next 20 years. Given that much of the storage and preparation of air freight is handled off airport, required investment in freight facilities at airports can reasonably be expected to be limited. Based on current practices and the forecast for continued growth in aircraft movements (see chapter 4), Australia's demand for air cargo services is likely to continue to be largely handled by RPT services

TIMING OF IDENTIFIED INVESTMENT EXPENDITURES

While this study does not address the issue of funding the investments, it should be noted that the funding of expansions of domestic terminals will largely be the responsibility of the airlines which have long-term leases on the terminals. Given the current state of uncertainty surrounding future ownership of the airports, it is difficult to predict where the incidence of funding for other airport infrastructure will fall. Cairns Airport is the exception, as it is operated by the Cairns Port Authority which is responsible for development of the airport.



Source ACS for BTCE

Figure 5.4 Cumulative expenditure on proposed aviation infrastructure, 1995-96 to 2014-15

Timings for the expenditures in table 5.2 have also been estimated. The cumulative amounts over the 20 year period are shown in figure 5.4. The height of each column represents the expenditure required in a given year plus the expenditure required since the beginning of the study period. Therefore, the height of the column for 2014-15 is equal to the total proposed expenditure of $2.8 billion.

Overall, the figure indicates that, although the expenditures vary from year to year, they are fairly evenly spread out over the period; that is, there is no significant bunching of expenditures. This is due to the number of airports involved and the opportunities for incremental infrastructure additions.

CHAPTER 6 SENSITIVITY ANALYSIS AND RELATED ISSUES

KSA is the critical component in the air transport network in Australia. Factors which affect activity there will have flow-on effects throughout the network. A sensitivity analysis was undertaken which uses alternative higher growth forecasts to those used in the primary analysis for KSA. This was done for three reasons. First, KSA is the largest airport in Australian in terms of passenger and aircraft movements and is therefore, vastly important in the overall flow of traffic through the network. Second, KSA suffers from delays more than any other airport and is often the cause of downstream delays in the system. Finally, the alternative forecasts are more up to date and take account of factors which are omitted from the primary demand figures (see chapter 4), for example the 2000 Olympics and the accelerated development of SWA.

Forecasts of total aircraft movements for Sydney were provided by the Department of Transport. Three scenarios were developed to produce a range of aircraft movements forecasts for the Sydney Basin.

- Low scenario - This scenario was developed by applying a best fit linear trend to historical passenger loadings (1983 to 1993), projecting the trend forward to 2015 and then applying this to passenger forecasts to obtain aircraft movement forecasts; and
- Central scenario - An assumed increase in average international passenger loadings of 1 per cent per annum and an increase of average loadings for domestic/regional aircraft of 1.8 per cent per annum.
- High scenario - International passengers loadings are assumed to increase by one per cent per annum up to the year 2000, with no increase in passenger loadings for domestic/regional aircraft. After 2000 international loadings are assumed to increase by 1 per cent per annum and domestic/regional loadings by 1.8 per cent per annum (reflecting increased capacity constraints at KSA);

Each of the scenarios presented here produced higher aircraft movement forecasts than produced by the primary demand forecasts. AVSTATS believes that the central and high scenarios are the most likely, based on indications that the airlines want to stay at KSA for as long as possible and would therefore be under pressure to increase passenger loadings. The alternative passenger and aircraft movement forecasts are included in appendix I (table I.7).

The high scenario forecast produced by AVSTATS for Sydney (3.07 per cent per annum) was approximately 60 per cent higher than the FAC (1993a) forecast (1.92 per cent per annum). On the basis of this, the FAC (1993a) forecasts for Melbourne, Brisbane, Perth and Cairns airports were increased by the same factor. Time and data limitations associated with this study meant that individual scenarios for each airport could not be developed. However, we believe that applying a 60 per cent increment to the FAC (1993a) figures produces a likely upper growth bound. The alternative forecasts for these four airports are presented in appendix I (table I.7).

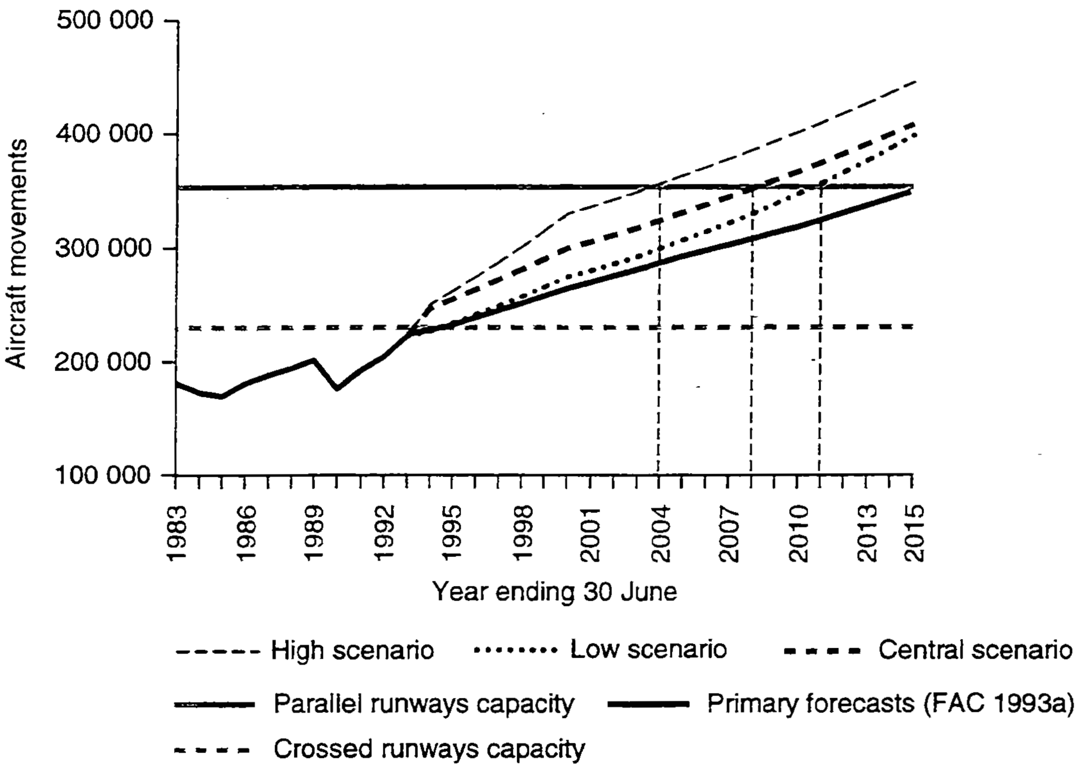
Given that the growth rates apply to total aircraft movements, the sensitivity analysis has been limited to the impact the alternative forecasts have on runway capacity. No comments have been made as to the subsequent requirements for apron, terminal and aerobridge development associated with the higher growth forecasts.

Results

The higher growth rates from the alternative forecasts were applied to the 1992-93 total aircraft movement figures for each airport. The results were compared against the nominal runway capacities for cross, and parallel, two runway systems (based on figures for Sydney). In the case of Sydney, the low and central alternative forecasts provided by AVSTATS were also used in the sensitivity analysis.

For Sydney the primary analysis indicated that the parallel runway system at KSA would have sufficient capacity to accommodate forecast demand over the study period. The alternative forecasts indicate that demand would exceed capacity at KSA during the twenty year period and the additional capacity of SWA would be required to satisfy demand. Capacity at KSA is forecast to become inadequate in 2003-04 under the high growth forecast, in 2007-08 under the central forecast and in 2010-11 under the low alternatively forecast respectively. The results for Sydney under the alternative high forecast, indicate that the runway capacity in the Sydney Basin (that is 353 000 and 150 000 movements per annum at KSA and SWA, respectively) will be sufficient to accommodate forecast demand to the year 2014-15.

Figure 6.1 illustrates how the alternative demand forecasts for Sydney were compared to theoretical runway capacities for the sensitivity analysis to determine when runway capacity at KSA becomes inadequate. The sensitivity analysis for the other airports was done in a similar manner.



Source DoT (1994). DoT (unpublished forecasts).

Figure 6.1 Sensitivity analysis for Sydney (KSA)

For Perth and Cairns the alternative demand forecasts have no impact on the need for runway capacity improvements at these airports.

The alternative forecasts affect the timing of the identified parallel runway developments at Melbourne and Brisbane airports. Under the primary analysis forecasts the parallel runway at Melbourne is required in 2009-10. The sensitivity analysis indicates that under the higher growth forecasts the development of a third runway at Melbourne will be required by 2001-02, or shortly thereafter given the curfew-free operations of the airport. The sensitivity analysis also indicated that a parallel runway system at Melbourne would be close to capacity by the end of the study period. Brisbane is identified as requiring the development of a third runway around 2014-15 under the primary analysis. The sensitivity analysis indicates the runway will become necessary by 2005-06.

LAND INTERFACES

Surface access can be a problem at major Australian airports. Experience with the development of KSA, Melbourne and Brisbane airports indicate that the problem emerges when traffic volumes approach seven to eight million passengers per year. Each of these airports now suffers road congestion because their peak hour operations coincide with the morning and evening peak periods for urban commuter traffic.

In Sydney, airport related traffic shares the northern perimeter road (constructed for international/domestic transfer of passengers) with local traffic using the link as a short cut between the suburbs of Arncliffe and Mascot. Traffic using this short cut causes congestion at the junction of O'Riordan Street and the General Holmes Drive roundabout (FAC 1990a).

Congestion around Sydney airport will increase, with passengers processed forecast to more than double over the next twenty years.

On completion of the extension of the M5 east, M5 traffic will be injected into the Sydney Airport environs. Currently, there are restrictions on dangerous goods being carried through the General Holmes Drive tunnel which passes underneath the north-south runway. If these restrictions still apply this will force some M5 traffic to go around the airport using airport roads, thereby adding to congestion on the airport road system.

The NSW Government recently announced the go ahead for an underground rail link between KSA and the central business district (CBD)(AFR 4 August 1994). The link will be predominantly publicly funded, with the private sector undertaking the construction of the link and funding the four new stations along the link. The project is forecast to cost approximately $600M and is due to commence in early 1995 for completion in mid-1999. The link is expected to relieve road congestion to and from KSA by attracting 20 per cent of all airport generated trips.

The Federal Government is currently funding an engineering study to examine a rail corridor to link the new SWA with the Main Southern Line, north of Campbelltown. With the development of the KSA-CBD rail link, this would provide a direct rail link between the airports. Development of the Sydney Orbital Road will join the M5 and Elizabeth Drive, providing road access to SWA. The extension of the M5 will provide a direct road link between the airports.

Melbourne Airport suffers generally similar problems via the Tullamarine freeway. Since the airport was first opened in 1970 with a new high speed expressway between the CBD and the then remote Tullamarine airport, residential and other development has occurred adjacent to that transport corridor (SAMC 1986 and FAC 1989). The road traffic in the morning and evening peak hours now severely inconveniences air travellers connecting with their flights. Plans outlined by the FAC to develop Melbourne Airport into a major freight hub, known as 'Freight City', will require major road development, with a dedicated freight road identified as a possibility. Rail links to Tullamarine are also under investigation.

Brisbane Airport currently processes 7.9M passengers, increasing to a forecast 19.2 million in a twenty year period. It suffers traffic congestion around Kingsford Smith Drive and Newstead Road. Currently, congestion is marginal, but with the forecast growth in airport passengers, it should not be ignored. However, the issue has not been addressed in this report.

Although total passenger throughput at Adelaide airport will not have reach the volumes currently experienced at Sydney, Melbourne or Brisbane by the end of the study period, already there are indications that the road feeder system is approaching capacity during peak hour (FAC 1991). Further, any extension of the main runway will require either the realignment of Tapleys Hill Road or a tunnel to be built under the runway for the road.

CONGESTION AT KSA AND THE ACCELERATED DEVELOPMENT OF SWA

It is undisputed that congestion at KSA is increasing. The significance of this is reflected in the impact that congestion and delays in Sydney have on the other airports in the network. For example, the CAA has a policy of holding aircraft on the ground at a number of airports if they can not be guaranteed a landing slot at KSA. This leads to a ripple effect which works through the network and the 'weakest' link (that is the most capacity constrained and congested airport) will largely determine the activity on the system.

The Government has announced its intention to accelerate the development of SWA, to be commissioned before the end of the century (1998-99). When SWA is commissioned there will be substantial increase in the total runway capacity of the Sydney Basin. The ultimate addition to capacity is expected to be in the vicinity of 150 000 aircraft movements per annum (Department of Transport, pers. comm. 1994). Forecasts indicate that with the addition of the extra capacity the runway capacity requirements of the Sydney Basin will be satisfied over the period of this study.

Two issues need to be addressed. First, the level of facilities, in particular taxiway, terminal and support facilities, at SWA in 1998-99 is yet to be determined. The Federal Government has made a commitment to fund a 2900 metre runway and terminal platform (estimated to cost $120M: AFR 29, September 1994). The level of development of the taxiway system, for example, will be a significant factor in determining runway occupancies, and therefore, the capacity of the runway. Almost certainly this will result in an initial capacity increment of less than 150 000 movements. The level of development of other facilities such as the terminals and the land transport interface will affect decisions by passengers and airlines to use the airport.

The second issue is that discussions with the industry indicate a reluctance on the part of the airlines to leave KSA or to split services between the two airports until it becomes absolutely necessary, that is, when congestion and delays at KSA can no longer be tolerated. The industry believes that most demand will continue to be for services into and out of KSA and, therefore, it will continue to focus its activities on KSA. Splitting operations between the two airports is considered to be uneconomical and inefficient, and the industry has indicated it will avoid doing this for as long as possible. It is possible that, despite the provision of the physical infrastructure and hence the capacity to cope with forecast demand, unless regulation is imposed to force airlines to use SWA, construction of SWA may do little in the short to medium term to relieve the congestion at KSA.

THE IMPACT OF APEC REGION DEMAND FOR AVIATION SERVICES ON AUSTRALIAN AVIATION INFRASTRUCTURE

Increasing international attention is being focussed on the Asia-Pacific region. From an Australian perspective, the role Australia can play in the region and the impact of the region on Australia, are emerging as major business and political issues. The International Civil Aviation Organisation (ICAO) and the International Air Transport Association (IATA) define the Asia-Pacific region as having four sub-areas:

- South Asia (or the Indian Sub-continent);
- Northeast Asia (including Japan and China);
- Southeast Asia (including Singapore, Indonesia and Thailand); and
- the Southwest Pacific (including Australia, New Zealand and Hawaii).

The members of the Asia Pacific Economic Cooperation (APEC) group include the countries in these regions as well as the North American countries. The Transportation Working Group (one of ten APEC working groups) is currently undertaking a congestion points study of airports and sea ports within member countries. The aim of the study is to identify bottlenecks and to propose solutions which will enhance the efficiency of transportation in the region. Currently, this study is in its early stages and we are unable to draw upon it.

The Asia-Pacific region has the fastest growing aviation market in the world. This growth is expected to be largely driven by the leisure market (BTCE 1994). Table 6.1 summarises forecasts from a number of sources for the Asia-Pacific and world markets, as well as for the trans-Pacific and Asia-Pacific intra-regional markets.

TABLE 6.1 AIR TRAFFIC FORECASTS

Source	*Forecast region or market*	*Average annual growth %*	*Traffic measure*	*Forecast period*
Airbus Industrie	Asia-Pacific	8.0	Passengers	To 2006
	World	5.5	Passengers	To 2006
	World	5.8	RPKs[a] performed	1992-2001
Boeing	World	5.9	RPKs performed	1992-2000
IATA	Asia-Pacific	12.1	Passengers	1985-90
		8.6		1990-95
		7.5		1995-2000
		7.0		2000-10
	World	7.6	Passengers	1985-90
		5.7		1990-95
		5.5		1995-2000
		4.3		2000-10
	Asia-Pacific intra-regional	9.2	Passengers	1990-95
		7.8		1995-2000
		7.3		2000+
ICAO - Asia-Pacific Area Traffic Forecasting Group	Trans-Pacific	7.8	Passengers	1990-2000
	Asia-Pacific intra-regional	8.0	Passengers	1990-2000
	Japan-Australia	12.5	Passengers	1992-2010
	All Asia-Australia	14.5	Passengers	1992-2010
	World	5.0	RPKs performed	1990-2001

a. revenue passenger kilometres (RPKs) - 'The number of paying passengers on an aircraft times the number of kilometres flown. RPKs may be measured for a single flight, an airline, or industry wide. RPKs are a measure of demand for air passenger travel services'(BTCE 1994).

Source Airbus Industrie (1994). BTCE (1994). IATA (1992). Report from 1993 ICAO Asia-Pacific Area Forecasting Group meeting, Jon Henchy, Australian Delegate, Director, AVSTATS, DoT.

Boeing predicts that growth in aviation in the region will account for more than 40 per cent of world growth in passenger traffic between 1992 and 2010 (BTCE 1994). The region is forecast to replace Europe as the largest international market by 2000 (based on RPKs performed) (BTCE 1994).

An IATA study in 1992 examined air traffic growth and constraints in the Asia-Pacific region (IATA 1992). The forecast growth rates from this study are included in Table 6.1. On the basis of these forecasts, intra-regional passenger traffic is expected to reach 262M by 2010 (IATA 1992). IATA forecasts that the

Asia-Pacific region will account for more than half of total world-wide schedule passenger traffic by 2010. The region is also expected to account for 39 per cent of total international scheduled traffic by the year 2000, growing to 50 per cent of the market by 2010.

Reasons put forward to explain the high growth in aviation in the Asia-Pacific region include;

- the strong growth in many of the regions' economies;
- increasing personal disposable incomes;
- large population centres within the region which are separated by ocean or difficult terrain;
- 56 per cent of the world's population lives in the region;
- less mature markets in the region than in Europe and North America, which provide greater opportunities for expansion and development of markets, and
- the continuing liberalisation of air transport (IATA 1992).

Worsening congestion and infrastructure capacity constraints are expected to emerge in the region over the next 20 years. The IATA study found that there were critical congestion problems at seven airports in the region, which together accounted for two-thirds of the region's total international traffic. The airports identified were: Bangkok, Bombay, Hong Kong, Tokyo-Narita, Osaka, Seoul and Sydney. Congestion during peak hours is expected to increase at the region's major airports due to curfews imposed on airports. The IATA study also found that Asian hubs will continue to play an increasing role in the region.

What are the implications for Australia? In 1992, Australia accounted for 9 per cent of total intra-regional international passenger traffic (IATA 1993). This figure is expected to grow to 11 per cent by 2010. In 1992, regional passenger traffic accounted for 77 per cent of total international passenger traffic through Australia and it is expected to have increased slightly by 2010 (IATA 1993).

With strong regional and intra-regional growth expected to continue, demand on Australia's aviation infrastructure will increase. Exactly to what extent is difficult to predict; however, it would reasonably be expected that Sydney, Brisbane and increasingly Cairns will be the Australian airports most affected by the growing demand in the region. This will perhaps be most noticeable at Cairns where some airlines, most notably Qantas, are developing the airport as a hub for international services to/from the region (Qantas, pers. comm. 1994). The 1992 IATA study identified use of the international apron at KSA as currently being close to capacity (IATA 1992). The implication is that unless more apron capacity is developed and/or some aircraft movements are shifted to SWA, additional international airline access to KSA, particularly during peak hours, will be increasingly limited.

CHAPTER 7 CONCLUSIONS

INVESTMENT NEEDS

The major finding of this study is that a significant level of investment in aviation infrastructure is necessary if demand over the next twenty years is to be satisfied. Investment of $2.8B has been identified, and it has been argued that this represents a lower bound on necessary investment as a number of significant complementary investments, such as road developments, freight developments and car parking, have not been taken into account. Also the development of terminal, apron and other supporting infrastructure and facilities at SWA has not been assessed.

89 per cent of total airport investment has been identified as being required at Cairns, Brisbane, Coolangatta, KSA, SWA and Melbourne. This arises from the fact that the greater part of the population and economic activity is focused on the eastern seaboard, and high population growth rates are expected along the coast between Sydney and Cairns. In fact, required investment at KSA represents 30 per cent of total investment, while investment at Brisbane and Melbourne Tullamarine represent 26 and 18 per cent, respectively.

The total terminal expansions identified account for 67 per cent of the $2.8B cost estimated for the total identified expenditure requirements. Of the total terminal investment, 41 per cent will be required at KSA.

A significant conclusion of the assessment is that runway capacity of the parallel runway system at KSA will be adequate under the primary analysis based on the FAC (1993a) demand forecasts. However, on the basis of the alternative higher demand forecasts used in the sensitivity analysis, capacity at KSA could become inadequate as early as 2003-04. However, the commissioning of SWA will ensure that demand for RPT movements in the Sydney Basin will be satisfied.

The analysis also identified that third (parallel) runways will be required at both Melbourne and Brisbane airports during the study period.

FUTURE WORK

The short timeframe available and the strategic nature of this study have necessarily meant that a number of potential areas of study have had to be excluded. Therefore, it is desirable that further work be undertaken to expand on the research presented in this paper.

Unlike the analysis undertaken for the road and rail modes, an economic assessment of infrastructure was not possible for aviation. This is a result of the incomparabilities between, and inconsistencies of, delay data. Further, the time available did not permit development of the necessary modelling tools to forecast future delays and effects of capacity expansion. Clearly, these are obvious areas for future work, the results of which would be significant inputs into an economic assessment.

Future attempts to model delays will require detailed analysis of the peak periods at each airport and the network effects of delays. This will also require further development of concepts of capacity and levels of service for the aviation industry. Further research will also be required in order to be able to value delays and changes in delays. This would involve the development of a methodology to cost the various component of delays, in particular, the value of passenger time, indirect non-time dependent costs to airlines and the cost of environmental externalities which arise from aviation activity.

Another important area for ongoing work is the collecting and collating of existing data and the development of new information and data sources. Perhaps the most significant difficulties encountered during the current study have been data limitations. Therefore, it is important that new data sources are cultivated in order to maximise the potential gains to be made from future research. More discussion of potential areas for future work and data requirements is given in appendix III.

The strategic nature of this study has meant that there are many issues which have been dealt with summarily, for example air freight and surface access. Some heroic assumptions have been made to abstract from a number of factors which have a high degree of uncertainty and which are near impossible to account for within the methodology used here. For example, the assumption that the operational and regulatory environment will remain constant over the study period. Further research in these areas and further sensitivity testing of the assumptions made would be beneficial.

APPENDIX I AIR DEMAND FORECASTS

PASSENGER MOVEMENT FORECASTS

TABLE I.1 FORECAST PASSENGER MOVEMENTS FOR 1995-96
('000 p.a.)

Airports	*International*	*Domestic*	*Regional*	*Total*
Sydney	5 679.0	11 609.0	652.3	17 940.3
Melbourne	2 226.0	9 323.0	277.3	11 826.3
Brisbane	1 974.0	6 030.0	371.8	8 375.8
Adelaide	286.0	2 802.0	284.7	3 372.7
Perth	1 214.0	2 351.0	111.1	3 676.1
Hobart	N/A	745.0	4.2	749.2
Darwin	140.0	527.0	31.7	698.7
Cairns	890.0	1 832.0	192.5	2 914.5
Canberra	N/A	1 416.0	212.6	1 628.6
Townsville	N/A	399.0	115.6	514.6
Coolangatta	N/A	1 814.0	17.4	1 831.4
Launceston	N/A	416.0	63.8	479.8
Alice Springs	N/A	755.0	1.0	756.0
Mount Isa	N/A	51.0	N/A	51.0
Tennant Creek	N/A	N/A	0.9	0.9
Total	12 409.0	40 070.0	2 336.8	54 815.8

N/A Not applicable

Source Travers Morgan for BTCE (based on FAC 1993a).

TABLE I.2 FORECAST PASSENGER MOVEMENTS FOR 2014-15

('000 p.a.)

Airports	*International*	*Domestic*	*Regional*	*Total*
Sydney	13 854.4	22 144.7	773.9	36 773.0
Melbourne	5 119.0	16 342.5	359.4	21 820.9
Brisbane	5 427.4	13 205.8	658.0	19 291.1
Adelaide	776.3	3 952.4	411.9	5 140.6
Perth	3 761.1	3 839.2	168.9	7 769.2
Hobart	N/A	1 118.5	4.7	1 123.2
Darwin	579.4	1 003.5	47.1	1 629.9
Cairns	4 424.0	4 289.0	309.6	9 022.6
Canberra	N/A	2 057.4	323.6	2 381.0
Townsville	N/A	613.5	166.5	780.0
Coolangatta	N/A	4 638.1	32.7	4 670.8
Launceston	N/A	431.2	70.9	502.1
Alice Springs	N/A	1 985.0	3.0	1 988.0
Mount Isa	N/A	53.0	N/A	53.0
Tennant Creek	N/A	N/A	0.9	0.9
Total	33 941.7	75 673.8	3 330.9	112 946.4

N/A Not applicable

Source Travers Morgan for BTCE (based on FAC 1993a).

TABLE I.3 AVERAGE ANNUAL PASSENGER MOVEMENT GROWTH RATES, 1995-96 TO 2014-15

(per cent per annum)

Airports	*International*	*Domestic*	*Regional*	*Total*
Sydney	4.56	3.28	0.86	3.65
Melbourne	4.25	2.85	1.31	3.11
Brisbane	5.19	4.00	2.90	4.26
Adelaide	5.12	1.73	1.86	2.13
Perth	5.82	2.48	2.12	3.81
Hobart	N/A	2.05	0.64	2.05
Darwin	7.36	3.27	2.00	4.33
Cairns	8.35	4.34	2.40	5.81
Canberra	N/A	1.89	2.12	1.92
Townsville	N/A	2.17	1.84	2.10
Coolangatta	N/A	4.81	3.22	4.79
Launceston	N/A	0.18	0.53	0.23
Alice Springs	N/A	4.95	5.70	4.95
Mount Isa	N/A	0.19	N/A	0.19
Tennant Creek	N/A	N/A	0.00	0.00
Total	5.16	3.23	1.79	3.68

N/A Not applicable

Source BTCE (based on FAC 1993a).

AIRCRAFT MOVEMENT FORECASTS

TABLE I.4 FORECAST AIRCRAFT MOVEMENTS FOR 1995-96

('000 p.a.)

Airports	*International*	*Domestic*	*Regional*	*GA & Other*	*Total*
Sydney	40.5	117.7	51.3	26.4	236.0
Melbourne	17.3	89.3	19.3	39.2	165.1
Brisbane	15.0	64.2	33.7	26.5	139.4
Adelaide	3.0	27.7	30.1	61.1	121.9
Perth	7.4	24.7	11.9	40.9	84.9
Hobart	N/A	9.0	1.8	4.6	15.4
Darwin	2.3	7.2	6.9	67.3	83.6
Cairns	12.0	21.8	13.1	na	46.9
Canberra	N/A	21.6	11.3	115.5	148.5
Townsville	N/A	5.4	11.3	65.8	82.5
Coolangatta	N/A	21.7	8.0	79.4	109.1
Launceston	N/A	7.6	7.5	22.1	37.2
Alice Springs	N/A	11.4	0.2	23.7	35.3
Mount Isa	N/A	1.5	N/A	18.5	20.0
Tennant Creek	N/A	N/A	0.2	N/A	0.2
Total	97.5	430.8	206.5	591.2	1 326.0

N/A Not applicable
na Not available

Source Travers Morgan for BTCE (based on FAC 1993a).

TABLE I.5 FORECAST AIRCRAFT MOVEMENTS FOR 2014-15

('000 p.a.)

Airports	*International*	*Domestic*	*Regional*	*GA & Other*	*Total*
Sydney	66.5	192.3	56.8	29.4	345.0
Melbourne	28.9	138.8	23.4	64.0	255.1
Brisbane	30.8	118.7	54.0	28.7	232.2
Adelaide	6.2	38.1	39.5	79.3	163.1
Perth	17.1	43.7	16.5	46.4	123.8
Hobart	N/A	13.2	2.3	4.7	20.2
Darwin	5.7	13.2	9.2	99.3	127.4
Cairns	38.3	41.6	17.9	na	97.8
Canberra	N/A	31.0	14.5	153.0	198.5
Townsville	N/A	8.3	14.5	84.3	107.1
Coolangatta	N/A	45.7	11.2	141.7	198.6
Launceston	N/A	7.8	7.8	22.3	37.9
Alice Springs	N/A	31.1	0.2	35.3	66.6
Mount Isa	N/A	1.5	N/A	21.9	23.4
Tennant Creek	N/A	N/A	0.2	N/A	0.2
Total	193.5	725.1	267.9	810.4	1 996.9

N/A Not applicable
na Not available

Source Travers Morgan for BTCE (based on FAC 1993a).

TABLE I.6 AVERAGE ANNUAL AIRCRAFT MOVEMENT GROWTH RATES, 1995-96 TO 2014-15

(per cent)

Airports	*International*	*Domestic*	*Regional*	*GA & Other*	*Total*
Sydney	2.51	2.48	0.50	0.54	1.92
Melbourne	2.59	2.23	0.98	2.48	2.20
Brisbane	3.66	3.12	2.39	0.39	2.58
Adelaide	3.70	1.60	1.37	1.31	1.47
Perth	4.29	2.90	1.62	0.64	1.90
Hobart	N/A	1.92	1.30	0.11	1.37
Darwin	4.66	3.07	1.47	1.97	2.13
Cairns	5.97	3.29	1.56	na	3.74
Canberra	N/A	1.83	1.24	1.41	1.46
Townsville	N/A	2.16	1.26	1.24	1.31
Coolangatta	N/A	3.80	1.75	2.93	3.04
Launceston	N/A	0.13	0.17	0.05	0.09
Alice Springs	N/A	5.15	0.00	2.00	3.22
Mount Isa	N/A	0.00	N/A	0.85	0.80
Tennant Creek	N/A	N/A	0.00	N/A	0.00
Total	3.49	2.64	1.31	1.59	2.07

N/A Not applicable
na Not available

Source BTCE (based on FAC 1993a).

SENSITIVITY FORECASTS

TABLE I.7 SENSITIVITY ANALYSIS: AIRCRAFT MOVEMENTS AND FORECASTS, 1982-83 TO 2014-15

('000 p.a)

Year	*Sydney low*	*Sydney central*	*Sydney high*	*Melbourne*	*Brisbane*	*Perth*	*Cairns*[a]
1982-83	180.9	180.9	180.9	79.3	58.7	27.4	10.8
1987-88	188.0	188.0	188.0	92.5	65.4	32.2	17.6
1992-93	204.4	204.4	204.4	119.9	99.8	39.6	35.8
1994-95	233.7	255.0	262.0	163.5	140.8	62.1	54.7
1999-00	274.3	299.5	329.7	207.2	181.8	84.6	73.5
2004-05	306.4	330.6	363.0	250.9	222.8	107.1	92.4
2009-10	347.0	366.5	401.3	294.6	263.8	129.6	111.2
2014-15	398.1	408.1	445.4	338.3	304.9	152.1	130.1
Average annual growth rate (%)	2.51	2.65	3.07	3.52	4.13	3.04	5.98

a. RPT figures only (excludes GA).

Source ACS for BTCE (based on DoT 1994 unpublished).

AIR CARGO DEMAND FORECASTS

TABLE I.8 FORECAST AIR CARGO TONNAGES FOR 1995-96

(tonnes p.a.)

	Air freight				Mail				Air cargo[a]			
Airports	*Internat'l*	*Domest.*	*Reg'l*	*Total*	*Internat'l*	*Domest.*	*Reg'l*	*Total*	*Internat'l*	*Domest.*	*Reg'l*	*Total*
Sydney	258 825	70 400	71	329 296	10 431	14 595	0	25 026	269 256	84 995	71	354 321
Melbourne	109 221	72 394	118	181 733	5 167	13 471	0	18 638	114 389	85 865	118	200 371
Brisbane	50 144	34 498	1	84 643	1 932	8 335	0	10 266	52 076	42 833	1	94 909
Adelaide	11 013	16 406	193	27 613	340	4 017	0	4 357	11 354	20 423	193	31 970
Perth	41 678	26 215	222	68 115	1 136	4 353	40	5 529	42 814	30 568	262	73 644
Hobart	40	6 142	0	6 182	0	781	0	781	40	6 923	0	6 963
Darwin	1 564	3 568	254	5 386	18	522	34	573	1 582	4 090	288	5 959
Cairns	10 704	5 518	41	16 263	100	1 144	5	1248	10 803	6 662	46	17 511
Canberra	0	4 159	0	4 159	0	0	0	0	0	4 159	0	4 159
Total	483 189	239 301	900	723 390	19 124	47 216	79	66 419	502 313	286 517	979	789 809

a. *Air cargo is the sum of air freight and mail.*

Source Travers Morgan for BTCE (based on DoT 1994).

TABLE I.9 FORECAST AIR CARGO TONNAGES FOR 2014-15

(tonnes p.a.)

	Air freight				*Mail*				*Air cargo*[a]			
Airports	*Internat'l*	*Domest.*	*Reg'l*	*Total*	*Internat'l*	*Domest.*	*Reg'l*	*Total*	*Internat'l*	*Domest.*	*Reg'l*	*Total*
Sydney	424 927	115 014	71	540 012	17 126	23 843	0	40 969	442 053	138 857	71	580 981
Melbourne	182 145	112 553	118	294 816	8 617	20 943	0	29 560	190 763	133 496	118	324 377
Brisbane	102 931	63 788	1	166 719	3 965	15 411	0	19 376	106 896	79 199	1	186 096
Adelaide	22 775	22 558	193	45 526	704	5 523	0	6 226	23 479	28 081	193	51 752
Perth	96 586	46 420	222	143 228	2 305	7 708	40	10 053	98 891	54 128	262	153 281
Hobart	40	6 142	0	6 182	0	1 443	0	1 443	40	7 585	0	7 625
Darwin	3 887	6 528	254	10 669	44	426	34	505	3 932	6 955	288	11 174
Cairns	34 162	10 537	41	44 741	260	2 184	5	2 449	34 422	12 722	46	47 189
Canberra	0	5 976	0	5 976	0	0	0	0	0	5 976	0	5 976
Total	867 453	389 516	900	1 257 870	33 021	77 482	79	110 582	900 475	466 998	979	1 368 452

a. Air cargo is the sum of air freight and mail.

Source Travers Morgan for BTCE (based on DoT 1994).

TABLE I.10 AVERAGE ANNUAL AIR CARGO TONNAGE GROWTH RATES, 1995-96 TO 2014-15

(%)

	Air freight				*Mail*				*Air cargo*[a]			
Airports	*Internat'l*	*Domest.*	*Reg'l*	*Total*	*Internat'l*	*Domest.*	*Reg'l*	*Total*	*Internat'l*	*Domest.*	*Reg'l*	*Total*
Sydney	2.51	2.48	0	2.50	2.51	2.48	N/A	2.50	2.51	2.48	0	2.50
Melbourne	2.59	2.23	0	2.45	2.59	2.23	N/A	2.33	2.59	2.23	0	2.44
Brisbane	3.66	3.12	0	3.45	3.66	3.12	N/A	3.23	3.66	3.12	0	3.42
Adelaide	3.70	1.60	0	2.53	3.70	1.60	N/A	1.80	3.70	1.60	0	2.44
Perth	4.29	2.90	0	3.79	3.60	2.90	0.00	3.03	4.27	2.90	0	3.73
Hobart	0.00	0.00	N/A	0.00	N/A	3.12	N/A	3.12	0.00	0.46	N/A	0.46
Darwin	4.66	3.07	0	3.48	4.66	-1.00	0.00	-0.64	4.66	2.69	0	3.19
Cairns	5.97	3.29	0	5.19	4.90	3.29	0.00	3.43	5.97	3.29	0	5.08
Canberra	N/A	1.83	N/A	1.83	N/A	N/A	N/A	N/A	N/A	1.83	N/A	1.83
Total	2.97	2.47	0	2.80	2.77	2.51	0.00	2.58	2.96	2.47	0	2.79

N/A Not applicable

a. Air cargo is the sum of air freight and mail.

Source BTCE (based on DoT 1994).

APPENDIX II AIRPORT CONGESTION AND DELAYS

This appendix provides a discussion of the concepts involved with understanding delays in aviation, and how they are interrelated. It is not an exhaustive analysis; rather, an introduction. It also provides a more detailed overview of the delay performance of four of Australia's major airports than was included in chapter 5.

CONCEPTS, DEFINITIONS AND MEASUREMENT

In the consideration of the adequacy of airport infrastructure, delays are an important indicator of performance of both airlines and airports. As such, they are an useful tool in determining the efficiency of airline operations and airport management procedures, and the adequacy of airport infrastructure in coping with demand.

Despite improvements in infrastructure, technology and operational procedures which can reduce delay times, factors beyond human control and prediction, such as the weather, mean that delays will remain a component of air travel.

For the purposes of this study, the analysis of delays will predominantly be used for assessing the adequacy of airport infrastructure.

Closely associated with the issue of delays are the concepts of capacity, congestion and demand, which were discussed in chapter 2.

Delay

The Civil Aviation Authority (CAA) defines delay as the difference between the standard time required for take-off or landing with no air traffic intervention and the actual time taken (CAA, pers. comm. 1994). For an arriving aircraft, a delay is recorded when the actual touch down time is different from the estimated touch down time (that is wheels on the tarmac) with no intervention. For a departing aircraft, a delay is recorded between the time the aircraft is pushed back from a gate (or given approval to commence taxiing if it is standing on the tarmac) to becoming airborne, compared with a standard unimpeded taxi time calculated for the given parking position and runway intersection combination used.

On-time-performance

According to an international convention, an aircraft arriving at, or departing from, a terminal within 15 minutes of the scheduled time is considered to be on time. For departures, a service is considered on time if it is pushed-back from the gate or given permission to commence taxiing within 15 minutes of the scheduled departure time. Similarly, if a service arrives at its destination terminal within 15 minutes of the scheduled arrival time it is considered on time and no delay is recorded. The rationale for this is that the nature of air travel means that some delays are not unreasonably expected, and delays of up to 15 minutes should not inconvenience travellers to a significant degree and can be accommodated within a traveller's plans (BTCE 1993). This measure is known as on-time-performance (OTP), is commonly used by the airlines as one method of assessing their performance. In the USA, airlines are required to publicly release their OTP results on a regular basis.

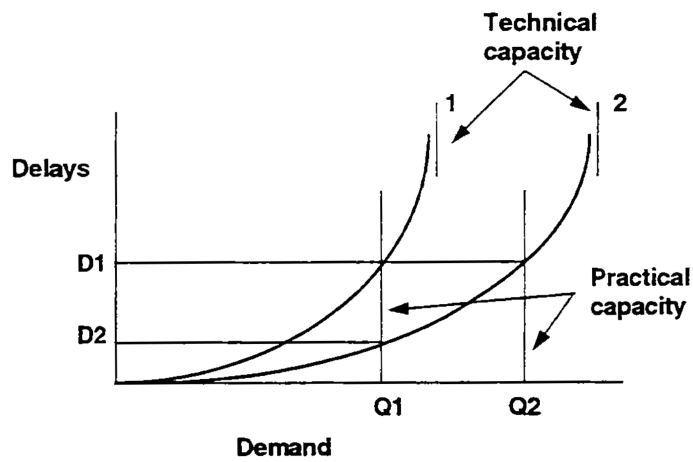
The OTP measure more closely reflects the delay experienced by passengers than the CAA delay measure.

Some OTP measures have been provided by Ansett Australia and Qantas airlines. It is difficult to combine or compare the data as definitions of cause are not uniform and different threshold times are used in determining when a delay is recorded. Due to the commercial sensitivity of this data, it cannot be quoted in the text. Where possible, comments based on the OTP measures have been made to support or refute inferences about delays which are drawn from other sources.

Relationship between capacity, demand, congestion and delays

As demand increases and approaches the level of capacity for an airport, queues begin to form, causing delays. As demand continues to increase, or remain above the rate of service (that is the number of aircraft movements which can be accommodated in a given time period), delays occur more frequently and delay times increase. When this occurs, it may be some time after demand eases to a level below the rate of service, and before the aircraft waiting in the queues are accommodated. This relationship is depicted in figure II.1.

In figure II.1, *Q1* and *Q2* represent the maximum practical or actual capacity levels of a runway infrastructure system associated with maximum technical or design capacity levels of 1 and 2, respectively. *D1* and *D2* represent delay times for given levels of demand and infrastructure capacity. For a given level of demand, *Q1*, operating within the runway system with technical capacity 1, total delays of *D1* will be experienced. As demand increases for a given technical capacity, the delays incurred increase. As technical capacity expands from 1 to 2, delays times recorded for a given level of demand, *Q1*, fall from *D1* to *D2*. Similarly, for a given improvement in technical capacity from 1 to 2, practical capacity also increases from *Q1* to *Q2*. This means it is possible to accommodate a higher level of demand for a given level of delay, *D1*.



Source Based on TRB (1990).
Figure II.1 The relationship between capacity, demand and delay

This technical relationship leaves unanswered the issue of the optimal level of delay. This is where an economic assessment becomes necessary.

Causes of delay

There are any number of possible causes of delays. For example, Ansett airlines uses 14 categories in its assessment of causes of delays in on-time-performance (Ansett pers. comm. 1994). An informal BTCE survey of delays revealed the most common causes of delays to be equipment failures, congestion, weather, consequential delays from prior delays, and passenger related delays. Another significant cause of delays is cluster scheduling by airlines in peak periods, which result in the congestion of airport facilities, which in turn result in delays.

The lack of publicly available data is one of the major problems associated with examining the level of delays at Australian airports. In particular, it is difficult to find measures of delay which attribute delay times to causal factors. This is due in part to the fact that much of the data that is available is either highly aggregated or only measures part of the total delay. The other reason is that a delay may be caused by flow-on effects from previous delays which obscure the causal relationship. For example, a departure is delayed in Melbourne due to a technical fault which means that the later than scheduled arrival contributes to air space congestion in Sydney causing a queue to form, which further delays the arrival of the Melbourne flight and also delays other arrivals and departures to and from Sydney.

Measurement of delays

Currently there is no publicly available measure of total delay which encompasses all possible factors, nor which can attribute delay to its various causes. The recording systems used by the airlines and the CAA are restricted to pre-determined start and finish points, which means that neither represents a measure of total delays.

The CAA records delay times for four major airports (Sydney, Melbourne, Brisbane and Adelaide) as part of its flow management system. In the second half of 1993, the CAA implemented a policy of giving arriving aircraft priority over departing aircraft, presumably on the basis that it costs less, and is easier, to hold an aircraft on the ground than in the air (CAA pers. comm. 1994). As a result, services into KSA are frequently being held on the ground if delays due to congestion in Sydney are expected to be encountered. The time spent waiting on the ground for approval to commence taxiing does not appear in the CAA delay figures and only appears in the airlines on-time-performance if the delay is of more than the delay threshold (for example 15 minutes). A example of this partial recording of delays was in May 1994 when due to poor weather conditions in Sydney, aircraft in Canberra were held on the ground for up to two hours (BTCE. pers. comm. 1994). In this example the on-time-performance is affected, but it would not result in any CAA record of delays, as approval to push back was not given.

Infrastructure delays

As discussed, accurately separating out delay times by cause is extremely difficult. Therefore, no direct measure of delay due to infrastructure inadequacies is publicly available. As congestion delays are generally associated with periods where demand exceeds capacity (within a given operating framework), they appear to be the most appropriate proxy for infrastructure delays.

The CAA measure of delay is perhaps the best available measure of congestion delay, and is, therefore, the best proxy for delays due to infrastructure inadequacies, as it does not include delays arising from airline operational procedures.

However, the CAA measure is incomplete. As mentioned previously the CAA measure does not include time when aircraft are deliberately held on the ground. This is most likely to occur during a peak period and is, therefore, largely due to congestion. As such, this delay should be added to the official CAA measure of congestion delay. Both these delays are picked up in the airlines' OTP measures and therefore these measures provide some insights into the airports' ability to accommodate demand.

MOVEMENT AND DELAY PERFORMANCE AT MAJOR AUSTRALIAN AIRPORTS

Due to availability of data, the examination of movement and delay performance is restricted to the CAA flow control airports of Kingsford Smith (Sydney) Airport, Melbourne, Brisbane and Adelaide. As the CAA does not collect delay data for other major FAC airports, it can reasonably be assumed that delays at these airports are insignificant for most, if not all, of the time[1]. Anecdotal evidence suggests that the only Australian airport seriously affected by congestion problems is KSA, and then only during peak periods.

Traffic movements

KSA handled almost 240 000 aircraft movements in the year to April 1994 (CAA 1994). This compares with more than 135 000 in Melbourne, 132 000 in Brisbane and 131 000 in Adelaide for the same period. Figure II.2 clearly shows that Sydney is handling approximately twice the volume of traffic per month as the other three airports.

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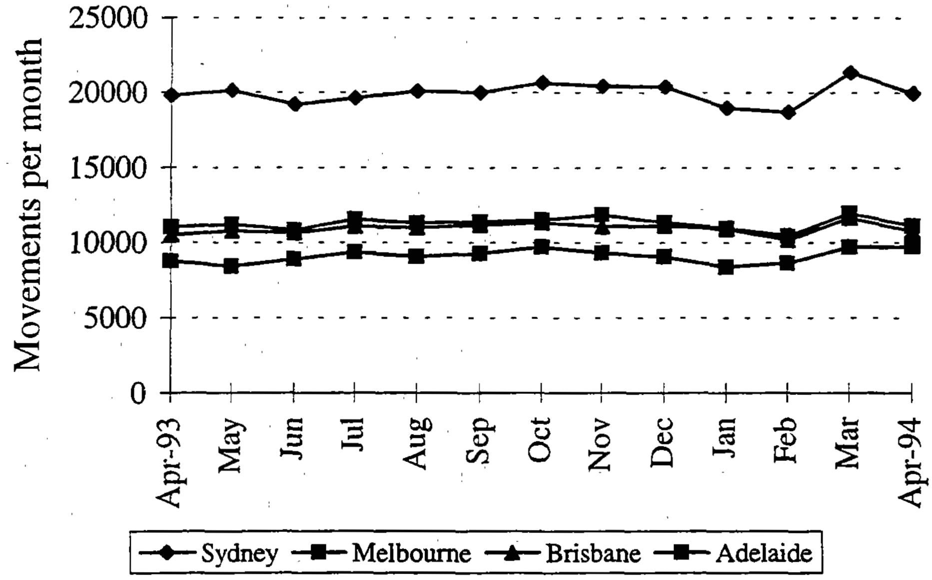
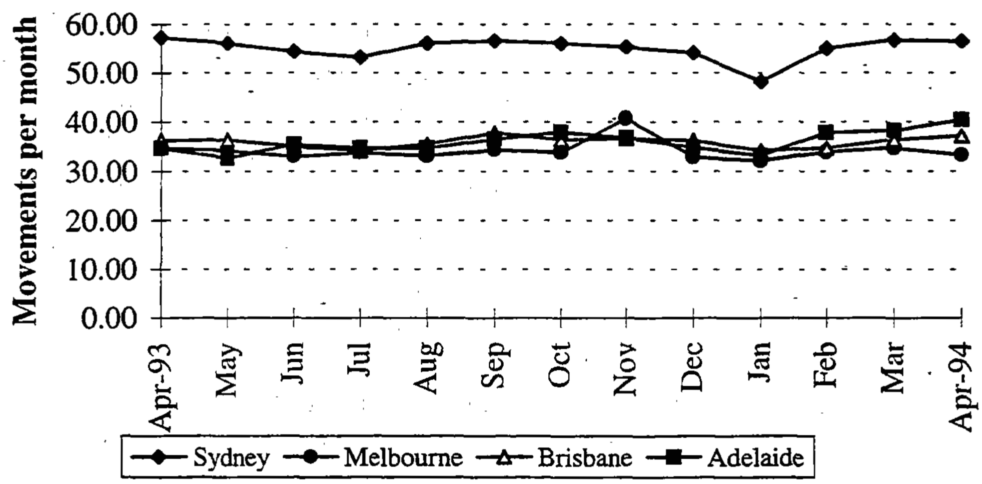
[1] Discussions with the CAA indicated that it is the volume of aircraft traffic which determines whether or not an airport warrants management and monitoring under the flow control system. Limited data has been recorded for Perth over the last 18 months (not a complete series). Perth is likely to come under flow management control in the near future (CAA, pers. comm. 1994).



Source CAA (1994) Flow Management Database.

Figure II.2 Monthly aircraft movements at major Australian airports, April 1993 to April 1994



Source CAA (1994) Flow Management Data Base.

Figure II.3 Busiest 30 hours average aircraft movement rate, April 1993 to April 1994

Figure II.3 reveals that the average movement rate at KSA for the 30 busiest hours per month is consistently one-third more than the other three airports (the two notable exceptions being in November 1993 and January 1994). The rate peaked in April 1993 at 57.3 and reaching a low of 48.2 in January 1994. Melbourne peaked at 40.7 movements per hour in November 1993, Brisbane at 37.8 in September 1993 and Adelaide at 40.5 in April 1994.

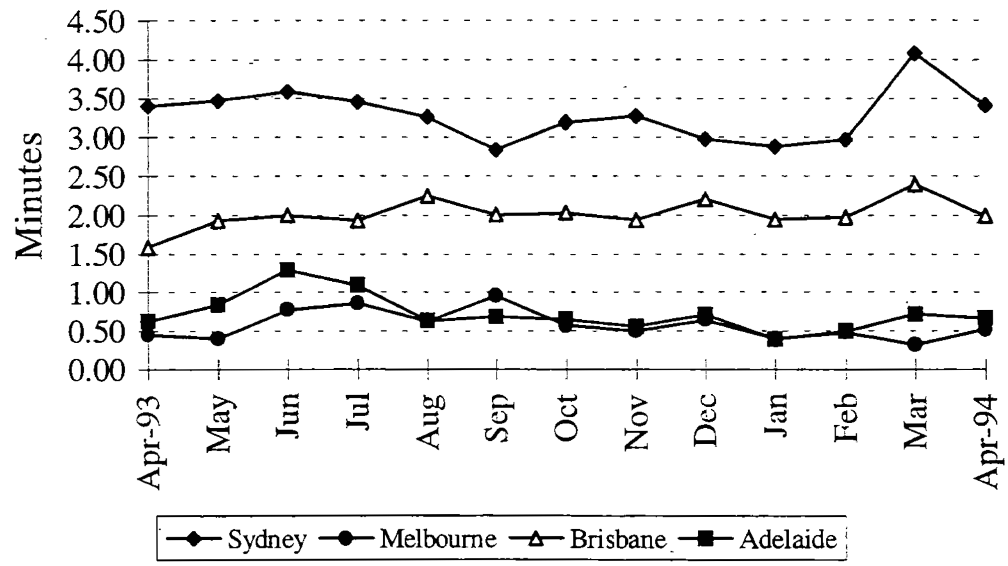
Delays

Average delays

Figure II.4 clearly shows KSA experiences far greater average delays than do the other airports. Brisbane recorded the second highest average delays. This may in part be due to the old radar equipment in use at Brisbane, which requires greater separation between aircraft than at other major airports around the country. According to the CAA there is a planned upgrade of the equipment at Brisbane scheduled for late 1994 (CAA, pers. comm. 1994).

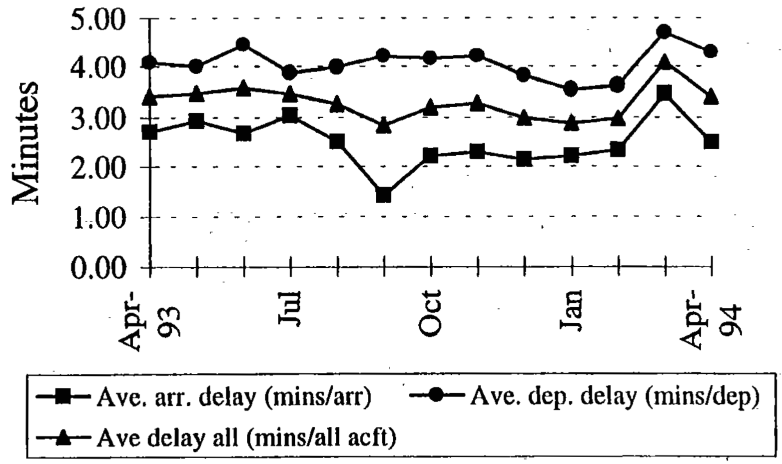
Figures II.5, II.6, II.7 and II.8 show the average arrival, average departure, and average total delays per month from April 1993 to April 1994 at the four airports. The graphs show that for KSA, Brisbane and Adelaide (with the exception of June 1993 for Adelaide), average departure delays have been significantly higher than average arrival delays. This is consistent with a change in CAA procedures during 1993 giving priority to arrivals over departures. The decline in average delays seen in the final period at KSA and Brisbane is consistent with the CAA policy of holding aircraft on the ground in other cities when Sydney is congested. The picture depicted for Melbourne is different. Average delay times are much more erratic than for the other airports and for the period May 1993 to August 1993, average arrival delays exceeded departure delays.

Average arrival delays for March 1994 for Melbourne were negative. This means that in fact on average arrivals were early for that month. The negative



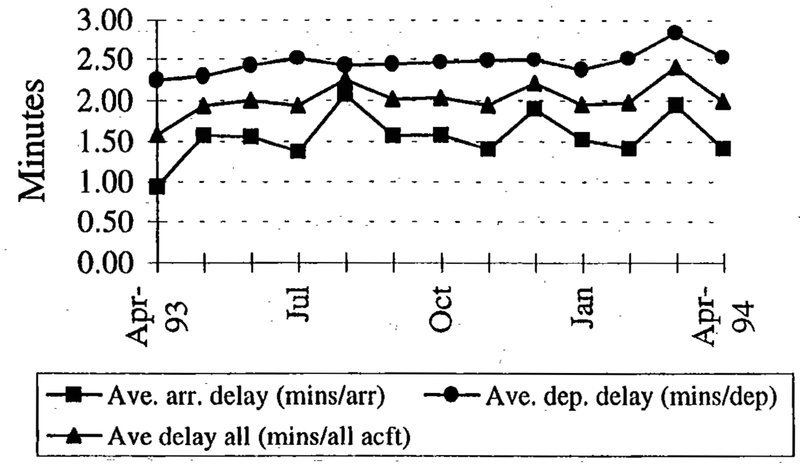
Source CAA (1994) Flow Management Database.

Figure II.4 Average delay per movement, April 1993 to April 1994



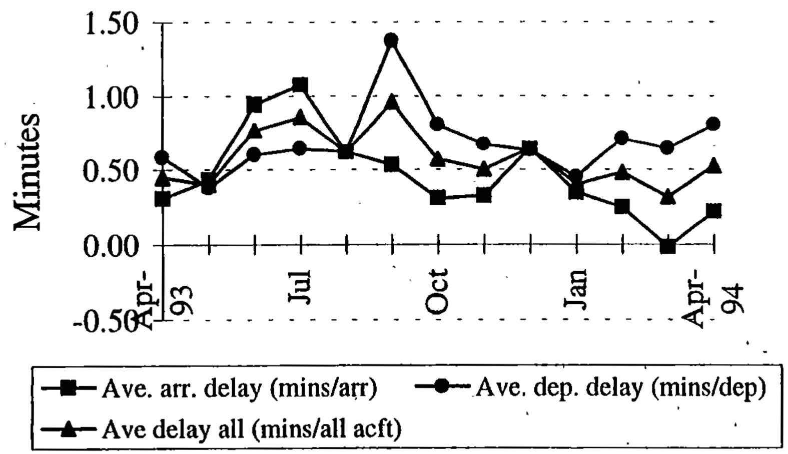
Source CAA (1994) Flow Management Database.

Figure II.5 Average movement delays at KSA, April 1993 to April 1994



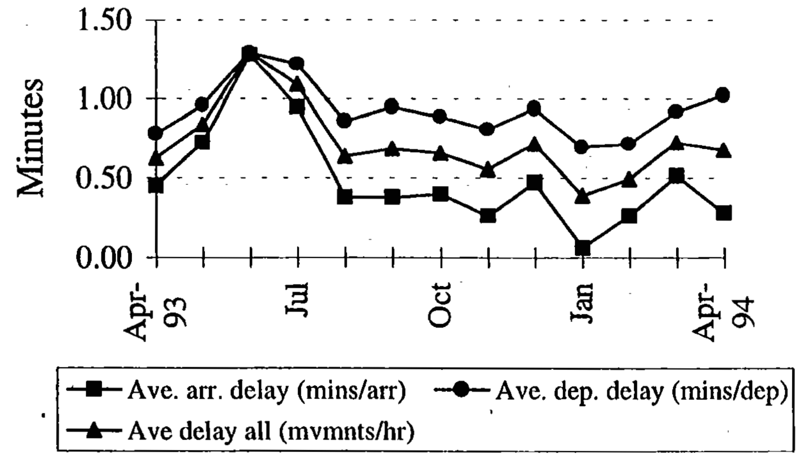
Source CAA (1994) Flow Management Database.

Figure II.6 Average movement delays at Brisbane, April 1993 to April 1994



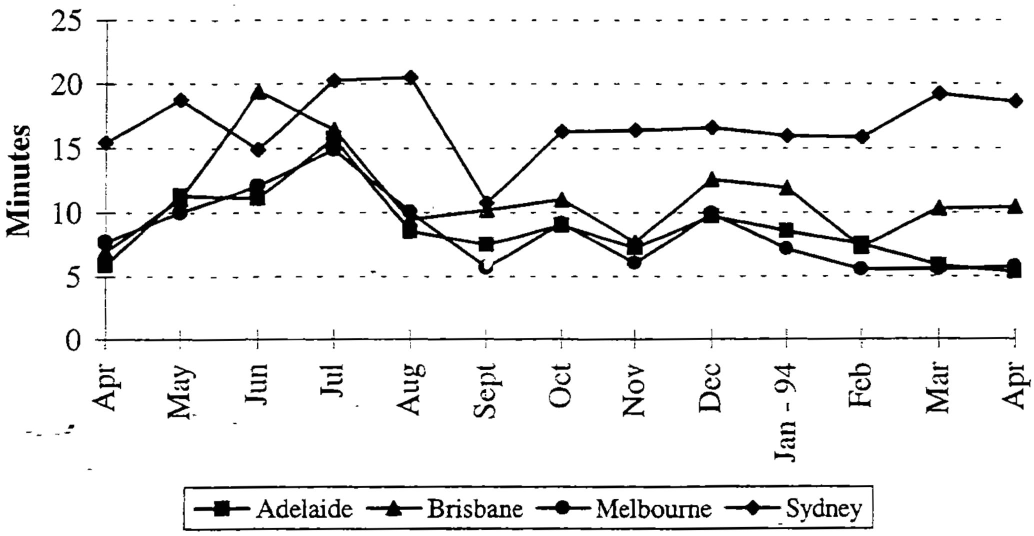
Source CAA (1994) Flow Management Database.

Figure II.7 Average movement delays at Melbourne, April 1993 to April 1994



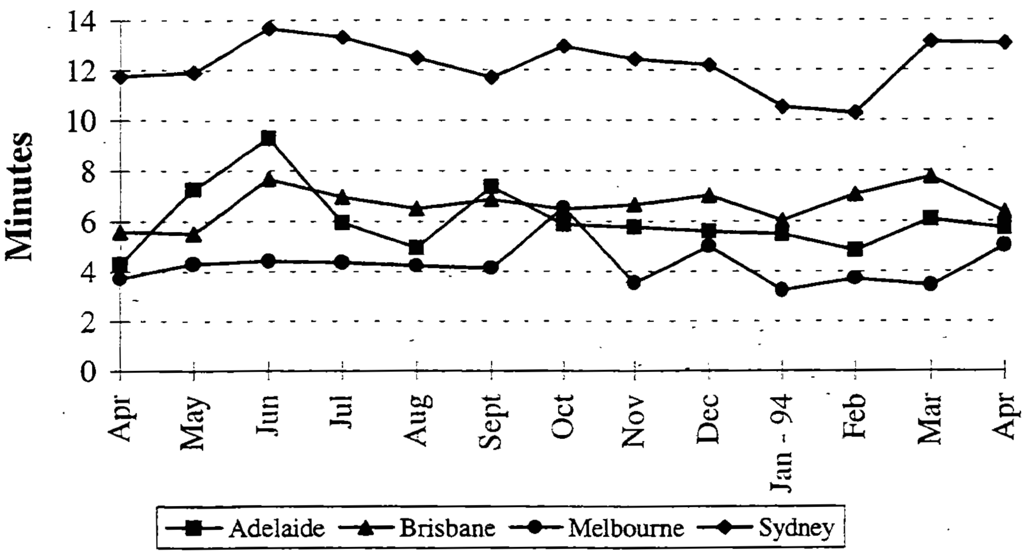
Source CAA (1994) Flow Management Database.

Figure II.8 Average movement delays at Adelaide, April 1993 to April 1994



Source CAA (1994) Flow Management Database.

Figure II.9 Average arrival delay for worst 30 arrival hours, April 1993 to April 1994



Source CAA (1994) Flow Management Database.

Figure II.10 Average departure delay for worst 30 departure hours, April 1993 to April 1994

figure is recorded due to the start and finish points that the CAA uses in measuring the timing of movements for its delay measurement (in this instance the negative figure means that on average flights were actually ahead of schedule).

Figures II.9 and II.10 show the average arrival delay and average departure delay, respectively, for the respective worst 30 hours. As expected, Sydney consistently recorded the highest average delay per movement in the worst 30 arrival and departure hours over the year April 1993 to April 1994. The average arrival delay peaked in August 1993 at 21 minutes, while the average departure delay peaked at 14 minutes in June 1993. The lowest average delays for Sydney were recorded in September 1993 for arrivals (11 minutes) and in February 1994 for departures (10 minutes). In June 1993 Brisbane recorded the highest average arrival delay (19 minutes). This was the only month during the year in which Sydney did not record the highest average arrival and departure delay times.

The distribution of traffic over the course of the day will ultimately determine the delays incurred at an airports. Clearly, Sydney has high peak demand given the consistently high level of delays incurred during the year examined. The CAA estimates that demand for aircraft movements at KSA during peak periods exceeds supply, that is actual aircraft movements, by approximately five movements per hour (that is, approximately 70 movements are demanded per hour) (CAA pers. comm. 1994).

Peak period and shoulder delays

Peak period pricing[2] was introduced at KSA in 1989 on movements other than regular public transport (RPT) movements during the peak hours 8am to 9am and 6pm to 7pm. The arrangements have been modified several times since; currently charges apply to all aircraft during the peak periods, including RPT, and charges apply to non-RPT movements in the shoulder periods (that is, the hour either side of the morning and afternoon peaks).

The aim of introducing peak period charges was to reduce demand during peak periods in order to reduce congestion. The policy has been successful in reducing demand during the peak periods, particularly regional and GA demand, and has resulted in average delays per movement being maintained at less than 4 minutes per movement (except for March 1994, see figure II.4) which is generally considered to be an acceptable level. The pricing policy has had another important effect: it has pushed significant traffic volumes into the shoulder periods, resulting in a "double peak" (CAA, pers. comm. 1994). Currently the peak and shoulder charges at KSA are $250 for all movements during the peak, and $200 per landing and $100 per departure in the shoulder periods.

2 Peak period charges are in addition to normal airport charges which are applied to all movements irrespective of what time of day they occur.

On-time-performance

Little can be said in this study about OTP. The data made available by Ansett and Qantas provides some interesting insights. However, due to the commercial sensitivity of the OTP data, comments which can be reported publicly are extremely limited.

Both airlines reported a significant number of delays attributed to air traffic control. This is not surprising, particularly in light of the fact that the two domestic airlines combined schedule up to four movements at any one time during the peak periods. Clearly, only one movement can occur at any time, although two movements may occur under SIMOPS: therefore, two or three of the scheduled movements will be delayed.[3] While the airlines attribute such delays to air traffic control, it is more accurately attributable to the their scheduling practices than to CAA operating procedures in these circumstances.

Costs of delays

The costs associated with delays can be divided into three main categories:

- costs to consumers;
- costs to the airline industry; and
- external costs.

It is extremely difficult to estimate the total costs arising from delays. Attempts have been made to estimate costs for various components of costs. However, the difficulties associated with valuing many of the indirect costs, in particular the value of passenger time and negative externalities which may occur due to delays, mean that existing studies tend to focus on the direct operational costs of delays.

Consumer delays

The value of passenger travel time is comprised of an opportunity cost and a marginal disutility cost. The opportunity cost is the loss of productivity incurred during travel. The disutility cost arises from a traveller's preference for using the time spent travelling in undertaking other activities. It could reasonably be assumed that business travellers place a higher value on their time than do leisure travellers, as leisure travel tends to be less time critical, but converting this value of time to a dollar value is highly subjective. There is some debate as to what values should be applied to the cost of travel time. However, this a complex task and currently no consensus exists.

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[3] Two simultaneous movements will be achievable most of the time once the parallel runway is fully operational at KSA.

Other costs which maybe incurred by consumers due the delays include, missed connections and meetings, and additional accommodation costs.

Airline industry costs

The two broad categories of costs due to delays are direct and indirect costs. Discussions with the industry revealed that the most significant direct costs include the cost of additional fuel required to accommodate delays (particularly airborne delays), crew costs, and aircraft maintenance and engineering costs. Airlines may also experience a reduction in aircraft utilisation as a result of delays. Indirect costs include depreciation, overheads, fixed operating costs and loss of customers and customer goodwill due to a perception that delays are the fault of the carrier (which may or may not be the case).

Little information is currently available as to the costs imposed on airlines by delays, particularly in relation to the non-time dependent indirect costs.

External costs

Delays also impose costs on the community at large and in particular those communities surrounding the airport environs. These costs include: the cost of environmental damage from increased fuel consumption from airborne delays and noise pollution if held over residential areas. If delays become, or are perceived to be, particularly inhibiting to travellers there is the potential for tourism and business revenues to be foregone.

CONCLUSIONS

This study supports the anecdotal evidence that KSA is the only major Australian airport which is seriously affected by congestion, and then only during peak periods. On average, delays (the CAA measure) at KSA are less than the accepted benchmark of 4 minutes per movement. However, this conceals the frequency and magnitude of peak period delays, which may exceed 30 minutes. Again, it is important to note that the CAA measure is not a measure of total delay.

This study has highlighted some of the difficulties associated with examining delays in the aviation industry. First, there is the problem of consistency of definitions of delays, of identifying causes of delay, and in the measurement and recording of delays. Second, the commercial-in-confidence nature of airline OTP measures restricts access to the data and explicit reference to it. Third, the absence of a delay measure which represents total delay and which attributes delay to its various causes, and finally, there is currently no readily available method for valuing the costs of delays.

APPENDIX III DATA ISSUES

This study has identified serious deficiencies in the availability of data on both the characteristics and the usage of transport infrastructure. Such deficiencies severely limit the ability to undertaken large scale strategic assessments of infrastructure. Development of nationwide, standardised databases on infrastructure characteristics, usage and performance for all modes will enable more rigorous and detailed strategic assessments to be undertaken in time for strategic expenditure decisions.

As far as the aviation component of the study is concerned, the greatest deficiencies in data relate to a lack of consistency of definitions of delay, of identifying causes of delay and the measurement and recording of delay periods. The commercial confidentiality associated with delay figures creates difficulties with collecting and reporting results. This is compounded by the large number of international air carriers who provide services to/from Australia's international gateways. Obtaining consistent delay data from all carriers presents a challenging task.

Part of the difficulty associated with accessing available data in the current study is associated with the timing of the study, which coincided with the Government's decision to privatise the airports. As a consequence of this decision a number of new sensitivities emerged which severely limited the flow of data and information from some industry sources. This was not aided by the safety concerns surrounding the industry. It should be noted, that access to data may become even more restricted once the major airports are privatised. Therefore, doing the study at a different time may do little to overcome this problem of access to data.

Another area of difficulty is associated with valuing the costs of delays in the aviation industry. There are two aspects to this problem. First, there needs to be a measure of total delays for the industry, and second, there needs to be a methodology developed for evaluating the costs associated with the various components of delays. For example, the value of travellers' time, indirect non-time dependent costs to the airlines, and the cost of externalities arising from aviation activities. A more detailed discussion of issues related to assessing and modelling delays was presented in appendix II.

In a future study it would beneficial to extend the analysis in the current study to incorporate an economic assessment. In order to do this further research into concepts of capacity and levels of service of aviation infrastructure would be necessary prior to the development of delay models. Such work would require a detail data on infrastructure characteristics, levels of usage, volume/capacity ratios and future demand. It would also require the further development the concepts of standards of levels of service.

The Department of Transport collects and maintains a good historical series of RPT aircraft movements and passengers. The recording of GA is less consistent. As mentioned in chapter 4, there is an increasing degree of non-reporting of freight volumes carried in RPT services and no reporting of freight volumes carried in dedicated freighters. The development of this data in the GA and freight areas would be a useful input to future work.

The success of future work will depend on the development and cultivation of data sources. This will require a far more collaborative approach between researchers, the industry and industry regulators. While there are some obvious impediments to this happening, it would encourage a greater flow of information and therefore a more rigorous analysis of the industry. Potentially, this could provide a better understanding of the industry and the effects of changes in policy have on it, and develop a sound information base for policy formulation by the Government, industry and regulators.

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Abbreviations

BTCE	Bureau of Transport and Communications Economics
BTE	Bureau of Transport Economics
CAA	Civil Aviation Authority
DoT	Department of Transport
EIS	Environmental impact statement
FAC	Federal Airports Corporation
IATA	International Air Transport Association
SAMC	Melbourne Airport Surface Access Monitoring Committee
TRB	Transport Research Board

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ABBREVIATIONS

ACS	Australian Construction Services
AFR	Australian Financial Review
ALP	Australian Labour Party
APEC	Asia Pacific Economic Cooperation group
ATS	Air Traffic Services
AVSTATS	Aviation Statistics Branch, Department of Transport
B	Billion
BCR	Benefit-cost ratio
BTCE	Bureau of Transport and Communications Economics
BTE	Bureau of Transport Economics
CAA	Civil Aviation Authority
CBD	Central business district
DoT	Department of Transport
EIS	Environmental impact statement
FAC	Federal Airports Corporation
GA	General aviation
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
IFR	Instrument flight rules
KSA	Kingsford Smith (Sydney) Airport
m	metres
M	Million
N/A	Not applicable
na	Not available
NSW	New South Wales
NTPT	National Transport Planning Taskforce
OTP	On-time-performance
p.a.	Per annum
PARM	Parallel Approach Radar Monitor
PAX	passengers
RPK	Revenue passenger kilometres
RPT	Regular public transport
SAMC	Melbourne Airport Surface Access Monitoring Committee
SIMOPS	Simultaneous runway operations
SWA	Sydney West Airport
TM	Travers Morgan

TRB	Transportation Research Board
USA	United States of America
VFR	Visual flight rules