# HKIA's Third Runway
# —The Key for Enhancing Hong Kong's Aviation Position

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by

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**Content**

# Chapter 1 Objectives of the Study

## 1.1 Background

Hong Kong International Airport (HKIA) has been gaining excellent reputation from the aviation industry and travellers worldwide since its early days of operation. In recent years, Hong Kong's air transport industry benefited directly from the rapid growth of the Asia-Pacific and Chinese markets. Despite such strong growth, Hong Kong has encountered fierce competition from its regional neighbours and even within the same catchment area (the Pearl River Delta Region, PRD). Airspace and ground congestion have become more serious over time.

To cope with the increasing air traffic demand and competition, the Airport Authority Hong Kong (AAHK) has published a report on 'HKIA 2025' in December 2006: a master plan outlining the airport potential plan to meet the future demand. The AAHK has suggested constructing a third parallel runway with around 1km separation from the current north runway. However, mixed views have been received from both the industry and the public about the proposal.

'HKIA 2025' also proposed a HK$ 4.5 billion investment programme which would include an injection of HK$1.5 billion to enhance the Passenger Terminal Building. The remainder would be invested in the airfield including the construction of a new satellite concourse for smaller aircraft. The AAHK will work with the Civil Aviation Department to maximize the capacity of the existing two runways, assess the feasibility of the third runway and support the co-ordinated development within the PRD airports network system.

According to The Basic Law (*Chapter 5 Economy, Section 4 Civil Aviation, Article 128*), it has clearly stated that '*The Government of Hong Kong Special Administrative Region shall provide conditions and take measures for maintenance of the status of Hong Kong as the centre of international and regional aviation*' [HKSAR, 2007]. Thus, HKIA and the HKSAR Government must address capacity constraints both on the ground and in the air in the short term and long term, in order to sustain Hong Kong's position as an international aviation hub.

The current capacity of the two runways is around 54 movements per hour, which is still below the ultimate capacity estimated by the government [HKSAR, 2007]. The third runway will be costly and require another major landfill at HKIA. Given the curent atmosphere in Hong Kong, costing and environmental issues will likely be under much public scrutiny and the process will be lengthy. Some industry experts also suggested that building the third runway would be pointless, unless the PRD airspace issue has first been resolved.

## 1.2 Objectives

HKIA is very congested now and will run out of capacity at some point in time in the not-too-distant future. Of course, many enhancement measures can be implemented to expand its capacity to some extent during the interim period. However, this "ultimate capacity" would be reached eventually and the third runway should be ready to serve. In this study, we attempt to take a look at the timing when this third runway "should be ready" so as to prevent significant impairment to our economy. Objectives of this study can be stated as the follows:

(a) To review the air traffic demand forecasts which are relevant to Hong Kong, and the expansion plans of other regional and PRD airports (Chapter 2 and 3) ;

(b) To examine factors affecting the current capacity of HKIA and the feasibility of enhancement measures to improve capacity (Chapter 4) ;

(c) To review recent experiences on building new runways by other major airports (Chapter 5) ;

(d) To estimate the “ultimate capacity” of the HKIA under the current two runways configuration and establish a time schedule for the planning and construction of the third runway (Chapter 6) ;

(e) To examine the important issues, particularly operational and environmental, involved in the building of the third runway (Chapter 7) ;

(f) To provide an economic assessment of the third runway (Chapter 8) ;

(g) To provide policy recommendations regarding the third runway (Chapter 9).

## 1.3 Research Framework

The Aviation Policy & Research Centre (APRC) began work on the subject since the AAHK 'HKIA 2025' was unveiled. Researchers have visited relevant organizations locally and internationally to learn more about the subject. In the following, we illustrate the research framework for reference.

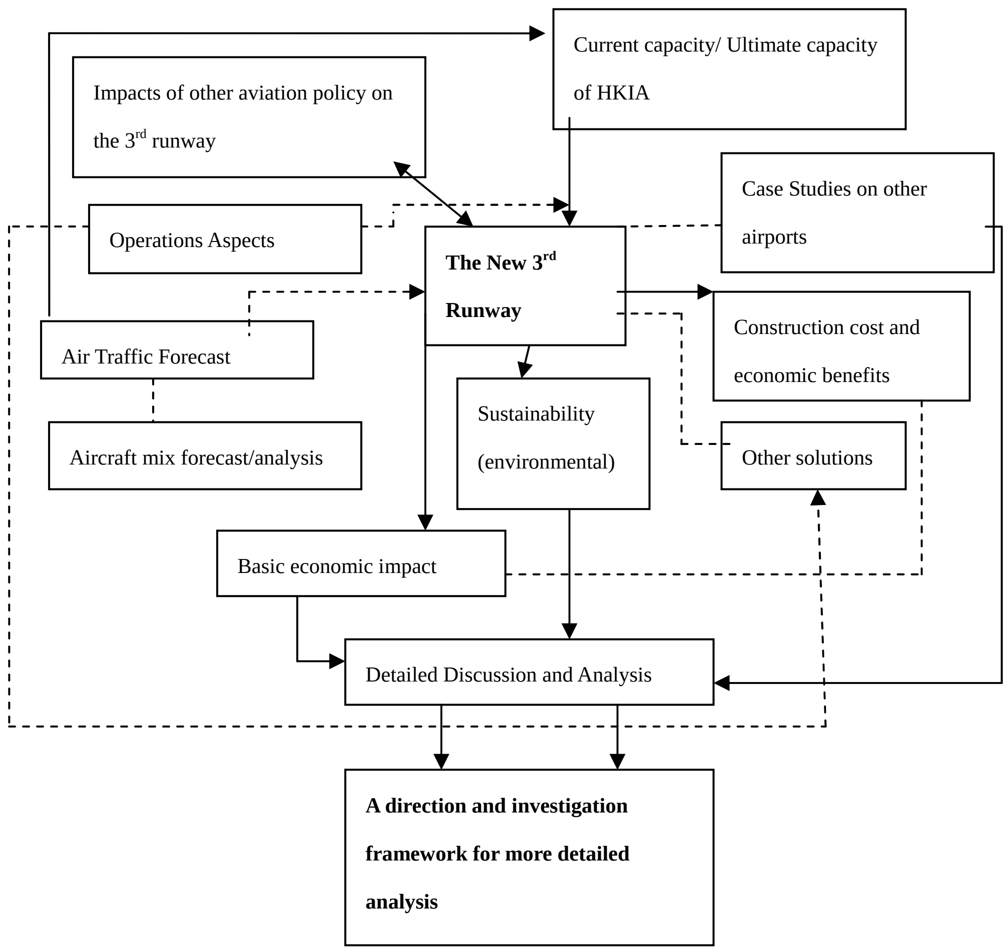



Fig 1: Analytical Framework for this report

# Chapter 2  Regional Airports' Development and Expansion

In this section, the development of airport infrastructure in the Region, including major airports in Mainland China is reviewed. It will provide an overview of the competitive landscape for the HKIA, within which HKIA's third runway is to be considered.

## 2.1 Asian Aviation Hubs

Air transport has been growing rapidly in Asia in the last ten years. The rate of growth is much higher than that in the more mature markets of Europe and North America. Asian nations have now recognised the importance of the aviation industry to their economies, and recent economic development in the region has provided the impetus and resources for aviation infrastructure development. Table 2.1 below summarized some of the major airport projects in the region in recent years.

| | Asian Airports' Development (all having 2 runways currently) |
|---|---|
| Bangkok Suvarnabhumi Airport, Thailand (commencing in 2006) | The new Suvarnabhumi Airport opened for operation in September 2006, with 2 runways of 4,000m and 3,700m respectively. Its passenger terminal is the 2$^{nd}$ largest in the world, just behind HKIA. Project costs was around 155 billion baht |
| Kuala Lumpur Sepang Airport, Malaysia (commencing in 1998) | A new runway & a new satellite building are under the planning stage |
| Singapore Changi Airport, Singapore (commencing in 1991) | New low cost terminal opened in March 2006, plus extensive upgrade costing S$240 million in Terminal 2. Terminal 3 will be operational in 2008. Additional land has been reserved for two extra wide-spaced runways |
| Tokyo Narita Airport, Japan (commencing in 1978) | 2$^{nd}$ runway started operation in April 2002, after long delays. Plans for new taxiways construction |
| Taipei Taoyun Airport, R.O.C. (commencing in 1979) | Taiwan is having plans to develop the 4$^{th}$ terminal, the 3$^{rd}$ runway, a new cargo area in the longer term |
| Seoul Incheon Airport, South Korea (commencing in 2001) | The 3$^{rd}$ runway of 4,000m and taxiway system will become operational before August 2008. Construction cost is about US$1.22 billion |

Table 2.1 Major Airport Developments in Asia-Pacific Region

These airports are major international hubs in the Region and all are competing directly with Hong Kong for both passenger and cargo traffic. They are seriously considering the expansion of their airport infrastructures at various stages in order to capture the anticipated growth of demand in the region. For example, new Asian hubs like Seoul Incheon Airport and Kuala Lumpur Airport are both having the third runway under the planning stage. As for Kuala Lumpur, the Malaysia-based low cost carrier AirAsia has been expanding rapidly. The recovering of South Korea's economy plus its recent increased business ties with China on air cargo services have provided optimism for Korea's future aviation development.

## 2.2 Mainland Major Airports

For Hong Kong, airports in Mainland China also generate significant competition. All the 'Big Three' airports in China: Shanghai Pudong, Beijing Capital, Guangzhou Baiyun are planning to expand their existing facilities. The expansion plan for Guangzhou is particularly ambitious. It is planning to build a new runway every 5 years. As we can see from Table 2.2, all of them have a new runway included in their Master Plans.

| | Project Development | Estimated budget | Starting date | Expect finishing time | Expect operation time |
|---|---|---|---|---|---|
| Shanghai Pudong | 2nd Terminal for international pax (480,000 sq.m)<br><br>3rd runway (3,400m) & ancillary facilities<br><br>South side cargo terminal | RMB 20 billion | Dec 2005 | 2007 | 2008 |
| Beijing Capital | 3rd pax terminal to cope with the upcoming Olympics<br><br>3rd runway and ancillary facilities<br><br>Related surface access roads and highway | RMB 19.45 billion | Mar 2004 | 2007 | 2008 |
| Guangzhou Baiyun | New pax terminal (300,000 sq m)<br><br>Pier expansion to increase apron number to 166 (inc. both pax & cargo)<br><br>New cargo terminal<br><br>Expansion of Metro Line 3 to Terminal 2<br><br>Set space for the planning of the 5th runway | RMB 11.4 billion | 2006 | 2010 (2nd expansion phase)<br><br>2008 (UPS Asia-Pacific hub) | 2010 (2nd expansion phase)<br><br>2008 (UPS Asia-Pacific hub) |
| Shenzhen Bao'an | 2nd runway<br><br>New passenger terminal | RMB 11 billion | Dec 2006 | 2009 | 2010 |

Table 2.2 China's major airport development

China, being the second largest commercial aviation market in the world [Boeing, 2006], would need to provide more runways and airports to support its tremendous economic development in the coming years. According to Civil Aviation Administration of China (CAAC), there are only 147 airports for civil aircraft to serve a population of over 1.3 billion [CAAC, 2007]. This compares very unfavourably with developed countries such as the US, which has 14,807 airports serving a country with 270 million people [ATW, 2006]. During the $10^{th}$ Five-Year Plan period (2000-2005), a total infrastructure investment of 94.7 billion Yuan was made in fixed assets in the whole industry, 21 new airports were built and a large number of airports were modified or expanded in China. In the current $11^{th}$ Five-Year Plan period (2005-2010), 140 billion Yuan will be spent on airport infrastructure [CAAC, 2007]. Some 190 civil airports is expected to be in operation by 2010 in China [Wang, 2007], and this number is expected to further increased to 220 by 2020 [Ionides, 2007]. Despite the expansion efforts, it is anticipated that demand will likely be outpacing supply in China.

The capacity shortage problem is especially severe for the Beijing Capital Airport. The upcoming 2008 Beijing Olympic Game will most likely worsen the capacity constraints. As for the southern part of China, being the most rapidly growth region of the boosting economy, we have seen increasing aircraft movements within the PRD region. Table 2.3 summarized aircraft movement statistics of the five major airports in PRD.

| | Hong Kong | Macau | Guangzhou | Shenzhen | Zhuhai |
|---|---|---|---|---|---|
| | | | Aircraft Movement (Flights) | | |
| 2000 | 181,927 | 28,692 | 132,776 | 74,251 | 17,369 |
| 2001 | 196,833 | 32,506 | 137,355 | 87,875 | 23,298 |
| 2002 | 206,705 | 37,564 | 147,740 | 106,718 | 23,260 |
| 2003 | 187,508 | 31,293 | 142,283 | 119,523 | 14,965 |
| 2004 | 237,308 | 40,506 | 182,780 | 140,452 | 22,389 |
| 2005 | 263,506 | 45,004 | 211,309 | 151,430 | 22,742 |
| 2006 | 280,387 | 51,049 | 232,404 | 169,493 | 24,352 |
| Average Annual Growth | 7.48% | 10.1% | 9.78% | 14.7% | 5.79% |

Table 2.3: Aircraft movement growth in Pearl River Delta (PRD) region [Data sources: CAD& MIA homepage, 2007, CAAC Statistical data 2001-2007]

The five major airports in PRD have passenger growth at an annual rate exceeding more than 5%, with Shenzhen having an average annual growth rate of nearly 15% between 2000 and 2006. Although Zhuhai experienced a relatively low level of growth during the period, the recent co-operation between AAHK and the Zhuhai Government (under the Zhuhai-Hong Kong Airport Management Company: a joint-venture between AAHK with a 55% stake and the state-owned Assets Supervision & Administration Commission of the Zhuhai Municipal People's Government) will bring new impetus and growth to its operation. HKIA aircraft movements have been growing at 7.5%, much higher than the original official forecast.

# Chapter 3 Regional Demand Forecast for Aviation Services

In this section we review major air traffic statistics and forecasts, which points to the rapid growth projected for Asia Pacific in the next 20 years.

## 3.1 Rapid Growth in Asia-Pacific's Air Transport

Despite the downturn of the aviation industry after the 9/11, the growth of world economy, tourism, trade and more liberalized air market have resulted in a stronger than ever demand for air services. Different organizations and companies from the industry such as Airport Council International (ACI), Boeing and Airbus have all forecasted a strong growth in air services in the next 20 years. This is particularly true for the Asia-Pacific market. During the period, the Asia market is projected to overtake the North America market [Boeing, 2006]. Table 3.1 summarized the views from the industry forecast of the world and Asia-Pacific for the next 20 years.

| Annual Growth | Airbus | Boeing | ACI |
|---|---|---|---|
| Asia-Pacific Passenger Growth | 6% | 6.4% | 5.8% |
| Global Passenger Growth | 4.8% | 4.9% | 4.0% |
| Asia-Pacific Freight Growth | 6.8% | 6.9% | 6.5% |
| Global Freight Growth | 6% | 6.1% | 5.4% |
| Asia-Pacific Aircraft Movement Growth | N/a | N/a | 6.3% |
| Global Aircraft Movement Growth | N/a | N/a | 2.8% |

Table 3.1 Global and Asia-Pacific air traffic growth forecasts 2006-2025 [ACI, Airbus, Boeing 2006]

All of these forecasts expected that the Asia-Pacific passengers would grow by about 6% per annum on average, while freight would grow by about 6.5%. These two numbers are about one percentage point higher than the corresponding global average growth rate.

Within this scenario of high growth, Hong Kong's aviation market recorded a double-digit growth in 2006, i.e. 40.7 million passengers (included 930,000 in transit) passed through the airport (up from 9.7% over 2004). Aircraft movements went up by 11% to a total of 263,000, and air cargo increased by 10% to 3.4 million tones. The corresponding value of air cargo also increased by 17% [HKSAR, 2007]. As an international aviation hub, the aviation sector has been contributing to Hong Kong economy: APRC has estimated that the aviation sector contributed 8.67% of GDP to Hong Kong, and around 7% of Hong Kong's employment in 2005.

## 3.2 The Increasing Importance of China's Aviation Market

Asia nations are the fastest growing economies in the world and is home to 60.4% of the world's population in 2007 [UN, 2007]. While this number is projected to decrease to 55% by 2050, the economic contribution from this 55% will most likely be significantly higher than that contributed by the 60.4% today. Asia nations are the world's major exporters and attract a record amount of foreign investment. China is now the fourth largest economy in the world, behind the US, Japan and Germany. The GDP of China is estimated to be USD$2,630 billion in 2006. [IMF, 2007].

In the last ten years, China's aviation growth was almost twice as much as the average global growth and it's traffic movements has moved up from being ranked ninth in the world in 2000 to being ranked second in 2005 [CAAC, 2007]. In the presence of a strong demand, the airport infrastructure in China is facing both opportunities and challenges.

One of the difficulties that China is facing is insufficient runways for a population of 1.3 billion. There are only 147 certified airports in China (not including HKIA and Macau). Among them, only 113 and 25 can accommodate B737 and B747 respectively [CAAC, 2007]. Fig 3.2 shows the changes of aircraft movement of the 'Big three' airports in China (Beijing, Shanghai Pudong and Guangzhou). Shenzhen is also included in this figure due to its significance to the PRD region and effects on HKIA. The graph compares the annual aircraft movement of each airport from 2001 to 2006. Each airport shows a high level of aircraft movements, Beijing, Shanghai and Guangzhou airports are among the top three China airports in terms of aircraft movements. Shenzhen and Shanghai are particular worth noting because of the two airports still managed to grow in terms of aircraft movements during the SARS outbreak in 2003. These airports account for nearly 30% of total China's aircraft movements. The strong growth of China's aviation would mean that more runway capacity would need to be greatly expanded in order to meet the future demand, especially for these four airports.

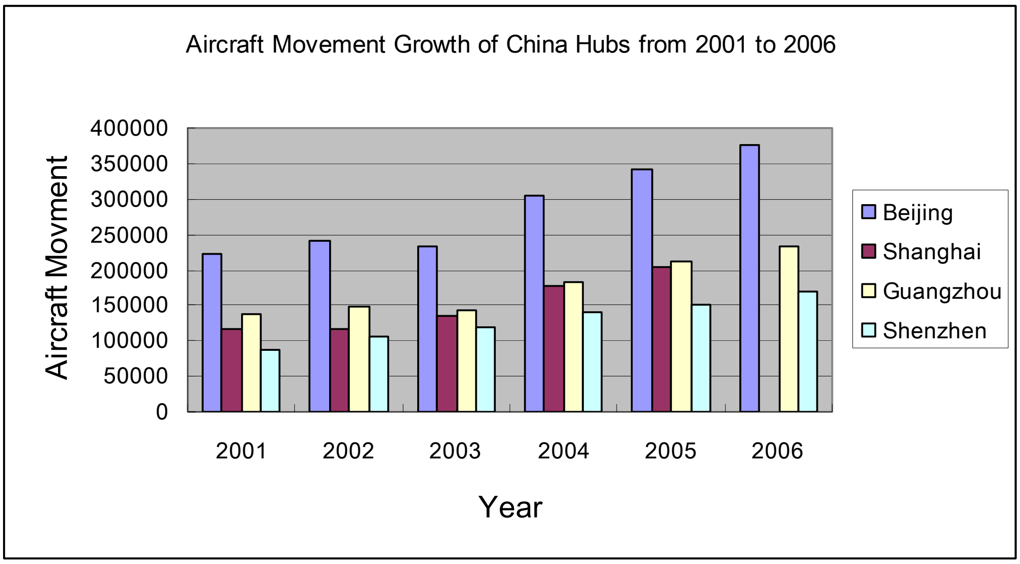



Fig 3.2 Aircraft Movement Growth of China Hubs from 2001 to 2006. [summarized from CAAC data, Shanghai Pudong's 2006 annual aircraft movement is not yet available]

China's aviation industry will encounter a major challenge in 2008 and 2010 as a result of the hosting of the Olympic Game and the World Expo. The Beijing Capital Airport was the top Asian airport by aircraft movement in 2006 (a 10.2% increase to 376,643 as compared with 2005) and second by passengers at 48.6 million [ACI, 2007]. As for 2007, domestic passengers have been estimated to increase by 16% to 185 million [Ionides, 2007]. This high growth is also reflected in the new aircraft orders depicted in Table 3.3 by major Chinese airlines in 2006, Airport infrastructures and airspace in China must be expanded significantly to cope with the growth.

| | Narrow-body type (single aisle) | Wide-body type (twin aisle) |
|---|---|---|
| Air China | 60 | 27 |
| Air China Cargo | 3 | - |
| China Eastern Airlines | 70 | - |
| China Southern Airlines | 85 | 24 |
| Hainan Airlines | 99 | 12 |
| Lucky Air | 1 | - |
| Shandong Airlines | 27 | - |
| Shanghai Airlines | 30 | 9 |
| Shenzhen Airlines | 35 | - |
| Total Aircraft Orders in 2006: 482 | | |
| Existing Aircraft in the China Air Transport Industry: 982 | | |

Table 3.3 China's Airlines Aircraft Orders Statistics 2006 [Summarized from ATW & CAAC, 2007]

According to statistics from CAAC, in 2005 the entire industry carried a total air traffic, passenger traffic and cargo traffic (included mail) of 25.92 billion tones-km, 138 million passengers and 3.035 million tones respectively, representing increases of 111.6%, 105.3% and 89.2% respectively as compared to the figures in 2000. The authority expected the strong growth in demand will continue. Figures 3.4.1-3.4.3 illustrate CAAC's forecast on aviation demand by 2020. The demand will be nearly 5 times more than the demand in 2005. [CAAC, 2006 & 2007].

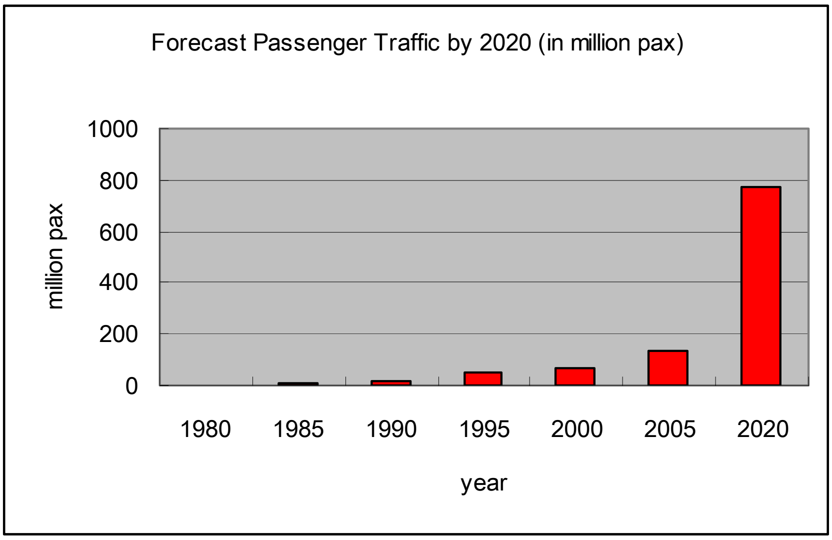



Figure 3.4.1 CAAC Historical Figures and Forecast on Passenger Traffic in China by 2020
[Data source: Statistical Data on Civil Aviation of China 2006, China Civil Aviation Magazine]

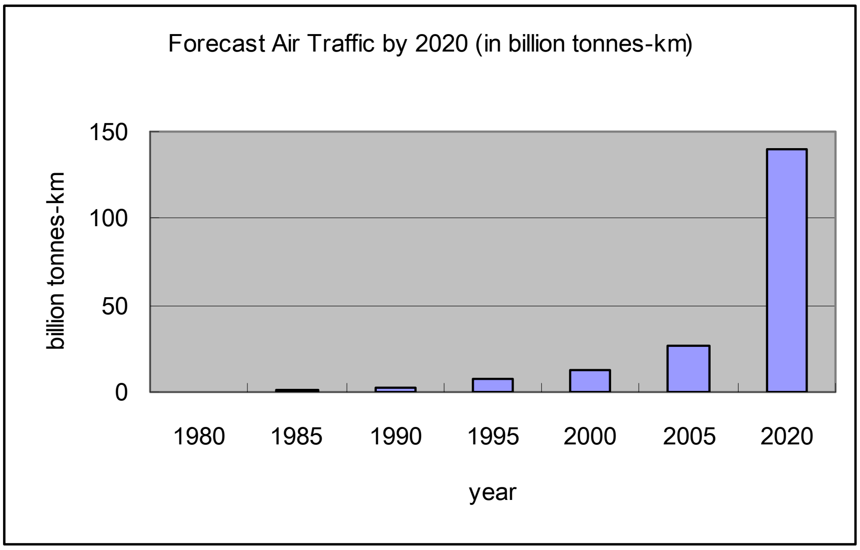



Figure 3.4.2 CAAC Historical Figures and Forecast on Air Traffic in China by 2020 [Data source: Statistical Data on Civil Aviation of China 2006, China Civil Aviation Magazine]

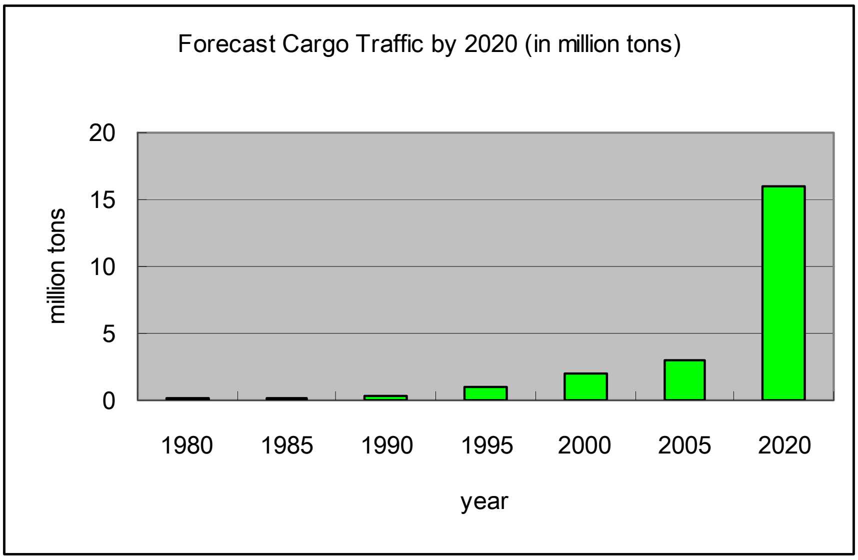



Figure 3.4.3 CAAC Historical Figures and Forecast on Cargo Traffic in China by 2020 [Data source: Statistical Data on Civil Aviation of China 2006, China Civil Aviation Magazine]

## 3.3 Hong Kong's Aviation Development under Mainland's Rapid Growth

Long before the rapid growth of China's modern economy, Hong Kong has always been "The Gateway to China". After the handover in 1997, the closer co-operation between Mainland and Hong Kong in air services has provided more opportunities for Hong Kong's aviation industry. However, Shenzhen and Guangzhou airports in the Pearl River Delta have become increasingly competitive as well in recent years. More liberal air service agreements have also resulted in more air traffic rights between China and the rest of the world. The restructuring of Chinese carriers would also improve their service quality and competitiveness.

Given the rapid growth and size of the Chinese economy, China will significantly influence and shape the pattern of airline networks in Asia and linkages with other continents. Hong Kong, being a Special Administrative Region of China, has obvious advantages over regional competitors such as Singapore and Taipei to expand into the China market. Hong Kong's efficient aviation industry could foster and attract new business opportunities into the Region and Mainland, where HKIA can play an important role.

Airports are fix-based assets and their businesses rely heavily on the quality of services providing to airlines, passengers and logistics service providers. HKIA has consistently been providing world class services since its opening 10 years ago, as evidenced by the top rankings they have received throughout these years, both by the travelling public and by other authoritative organizations. Given the fact that airport developments will take years to complete, it is crucial for the government to plan proactively ahead of time in its infrastructure development to maintain the competitive edge of HKIA, while taking account of demand factors and competitive environment into consideration. Table 2.3 showed that all the PRD airports except Zhuhai has experienced higher growth rate than Hong Kong. By assuming similar growth rates for the airports as depicted in Table 2.3, including the case where HKIA grows at the AAHK predicted rate of 3%, we can see in the resulting projection of aircraft movements as shown in Figure 4.5 that Shenzhen and Guangzhou airports will surpass HKIA by 2009 and 2011 respectively using the 3% rate for Hong Kong, and by 2014 using past growth rate of 7% for Hong Kong. According to sources from CAD, Guangzhou could experience more aircraft movements than HKIA by 2015.

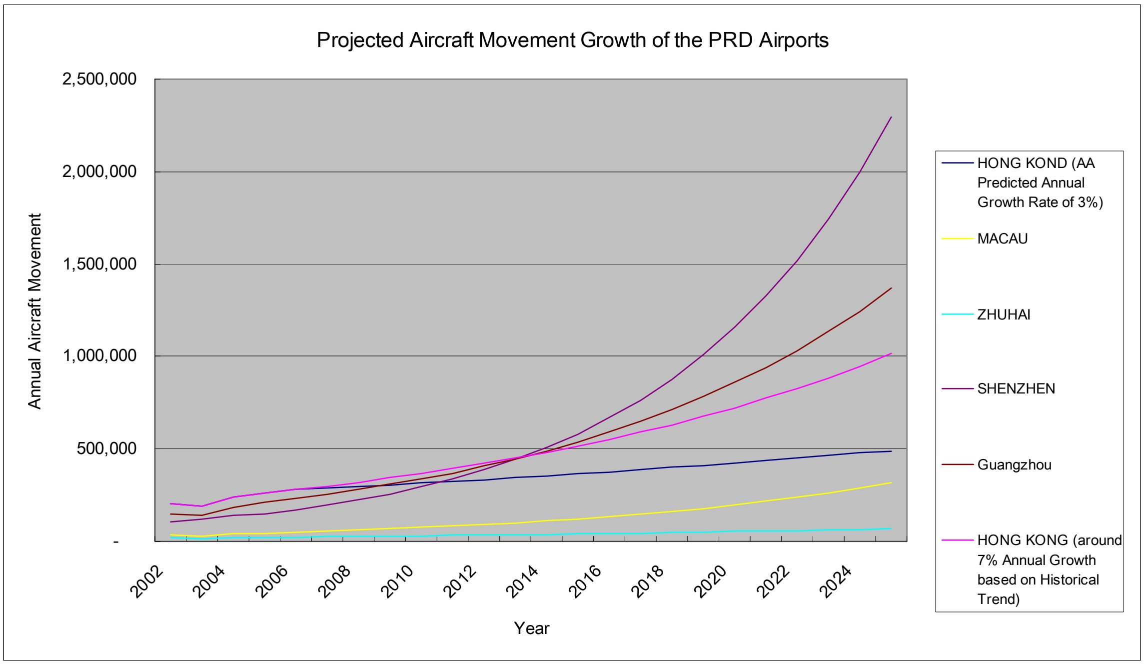



Fig 4.5 Projected Aircraft Movement Growth of the Five PRD Airports

# Chapter 4　Capacity Issues and Enhancement Measures for HKIA

## 4.1　The Capacity of the Hong Kong International Airport

In this section, the capacity of Hong Kong's International Airport is studied together with various measures which can be considered to expand the current capacity.　This will provide the basis for estimating when HKIA's ultimate capacity will be reached.

HKIA consist of two widely-spaced parallel runways, with a separation of 1,525m. Its current capacity is 54 movements/hour according to CAD. The two runways have an ultimate capacity of over 60 aircraft movement/hour [HKSAR, 2007]. Ultimate capacity is the maximum expected number of movements that can be performed in one hour of a runway system without violating air transport management (ATM) rules, assuming continuous aircraft demand. Because of the idealization, this ultimate capacity is unlikely to be achievable consistently in day-to-day operations.

Many factors will determine how close the practical capacity (which takes into account delays as a measure of level of services) each day could be when compared with the ultimate runway capacity. ATC procedures, of course, will have a big part to play. Yet, the design of these procedures is in turn affected by other external factors such as terrain, airspace availability and aircraft navigation performance. Hence, airport authorities seldom give a predicted 'ultimate annual capacity' due to the uncertainties involved. Indeed, the current 54 movements/hour at HKIA is a reference target number constrained by many dynamic operational factors. This 54 movements/hour is still below HKIA's runway's ultimate capacity.

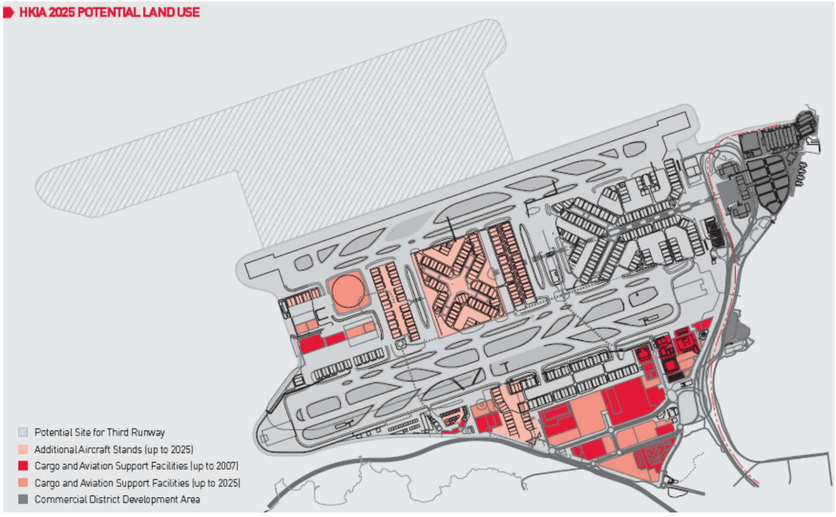



Fig 4.1 'HKIA 2025' Potential Land Use Map, the land take for the 3rd runway can be clearly seen from here [AAHK, 2006]

There are two concepts of airport capacity: Airside and Landside. Basically, *airside* facilities are infrastructures that serve aircraft and connect passengers to aircraft. It also includes the terminal airspace, taxiway system, aprons (the area where aircraft are served and parked) and gates. The runway is always the core element of the *airside* system. On the other hand, *landside* facilities include terminal building, car parking facilities, etc. Differences between the two concepts may have led to misinterpretations about HKIA's ultimate capacity.

According to the original design, the maximum capacity of HKIA was to be more than 80 million passengers a year [HKSAR, 2007]. Hence, HKIA can be considered to be fairly under-capacity based on the 45 million passengers handled in 2006. However, all indicators point to the imminent saturation of our airside capacity as can be seen in a typical weekly schedule of our runways depicted in Fig. 4.2.

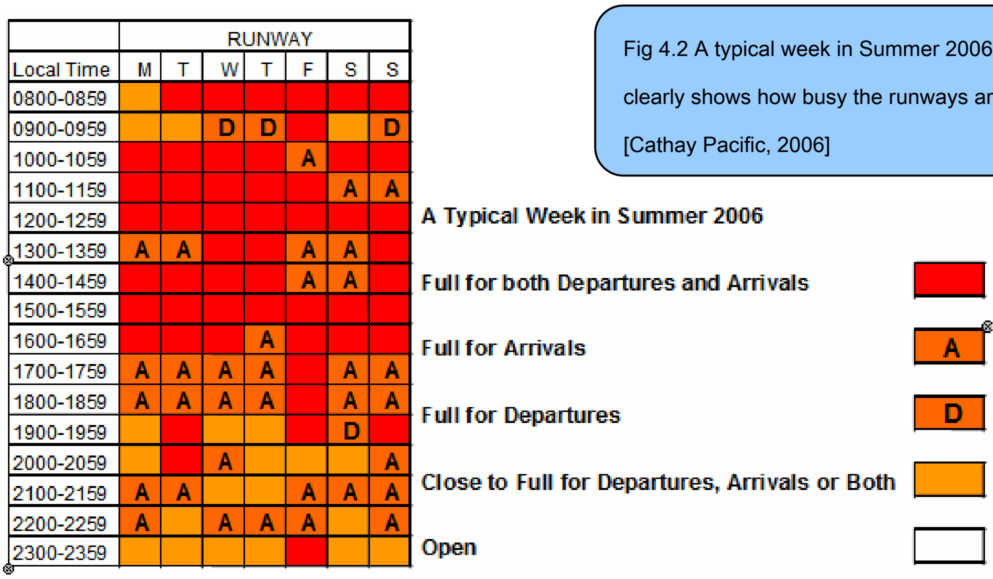



Fig 4.2 A typical week in Summer 2006, the table on the left clearly shows how busy the runways are during the season [Cathay Pacific, 2006]

The 'HKIA 2025' forecasts showed that by 2025, 80 million passengers, 8 million tonnes of cargo and 490,000 annual aircraft movements will be achieved [AAHK, 2006]. These forecasts would be equivalent to an average annual growth rate of about 3%. With this forecast growth and ultimate capacity given by the Government, we will attempt to estimate when this ultimate capacity will be exceeded. Due to the dynamic nature of capacity, an exact value for this ultimate capacity is not given (as indicated by the Government as over 60 movements/hour). We assume the 'current' ultimate capacity to be 65 movements per hour. This movement figure is a reasonable figure for analysis at this stage because according to CAD, the highest recorded aircraft hourly movement of HKIA is 65 movement/hour. As the aircraft annual movement is directly proportional to the aircraft hourly movement. We have estimated that the airside capacity is likely to be saturated around 2013. (see Fig 4.3)

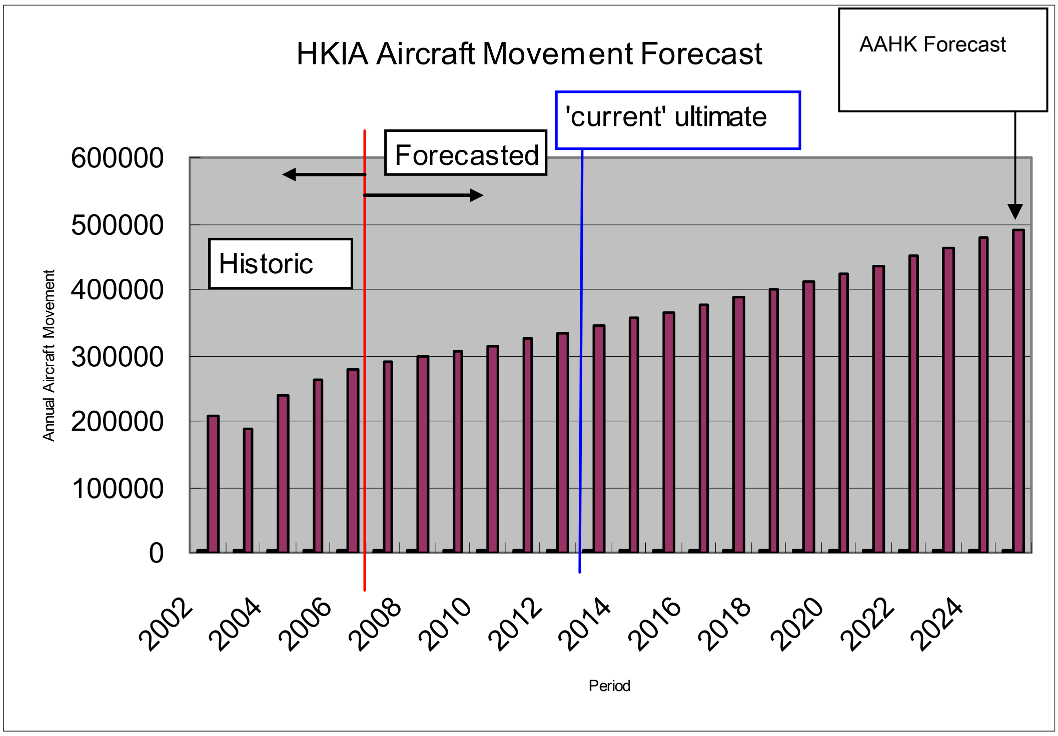



Fig 4.3 HKIA Aircraft Movement Forecast

Based on the above, one may conclude that there is an imbalance between the operational capacity of landside and airside facilities at HKIA, and it would be useful to explore possible means with which the capacity of airside facilities can be increased.

## 4.2 Runway Capacity Enhancement Measures

The ultimate airside capacity of an airport is a rather complex quantity which depends on many factors such as: the layout of the airfield, terminal location and footprint, runway and taxiway operations, apron maneuver, air-traffic peaking characteristics, aircraft mix of arrival and departure queues, and airspace approach and departure routing plus hold points and speed control. Beside the airport layout itself, the aircraft mix is the most dominate factors in terms of runway capacity. As an airport is nearing its full capacity, the government and airport authority will attempt to derive measures to enhance its capacity. In theory, all the following measures can be considered:

### 4.2.1 Aircraft Types Trends and its effects to Runway Capacity

Aircraft types (mix) have an enormous effect on runway capacity. In air traffic control, aircraft are required to be separated by a certain minimum distance to ensure air safety. The standards of the separation vary in different country. However, it must at least refer to the standards of International Civil Aviation Organization (ICAO) (document no 4444- '*Procedures for Air Navigation Services - Air Traffic Management*'.) Separation distance varies with aircraft size. It is mainly due to the different scale of *wake vortices* generated. Wake vortice is a by-product of lift generated behind an aircraft's lifting surface (e.g. wing). Hence, larger aircraft generate more wake vortices and a smaller aircraft would need a wider safety distance to fly behind a large wide-body airliner. As a result, this will affect the runway capacity.

Table 4.4 shows the required separation distance for different aircraft size recommended by the ICAO. The new ICAO guidance takes into account the operation of new A380 aircraft which will generate more wake vortex than existing civil aircraft types. A380 is in a category of its own while other aircraft types are divided up into three categories: Heavy (H), Medium (M) and Light (L) based on their weights as the categories suggested. Although at this moment there's no 'L' class aircraft using HKIA, the growing private jet business in Asia will likely have more influence to the HKIA operations in the future, as witnessed by the recent expansion of business aviation facilities at HKIA.

| Leading aircraft | Following aircraft | Approach separation (in nautical miles) |
|---|---|---|
| A380 | A380 | 4 |
| | H | 6 |
| | M | 8 |
| | L | 10 |

Table 4.4 Modified ICAO Approach Radar Separation Recommendation [Cathay Pacific, 2007]

Airbus Industrie recently published ‘Global Market Forecast 2006-2025’ on world air transport market in 2006. According to the Report, more than 70% of all aircraft delivered in the next 20 years will be narrow-body types with seating for 100-220 passengers - representing more than 15,300 aircraft. Wide-body aircraft (e.g. B747, A340) requirement will continue to grow strongly, with an estimated 5,300 new airliners in this category being delivered in the next two decades. In the very large aircraft sector (VLA) e.g. A380, it anticipates a demand for 1,660 aircraft. Airbus also states that Asian LCCs is the key of narrow-body demand in Asia-Pacific. The Asian LCCs are expected to develop their fleets quickly from a relatively low base of 236 single-aisle aircraft today, to about 1,300 by 2025 [Airbus, 2006].

| | Regional Jets (e.g. Embraer, Gulfstream executive jets) | Narrow-body (e.g. B737, A320) | Wide-body (e.g. B777/A340 types) | 747 and Larger (e.g. B747/A380) | Regional Total |
|---|---|---|---|---|---|
| End of 2005 | 170 | 1,800 | 830 | 470 | 3,270 |
| End of 2025 | 670 | 5,340 | 2,830 | 770 | 9,610 |
| % change | 294.12% | 196.67% | 240.96% | 63.83% | 193.88% |

Table 4.5 Boeing Forecast on Asia-Pacific Aircraft Demand from 2005 to 2025 [Boeing, 2006]

Boeing also shared the same view as its European competitor. They expected stronger narrow-body growth than wide-body. Table 4.5 above summarizes Boeing's views on how the fleet will develop in Asia-Pacific over the next 20 years. Boeing classifications of aircraft types are slightly different from the Airbus. However, they both showed an emerging dominance of narrow-body aircraft than large-body aircraft in the market.

As for HKIA, data from the past few years did show that there was a growing number of narrow-body operations. According to an ex-Director General of CAD, back in the days when HKIA was still under the planning stage, the number of narrow-body short-haul aircraft such as the Airbus A320 and Boeing 737 was only predicted to be around 10% of the total traffic [Ming Pao 2006]. HKIA was expected to handle more wide-body aircraft such as the Boeing 747. The official statistics indicated that the numbers of the narrow-bodied aircraft in recent years has far exceeded this predicted aircraft mix. In the future, more smaller planes will be needed as regional flights will be growing rapidly, which reinforces the industry's forecasts on the expansion of small narrow-body aircraft in Asia. Table 4.6 summarised the aircraft types that have been using the HKIA from 2002 to 2005. The analysis assumes all the freighter aircraft were wide-body types. Cathay Pacific data also shows that the average seats per passenger aircraft at HKIA has droped from 295 seats in Summer 1998 (when Kai Tak was still in operation) to less than 250 seats in Summer 2006 [Cathay Pacific, 2007].

| | Share of narrow-body aircraft out of the total passenger operations (per week) | Share of the narrow body aircraft out of the total aircraft movement | Ratio of Cargo to Passenger aircraft movement |
|---|---|---|---|
| 2002 | 28.3% | 24.66% | 1: 8.8 |
| 2003 | 29.64% | 24.87% | 1: 7.45 |
| 2004 | 29.82% | 25.21% | 1: 5.6 |
| 2005 | 34.65% | 28.93% | 1: 5.87 |

Table 4.6 HKIA Aircraft Type Changes [Analysis based on CAD, Tourism Board and AA HK data, assuming cargo aircraft and non-revenue flights are wide-body type]

HKIA, being a major hub for worldwide hub-and-spokes operations and an important transit city on the famous 'kangeroo' route (flights between Europe and Australia and New Zealand, HKIA has a very strategic role to play in world's aviation. In fact, the A380 is tailor-designed for such operations and could replace a substantial number of

B747. According to Airbus, in 2025, 68% of the world's fleet of 1,263 VLA will be used on flights from just the top 20 large aircraft airports. Out of that 20 airports [Airbus, 2006], HKIA is predicted to be the top airport that would generate most of the A380 size traffic (see figure 4.7).

**Fig 4.7. Top 20 large aircraft airports by 2025**

The top 3 are predicted to be HKIA, London Heathrow and Dubai International. The London-Hong Kong route is one of the busiest and most lucrative international air routes and formed a vital link to both 'kangaroo route' and hub & spokes operations. Dubai is an upcoming world hub which is likely to take market shares from HKIA by its rapid air transport development and its expanding flag carrier- Emirates.


[Airbus, 2006]

In recent years, HKIA has been experiencing a more non-homogenous aircraft mix. New Hong Kong-based carriers such as *Oasis Hong Kong Airlines*, *Hong Kong Airlines* (formerly known as *CR Airways*), *Hong Kong Express* and *Metrojet* have been growing rapidly in Hong Kong. These carriers vary in their business models and adopt different aircraft types. The use of private and corporate jets is also on the increase. Together with the growth of the existing large aircraft operations by the long-established carriers, the introduction of A380, expanding LCCs and increasing number of private business jets in the region. it is very likely that we will see a wide variety of sizes of aircraft using HKIA in the future. This will further worsen the slot constraints at HKIA and may lead to further airside capacity reduction.

## 4.3 Possible Measures

### 4.3.1 Air Transport Management Approach

ATM enhancement is about how the runways at a particular airport could be operated in order to give the maximum possible capacity. Currently, HKIA's South Runway is mainly used for take-off, whilst, the North Runway is used for landing. Such arrangement is mainly due to the terrain near the South Runway. This may not be an optimal solution to maximize capacity. It may overload one runway and underutilize another at times when the number of arrivals differs significantly from the number of departures. An alternative operations mode such as the 'mixed-mode' (allow both departure and approach at the same runway) would give controllers much more flexibility to sequence flights based on prevalent traffic patterns. If the airport faced a departure push, aircraft could take off from both runways instead of lining up on the South Runway. Indeed, the two runways could be used for both take-off and landing at different times.

In this respect, British Airways has been urging Heathrow to adopt the 'mixed-mode' in order to provide extra capacity. The UK carrier's study showed that the mixed-mode could add 5-15% extra capacity to Heathrow, mainly because it is generally less wake-vortex dependent. Furthermore, BA suggested Heathrow to use an arrival procedure known as 'TEAM- Tactical Enhanced Arrival Mode'. The airline demonstrated that TEAM would provide an elementary level of mixed-mode operation and would improve the capacity in the short run. When the number of arrival holding reaches a high level, runways can be operated in a mixed arrival/departure mode. This allows air traffic controllers to 'handpick' the best aircraft combination to minimize the aircraft separation environment. Hence, the maximum capacity could be enhanced (see fig 4.8).

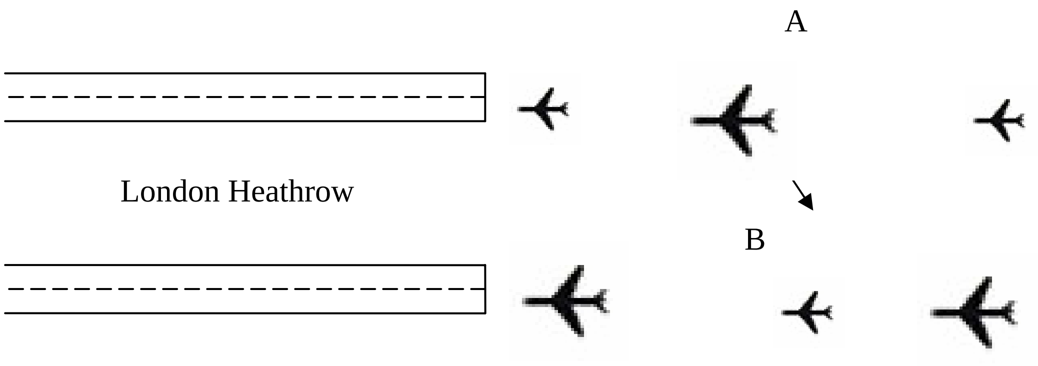



Fig 4.8 'TEAM' Operations: Imagine a day that LHR gets busy and 'TEAM' is used, whilst both runway could be used for approach, large aircraft (e.g. an Airbus A320) 'B' could use heavy aircraft (e.g. Boeing 747-400) 'A' slot and vice versa to allow better utilizations for both north and south runway. The separation saved could be significant during busy hour if managed properly.

Frankfurt airport, even with its closely-spaced (500m) parallel runways, as well as several airports in the United States, have achieved higher processing rates through such a strategy. This may provide potential improvement to HKIA's runway capacity as our runways become more congested. However, this would result in a more complicated ATC pattern and hence advanced equipment and extra manpower would be needed.

### 4.3.2 Enhanced ATC & Aircraft Equipment, Technology, Procedures and Manpower

Technology and human factors also play a decisive role in airport capacity improvement. Air traffic controllers in Hong Kong are generally considered highly skilled professionals and they form the core element of the ATM system. HKCAD's workload has been increasing rapidly due to the rapid increase in the demand on our airspace by flights entering and leaving Hong Kong and Macau, plus the increase traffic going to and from China via the Hong Kong Flight Information Region (FIR). According to CAD, the en-route movements to/from China was more than four hundred each day. The current workload is substantially greater than originally anticipated while the head count of air traffic controllers has been frozen for many years. This human resource is an important determinant for airport capacity. CAD states that it normally takes seven years to train a student air traffic control officer into a full professional, and the international market for air traffic controllers has been tight and very competitive because of the global aviation demand. This is an area where additional efforts and attention can be useful if HKIA is to remain a center of regional and international aviation amid the growing demands of passengers and cargo in the region.

With the use of modern ATC/ATM equipment and advanced navigation-aids, air traffic controllers can provide more timely, effective and accurate communication with pilots. To cope with capacity constraints at major airports, ATMs in the US and Australia have introduced new technology such as the Automatic Dependent Surveillance-Broadcast (ADS-B). The ADS-B allows air traffic controllers to reduce separation in increasingly crowded skies. ADS-B differs from conventional radar in that it uses electronic equipment onboard an aircraft to automatically broadcast position, altitude, velocity and other data every second via digital datalink using a navigation system like GPS.  In future, ADS-B data will also be used by other aircraft and controllers to show an aircraft's position and altitude on display screens without the need for extensive radar coverage.

It is worth noting the recent decision by the HKSAR Government to invest HK$1.56 billion in a new ATM system. This system is schedule to come online in 2012. At the same time, CAD has begun looking at the options of satellite-based navigation aids (navaids). Around 20 student air traffic control officer will also be recruited annually for the next five years [CAD, 2007]. However, one should also note that ATM's are continuously being improved and new technology will be adopted by progressive airports around the world. The relatively long lead time required to move to a new system versus the fast pace of the technological development in this area means that Hong Kong needs to be continuously exploring improvements to our system in order to maintain the competitiveness of our airport.

#### 4.3.3 Expansion of Auxiliary Airside Facilities

Beside the flight separation standards, aircraft have to enter and leave the runway quickly, so that unnecessary delays will not occur. Many modern hubs often have four to six exits along their runways. This permits different types of aircraft to reach their nearest runway exits with the least amount of time. The location of runway exits plays a very significant role in runway capacity.

There are two main types of runway exits: *Conventional* and *High Speed* exits. A conventional exit forms a 90° angle with the runway. It requires pilots to slow down the aircraft considerably (to 10 kts or 18 km/h) to make the tight turn. On the other hand, a high-speed exit is having an inclined layout along the runway's direction. This permits the aircraft to vacate the runway rapidly, at speeds up to (50 kts or 92 km/h), by making a relatively high speed and smooth turn. Therefore, if mixed mode is used it would help utilizing the runway movement by allowing the landing aircraft to vacate more quickly and hence expediting the next departure. Revised movement strategies on the airside and how it may affect the benefit obtained from a high speed exit needs to be examined carefully with input from experts and pilots with good first hand information of the specific facilities.

Regarding taxiways, delays can arise due to inefficient taxiing patterns. Taxiway layout designs for airports, such as HKIA and Seoul Incheon, were based on the principle of uni-directional flow management for the achievement of minimizing taxiway conflicts and delays. The departure queue often causes severe delays at busy airports, including HKIA. The mixed-mode operation may alleviate the problem by diverting some aircraft to the other runway. The apron area can also occasionally be a constraining factor on the overall airside capacity. This points to the need for overall planning and optimization of the various elements on the airside so as to maximize the operational capacity of the airside system under varying conditions which the airport may be subjected to.

### 4.3.4 Peak Spreading

By spreading some of the demand from the peak period of the day to a less busy period, airport capacity can be improved. However, as airlines primarily schedule flights to meet their market demands and optimize their fleet utilization, they would aim at choosing slots of a particular time of the day to offer the best travel services for customers and balance resource utilization within its service network. Most airports experience their peak hours from 08:00 to 19:00 each day. For Hong Kong, the peak period occurs from 07:00 to 20:00 in summer (see Fig. 4.2). During this period, airport slots are basically full (for both departure and arrivals) [Cathay Pacific, 2007]. The situation is particularly worse on Tuesday and Friday. Airlines are usually reluctant (especially for hub-and-spokes legacy carriers which heavily depend on smooth and accurate transits from one flight to another on their networks) to re-organize their flight schedules, as this will bring inefficiencies to the airlines operation and can significantly affects the bottom line of their company. Thus, peak spreading is often easier said than done, as it involves the convoluted consideration of optimizations of the individual airlines schedules and interests. However, this approach may be applicable with less technical difficulty to freighter flights which usually operate on a 24-hour basis. The slot requests of LCCs and chartered services can also be more flexible.

### 4.3.5 Aircraft Size Restrictions

Airport authorities can consider measures to encourage airlines to use larger planes in their operations. As previously mentioned, aircraft generate vortices which affect aircraft flying behind. The smaller the aircraft relative to the preceding aircraft, the more severe would be the impact of the wake vortice effects, thus requiring more separation distance between the aircraft. Hence, using similar size aircraft, or larger/wide-body type aircraft would minimize the required separation distance and enhance runway movement capacity.

However, the selection of aircraft type is mainly dictated by the operational characteristics of the aircraft for the routes to be flown, market demands, and economics. Because of numbers of seats provided, wide-body aircraft would have lower seat-kilometre costs than a small narrow-body aircraft. It will also have a higher operating hourly cost than a smaller aircraft due to its large size. Hence it would often form a question for the airline management on choosing the aircraft with lower seat-kilometre costs or the one with the lower trip costs.

Therefore, it is very unlikely that an airline will choose a B747-400 Jumbo for short-haul and low-capacity routes, as compared with an A320 or B737. On the other hand, this approach might be possible to impose on high capacity short-haul routes such as the Hong Kong- Taipei route. Thus, this approach to improve runway capacity will likely be limited to a very small amount of routes and airlines, while it is almost impossible to impose such an approach on short-haul low cost carriers (LCCs). Some would suggest that an airline could ease up slots congestion by combining two or three flights into one and using a large wide-body aircraft for the route. This will obviously affect the flexibility and services offered to their travelers (especially for business travelers). However, the use of enhanced procedures such as TEAM and the consideration of having mixed mode operation of the runways as discussed in 4.3.1 would be able to reduce the efficiencies caused by mixing different aircraft sizes in the arrival or departure queues. These considerations will become even more important as new generation large aircrafts such as the Airbus A380s begin to operate in HKIA.

## 4.4 Conclusions

This chapter has illustrated that with our current 54 movements/hour, HKIA will still has room to increase its capacity. It is estimated that, at best, the current HKIA will be able to sustain it's operation until somewhere around 2013, assuming the rather conservative estimate of 3% growth in traffic by the AAHK without further enhancements. However, we must bear in mind that with the increasing movements of narrow-body aircraft, growing traffic demand and the introduction of A380 into service, HKIA is likely to experience a higher capacity demand from its airlines users. Hence we must prepare our airport for any future unpredictable demand. As our discussion shows, a new runway is not the only answer to the increasing runway demand. There are many ways to improve the runway capacity. Obviously, some measures are better than the others taken into the HKIA unique situation. Up to this stage, it seems that capacity enhancement through ATC technology, ATM approach, manpower and airspace usage would be practical measures to provide more capacity beyond this ultimate capacity in the medium term. The recent announcement from CAD on HKIA capacity enhancement had clearly illustrated the importance of these measures. Building new runway is clearly an option to provide more runway capacity. However, we must fully utilize our current runways beforehand.

# Chapter 5 Selected Case Studies for Building New Runways

In this section, we will examine the building of new runways by several international airports. Their experience in dealing with environmental issues and opposition from the community can be valuable case studies for our consideration.

## 5.1 London Heathrow Airport third Runway

The Heathrow third runway idea was first officially suggested by the UK Department for Transports (DfT) White Paper under the title '*The Future of Air Transport*' in December 2003, which aimed at providing a strategic framework for the development of airport capacity in the United Kingdom over the next 30 years. The UK Government agreed that additional capacities at Heathrow would generate the largest direct economic benefits of any new runway options. The Oxford Economic Forecasting Studies, a UK-based research centre, estimated that even a relatively short third runway could add £7bn to the UK economy by 2030 [BBC, 2006].

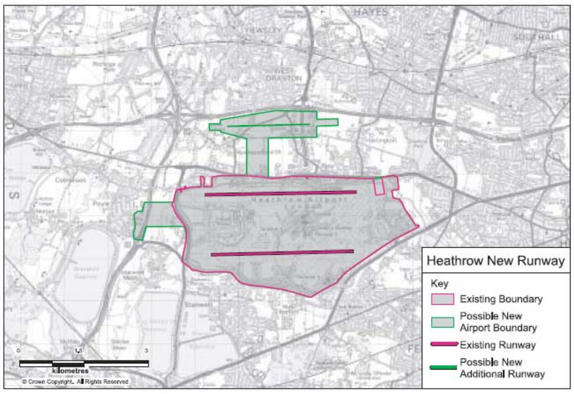
The demand for Heathrow has been extremely strong. It is in fact the busiest international airport in the world in terms of international passengers' throughput. Regarding total passengers movement, it ranks top 3 in the world and number 14 in terms of aircraft movements. The airport itself experiences the most aircraft movements in the world for an airport with only two runways [ACI, ATW, 2007]. Heathrow has two parallel runways running east-west, with four terminals. It handled 477,029 movements in 2006 [ ACI, 2007]. Despite the recent Terminal 5 development, major airlines at Heathrow, in particular British Airways, have long advocated for a third full-length runway at Heathrow. Europe has long been a heavy battleground for hubs, while Heathrow has seen relatively less development as compared to nearby competitors such as Frankfurt with 3 runways, Paris with 4 runways, and Amsterdam with 6 runways (see Table 5.1). Obviously, this has weakened London's competitiveness as an aviation hub. A key proposal of the White Paper was that a third runway would be built at Heathrow by 2020, provided that the new runway would meet targets on environmental issues such as aircraft noise, traffic congestion and pollution [DfT, 2003].

| | Pax (000) | Cargo (000, tons) | Aircraft Movement | No. of runways | Major future development |
|---|---|---|---|---|---|
| Amsterdam Schipol (AMS) | 42,541 (+6.5%) | 1,421 (+8.7%) | 431,000 (+3.4%) | 6 | Plans already exist for terminal expansion and new runway. |
| Frankfurt (FRA) | 51,100 (+5.6%) | 1,839 (+11%) | 477,500 (+4%) | 3 | New maintenance hanger for Lufthansa's A380, New runway and terminal addition at Terminal 3; 75 aircraft stands & associated taxiways. All together would cost Euro 3.4 billion. |
| **London Heathrow (LHR)** | 67,000 (+6.2%) | 1,325 (+8.3%) | 469.763 (+2.8%) | 2 | Terminal 5 due opening in mid-2008. A new 87m control tower. Costing £4.2 billion. |
| Paris Roissy-Charles de Gaulle (CDG) | 51,000 (+5.5%) | 1,637 (+9.4%) | 516.457 (n/a) | 4 | Rebuild new terminal 2E, Star alliance and Aeroports de Paris agreement on building a minihub at Terminal 1. Modernization of the 31-year old T1 (cost around €220 million). |

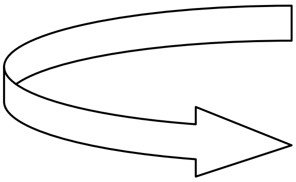
Table 5.1 Selected European hubs traffic growth and recent development in 2005 [summarized from ATW 2005]

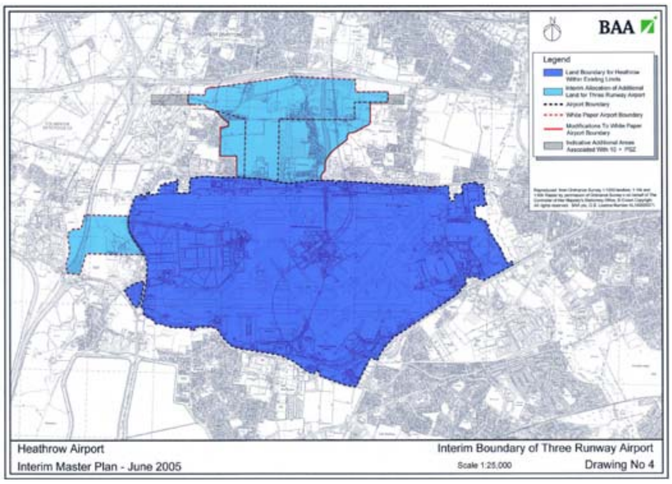
Fig 5.2 shows the DfT's potential new runway safeguarding map for Heathrow based on the consultation exercise undertaken in 2003. However, the owner and operator of Heathrow- BAA Ltd. revised the land-use map in 2005 in order to expand the area between the runways. The airport operator attempted to enlarge the airport layout in order to seek good balance and optimization of the facilities. This revised plan reinforced the importance the balanced airfield development.

However, the approval and detailed solution to this third runway continued to encounter difficulties. The key to modern airport planning often centres around the concept of 'sustainability'. As most of industry analysts suggested, the time require for preparing the environmental impact assessment (EIA) and to approve the third runway for Heathrow could be very long and turbulent.




DfT's Heathrow third runway landtake map (unbalanced layout) [DfT, 2003]






BAA revised Heathrow third runway landtake map (balanced layout) [BAA, 2005]

Fig 5.2. London Heathrow 3rd Runway Proposal, the expansion of the area between the current north runway and the new runway are for the sake of a new terminal and other supporting landside & airside facilities, hence as a result: a balanced airfield development.

Case in point - the BAA had made an initial application in 1993 to construct Terminal 5, and had experienced significant objections from local communities. Key factors considered by the inquiry panel formed were: the economic case for expansion, developmental pressure and regional planning, land use policy, surface access, noise, air quality, public safety and construction. The planning application was finally granted in late 2001 by the Transport Minister, following the longest public inquiry in British history for nearly four years. Construction work for Terminal 5 only began in 2002, almost 10 years after the initial application. Given the scale of the new runway project, it will be very likely to experience an even longer public inquiry if there is significant opposition being voiced, as is likely to be the case.

Follow the publication of White Paper *'The Future of Air Transport'* in 2003, the DfT new Consultation Document *'Adding Capacity at Heathrow Airport'* was released in Novemeber 2007. The Consultation Document has refined some of the parameters regarding to airport expansion outlined in the White Paper. A new terminal and balanced airfield development are also confirmed on the consultation document between the new runway and the current North 09/27 runway (see Figure 5.3). Technical reports done by National Air Traffic Services Limited UK (NATS) on future Heathrow capacity based on different operations scenerios are also released to the public in conjunction with the Consultation Document. These scenerios include maximising the current runway operations by adapting mixed mode operations at the current two runways. Together with the introduction of the third runway, it would be able to bring Heathrow annual capacity up to 702,000 movement and maximum hourly runway capacity of about 130 movements per hour based on simulations done by NATS [DfT, NATS, 2007]. The *'Adding Capacity at Heathrow Airport'* public consultation will end at 27th Feburary 2008.

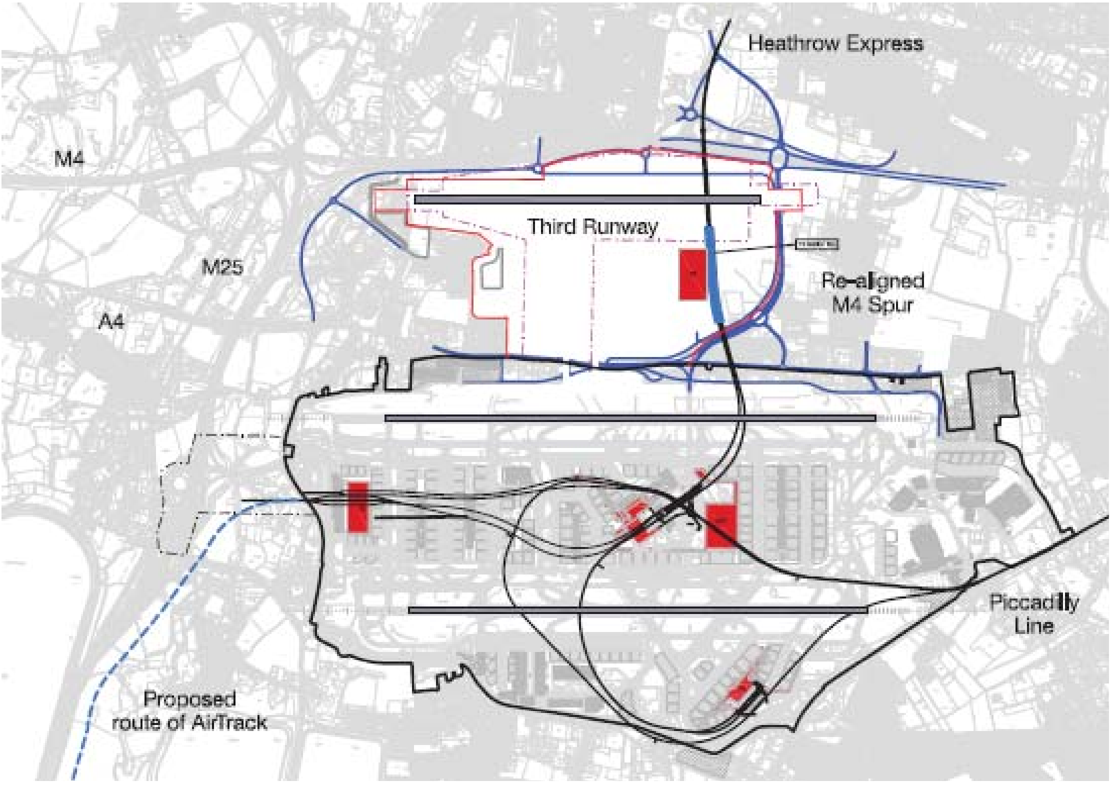



Fig 5.3 The Indicative Layout Plan published by the DfT in the Heathrow expansion consultation document 'Adding Capacity at Heathrow Airport' [DfT, 2007]

Airport developments in Europe and North America have been encountering more stringent challenges and requirements on environmental related issues. The global warming concern and the EU Emission Trading Scheme will likely make environmental issues the top Government's priority in considering Heathrow's development. Time required for the entire decision making process would be difficult to predict .

## 5.2 Manchester International Airport Second Runway

Manchester International Airport is the second biggest international hub in the UK, which is also the biggest airport in UK not managed by the BAA. Its second runway began operation in 2001 and is the newest runway in the UK. The airport is owned by the Manchester Airport Group which is in turn controlled by a group of ten local authorities in the Greater Manchester area. Before the second runway was built, the airport had a declared hourly capacity of 47 movements. By the early 1990s this single runway was running at full capacity. A development strategy was published in 1991 and identified the need for a second runway [Graham, 2003].

Before the final decision was made, the airport had entered into a legal agreement with the local planning authorities regarding a package of environment mitigation measures. The package contained over 100 different measures of targets and guarantees covering noise control, night flying, environmental works, highway improvements, public transport, community relations, social policy and the ultimate capacity of the airport. The planning permission was granted in January 1997, Table 5.4 outlines the key events in the development of Manchester Airport's second runway.

| | |
|---|---|
| August 1991 | Draft development strategy to 2005 published, identifying the need for the second runway |
| Sept-Nov 1991 | Public consultation period and eight public meetings held |
| June 1993 | Final development strategy was published and the environmental impact assessment (EIA) completed |
| June 1994- March 1995 | Public inquiry |
| January 1997 | Planning permission granted |
| Summer 1997 | Commencement of construction |
| Feb 2001 | Runway opened |

Table 5.4 Key events in the development of Manchester airport's second runway [Graham, 2003]

Airport planners had looked at four major configuration options. In the end, a closed parallel 'staggered' configuration was chosen (i.e. the threshold of one runway is farther along the central axis of the runway than the threshold of another runway). The final choice was mainly based on the consideration of following factors depicted in Fig. 5.5 :

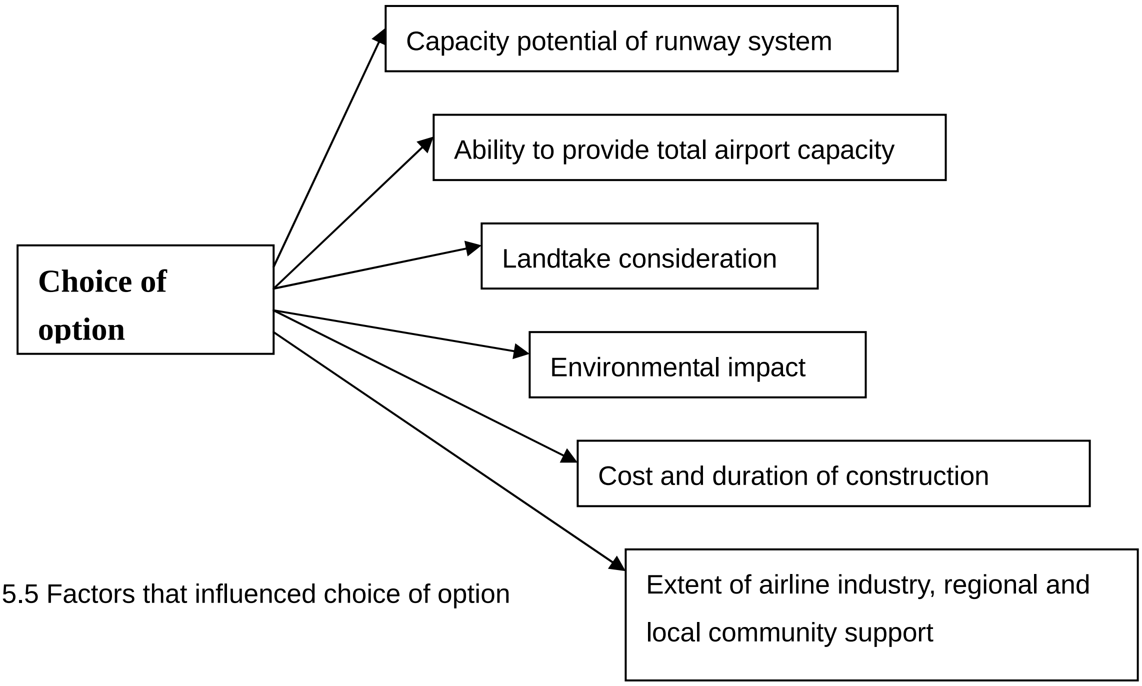



Fig 5.5 Factors that influenced choice of option

The choice of the final configuration was based on less requirement of new land, lower building cost, smaller environmental impact and sufficient increase in capacity. The runways have a threshold stagger of 1,850m that would allow arrivals and departures operate independently of each other. With the arrivals land on the existing runway 24R and departures take-off from the new runway 24L, both runways are of equal length (3,048m) [Gunn, 2005].


Fig 5.6 Manchester International Airport, although a wide-spaced runway is more preferred on enhancing capacity, land take is always a major obstacle for airport development worldwide that would limit the choices available [Photo courtesy of Google Earth 2007]

The new parallel runway is closely spaced at about 400m apart. Since this configuration will involve runway crossing when both runways are being used, the airport's control tower has been completely re-organized to cope with the extra traffic. It gives better views to air traffic controllers on observing the aircraft movement across the runway, and crossing aircraft are required to use the designated crossing points right in front of the tower to improve safety and avoid runway incursion.

Manchester claimed that the airport capacity could be increased to between 65-70 aircraft movement per hour by adopting the following measures on the airport’s two runways [CAA, 2007]:

(a) Enhancing air traffic control techniques and technology;

(b) Peak spreading and profiling in cooperating with airlines through the Co-ordination Committee; and

(c) Capital investment to provide an additional taxiway for Runway 2, which would increase arriving flights handling capacity.

Currently, Manchester’s two runways are operating in the segregated mode (one for take off and the other for landing). The airport management in Manchester and NATS believed that 80 aircraft movements per hour could be achievable if the *mixed mode* (runway used for both take-off and landing) operation on both runways were to be permitted. This would be subject to the provision of additional airside infrastructure such as a full-length parallel taxiway for the new runway.

## 5.3 Tokyo Narita International Airport Second Runway

Regarding airport planning, the Tokyo Narita Airport has always been an interesting case study. The Japan’s international gateway hub features a wide-spaced parallel runway configuration. The first phase of the second runway construction work began in 1986 and the new runway commenced operation in April 2002 prior to the 2002 FIFA World Cup in Korea & Japan. This airport project was full of bitterness and controversies. The land-take issue created tremendous problems for the Japanese Government, with several farming families not acceding to sell their land in order to make way for the new runway. For almost 30 years since, the completion of this runway project of national importance has been stalled by only a handful of objecting citizens.

Under the original plan, Narita was supposed to construct three runways. At the opening of the airport in 1978, only one runway was completed as a result of fierce protests from the local community and other activists. The single runway operation managed to handle one take-off or landing in every two minutes throughout the day, during which 100 protesters continued to maintain a 24-hour vigil outside the security fence [Dempsey, 2000]. In order to push the construction of the second runway for Narita, the Central Government proposed to compensate residents not covered by the Noise Prevention Law,  recover green space lost during construction, and to help farmers who received land in exchange for expropriated parcels [Daily Yomiuri , 1998]. Despite the government's efforts, some of the farmers still refused to give up their land and kept their henhouses close to the threshold of the new runway. As a result: the length of the second runway is being kept at 2,180m, adequate to support B777-200 flights, but far shorter than the proposed 4,000m in order to handle B747's.

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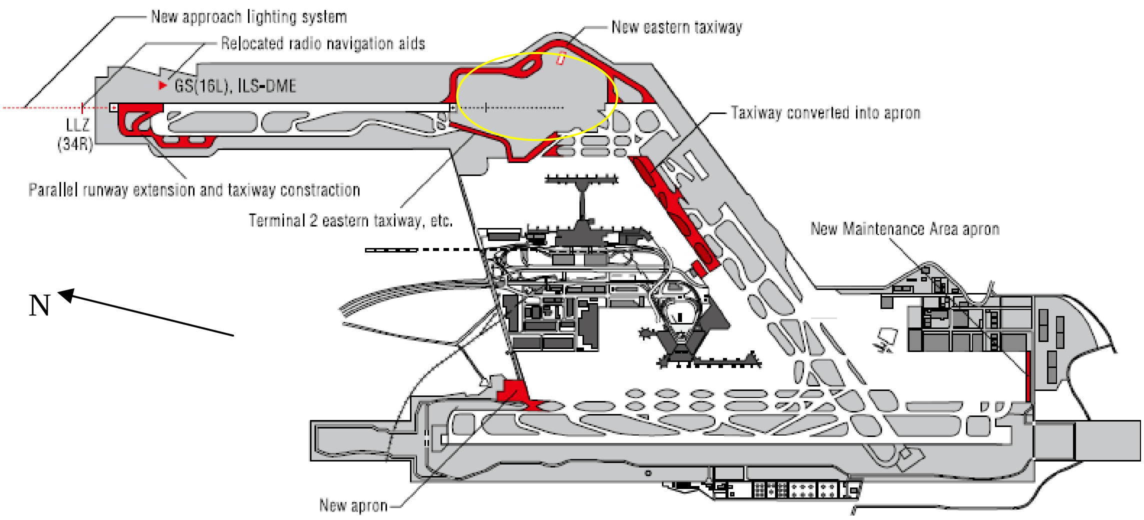



Fig 5.7 Tokyo Narita International Runway Extension Project [NAA, 2006], the new eastern taxiway will have to be extended and make a detour to avoid the private property (outlined)

In July 2005, Narita International Airport Corporation (NAA) reported to the Minsiter of Land, Infrastructure and Transport of Japan that, despite its best efforts to negotiate with owners of the land earmarked on the original plan for the parallel runway, it does not appear possible to obtain that land. The only available option was to extend the runway to the North to 2,500 meters so as to accommodate larger aircraft and increase Narita's capacity (see Fig. 5.7). The extended runway is expected to be ready some time in 2009.

NAA will, in conjunction with the Civil Aviation Bureau of Japan, hold ongoing briefings for local residents on the extension of the north runway and noise mitigation measures. [NAA, 2005 & 2006]. In the meantime, NAA will continue to negotiate with the farmers holding the land near the runway threshold (the area outlined by the yellow oval in Fig. 5.7). As one can see from Fig 5.6, the development proposed by NAA is not the perfect solution that would improve the capacity of Japan's gateway airport, as the newly proposed taxiways would take a longer detour from the runway end to the apron area. However, given the strong resistance from local residents, this would be the only solution to mitigate the capacity problem in the short run.

## 5.4 Conclusion

The above case studies are certainly not atypical of recent major infrasructure development projects around the world. Airport related constructions somehow tends to attract more interest and attention, as the aviation sector is often unfairly being seen as having more environmental impact than it really has, despite the fact that modern aircraft have made big strides in the reduction of noise and emissions. Acquisition of land for airport expansion almost always run into massive opposition from citizens from nearby townships and other interests. It is not unusual to endure long delays and expensive public inquiries, and yet the final outcome may only be sub-optimum in most regards, as the balance point among all competing interests is illusive. This points even more to the importance of careful planning and consultation with all relevent stake-holders, supported by a government with strong resolve to seek the best solution for the overall benefit of the community in the long run.

## Chapter 6 Supply of and Demand for HKIA Services -- When to Plan for the Third Runway?

In this section, an analysis on when the ultimate capacity would be reached is provided, given all the possible enhancement measures being implemented under various traffic demand scenarios.

### 6.1 The Estimated Future Traffic Demand for HKIA

Airport construction projects, with typically long lead time from planning to completion, are designed in such a way that the air traffic demand could be satisfied in the longer term. Traffic demand, on the other hand, is a dynamic variable which could have large variance in the short term, but more predictable in the longer term. Therefore, traffic demand should be regularly reviewed in order to devise suitable measures to track the needs of the aviation industry.

According to the information given by ‘HKIA 2025’, HKIA would target to serve 490,000 aircraft movements by 2025 [AAHK, 2006]. Based on 2006 traffic data, this is equivalent to about a 3% growth of movements each year until 2025. Thus, the current ultimate capacity as stated by the HKSAR Government would be reached around 2012-13 (see Fig 4.3)

Against this projection, we find that HKIA’s historical traffic data actually gives an average aircraft movement growth rate of 7.5% between 2000 and 2006 (please see Table 2.3), a number which is much higher than the 3% growth rate adopted in the

“HKIA 2025” Report. Projections from other organizations also point to a growth rate which is higher than the 3% estimate.

Airport Council International (ACI) predicted a 6% growth rate in the Asia-Pacific region until 2025. Additionally, a recent forecast released by International Civil Aviation Organization (ICAO) has shown that the total commercial aircraft departure movements would raise to 50.5 million annually by 2025, as compared with 24.9 million departures recorded in 2005. ICAO also stated that all international route groups would grow at average rates ranging between 3.5% and 6.6% per annum over the period. The fastest growth would be those routes to/from and within the Asia/Pacific region [ICAO, 2007]. Given all forecasts from various sources, it is possible that HKIA’s number is an overly conservative projection.

In what follows, we will consider three different traffic demand forecast scenarios (3%, 5% and 7% annual growth rate up to 2025) to analyze when the third runway will be needed for HKIA. The 5% scenario is mainly derived from the ICAO’s international routes demand and the ACI’s predicted Asia-Pacific demand. The 7% scenario is based on recent aircraft movement growth since 2000 for HKIA. The 3% scenario pertains to the conservative figure used in ‘HKIA 2025’.

## 6.2 Possible Capacity Enhancement Measures on HKIA’s Two Runways

A new runway is a big construction project which is often time-consuming and expensive. Therefore, it is crucial to maximize the airport’s current capacity. There are many ways to improve the airside capacity of an airport. However, not all of these enhancement measures could be applicable to HKIA (as provided in Chapter 4). We would mainly focus on the ATC and ATM measures.

### 6.2.1 ATC Systems Enhancement Measures (see also Section 4.3.2 & 4.3.3)

The upgrades of ATC procedures & technology and manpower support can contribute to enhanced operations and will be needed to support balanced growth of the ATC system. CAD will be upgrading its radar information processing and display systems by next year. Together with completion of two new high-speed runway exits by the south runway (see Chapter 4), they should help to enhance the current HKIA runways capacity.

More capacity can also be created by introducing delays. When Manchester Airport was still a single-runway airport, it had achieved further capacity increases by introducing delays. This trade-off between delays and available slots was reviewed by a Co-ordination Committee which represented airlines using Manchester Airport. According to the Airport, the Committee had indicated a broad agreement to tolerate a higher level of delays during peak hours in order to maximize the aircraft movement. The same procedure continued to operate even after the commencement of its 2$^{nd}$ runway in 2001. Together with the expertise from NATS, this has allowed Manchester to increase its capacity from 57 movements/hour to 60 movements/hour in summer 2002. This represents an extra 5% runway capacity [CAA, 2007]. However, this enhancement option should be carefully assessed together with close input from the airlines and other stakeholders, as it may affect HKIA's current high quality of services.

In reference to the Manchester Airport case studies in Chapter 5, the capacity of the airport can be increased from 60 to 65-70 movements/hour through the ATC approach and expansion of auxillary airside facilities. This should provide around 12.5% increase in capacity [CAA, 2007]. Thus for the case of Hong Kong, the ATC improvements being considered by CAD, together with the help of extra manpower, can provide an extra runway capacity of around 10%. This should be able to bring the current ultimate capacity of over 60 movements/hour to a new ultimate capacity of around 70 movements/hour.

### 6.2.2 ATM Procedural Enhancement Measures (see also Section 4.3.1)

HKIA's parallel runways are 1,525m apart. Such wide-spaced runways should be able to achieve higher runway capacity. According to FAA studies on simultaneous (independent) parallel runway IFR operations (from FAA AC 150/5300-13 CHG 5) [FAA, 1997], the Administration suggested with this wide distance, simultaneous operations of aircraft, i.e. any pair of aircraft movements (included both take-off and landing) on the runways need not be coordinated and operate independently instead. HKIA is not currently operating under this mode. The FAA also outlines clearly that for runway centerline separation of 5,000' (1,525m, exactly the separation of HKIA runways) should be able to perform both dual simultaneous precision instrument approaches and dual simultaneous departures. In other word: mixed-mode operations. British Airways showed that by using the mixed-mode operation, Heathrow Airport should be able to increase movements by an extra 5-15% (see Section 4.3.1). As the mixed-mode is less wake vortices dependent, both runways could be used flexibly for both arrival and departure at different times. Air traffic controllers could re-schedule the aircraft movements so that the airport could provide more capacity during busy hours.

Regarding the influence of terrain on HKIA capacity, this issue can partly be mitigated via more advanced air navigation procedures such as the Area Navigation (RNAV) and Required Navigation Performance (RNP). The new RNAV/RNP navigation procedures using GPS can reduce the air congestion and flight distance without the use of ground beacons and adopt satellite-based communications instead. For coping with the noise sensitive community near Heathrow, British Airways have suggested the use of RNP procedures as the Figure 6.1 illustrates. RNP is an advanced RNAV with containment. Similar procedures can also be introduced at regions where airports have geographical constraints [BA, 2007]. Air China conducts RNP operations at multiple airports in the Mainland, including in Lhasa, Linzhi and Jiuzhaigou. The Linzhi airport, opened in 2006, is notable for allowing only RNP-based operations, as the surrounding terrain did not permit the using of ground-based navigation aids. Such enhancements can also be considered for possible adoption for HKIA. RNP could also provide a good basis for mixed-mode operations.

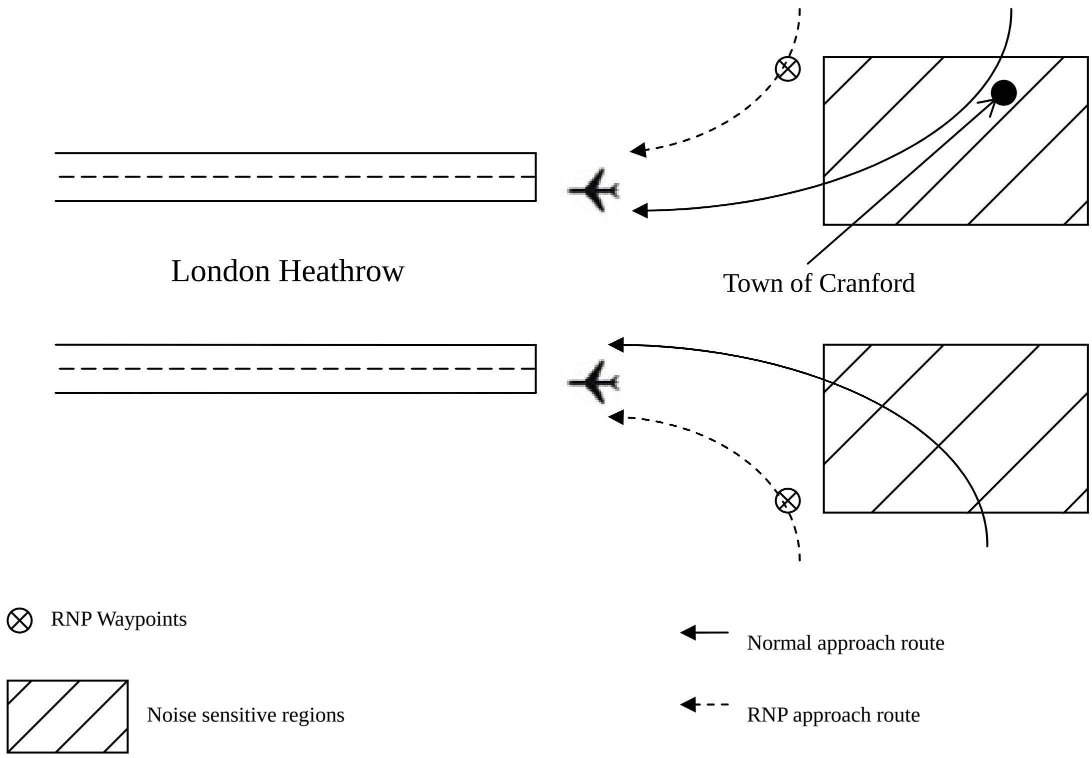



Fig 6.1: Mixed-mode (approach) illustration of Heathrow Airport, the mixed-mode operation here is further supported with the use of RNP procedures. (picture not in scale)

This onboard monitoring and alerting capability can reduce reliance on increased route separation, ATC intervention and/or ground-based navaids to maintain overall safety. Of course, the ATM systems need to be sufficiently advanced to sustain this mode of operation. The HKSAR government is investing HK $1.56 billion on new ATM systems at HKIA, to be operational by 2012. Extra air traffic controllers would also be needed to cope with the increase aircraft operation demands. This should be able to provide us with the foundation to more complicated operations procedures like mixed mode.

HKIA current aircraft separation standards on approach are believed to be more stringent than international standards, hence the runways have the potential to further upgrade its capacity. CAD have reviewed their procedures and by the end of this year the separation spacing between approaching aircraft will be shortened from the current 5nm to 4nm [CAD, 2007].

Therefore, by estimate from the above information and taken into account the effects of airspace issues and terrain, it is envisaged that a more moderate runway capacity improvement of say 12% may be more likely than the maximum 15% increase in airport capacity through mixed-mode suggested by British Airways. If the above measures are permitted, it should be able to help us to reach the ultimate capacity of around 80 movements/hour.

## 6.3 Airspace Utilization

In the air, aircraft follow defined airway routes and are separated by time, distance and altitude by the ATC. The application of minimum separation criteria therefore determines the maximum flow rate, or capacity of the airways system. Limitations in the operational procedures within the airspace around an airport can significantly affect the flow rate to and from a runway as a result and will drastically constrain the efficient design of arrival and departure routings. This issue has become increasingly crucial for the development of HKIA. The five airports in the PRD region are all experiencing enormous traffic growth. Terrain & obstacle considerations, airspace restrictions imposed due to maneuvering requirements by aircraft from nearby airports, military airspace restrictions, and other designated prohibited airspace could all have significant impacts on airport capacity. Hong Kong is having all these constraints amid significant growth in the demand for both passenger and cargo capacities. The rapid growth of other airports within the same catchment area would further worsen the situation, and this will likely be the most worrisome factor affecting HKIA's ability to meet future demands.

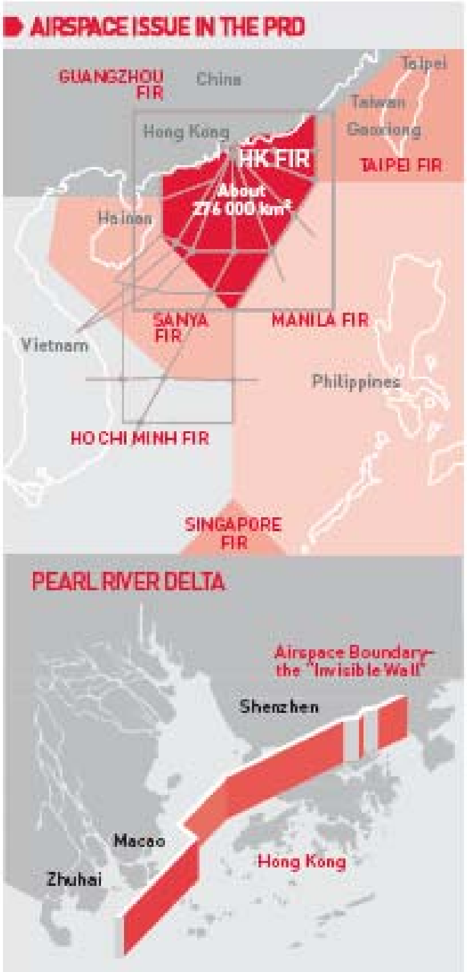



Fig 6.2 the Illustration of the PRD Airspace Constraints [AAHK, 2006]

The PRD region (including Hong Kong and Macau) accounts for 27% of the total China's passenger traffic and 48% of the total freight traffic [Cathay Pacific, 2006]. However, the usable airspace for civilian traffic at the north of Hong Kong's boundary is very limited. Currently there is a so-called "invisible wall" between the Hong Kong and China airspace. This "wall" is 15,000 ft high and aircraft have to travel above this altitude before entering China's airspace. This does not just affect aircraft movements to/from Hong Kong, but also those movements to/from the other four airports in the region, plus those aircraft en-route to/from China have to come through Hong Kong FIR. Such inefficiency has resulted in significant fuel wastage and increased emissions by aircraft as they travel the extra distance to climb to the required altitude within Hong Kong's airspace before crossing into China's airspace.

The "invisible wall" is estimated to have caused airlines 100 million tones of extra fuel and 531,000 extra minutes of flying altogether per year [Cathay Pacific, 2007]. The total additional cost of fuel alone was over HK$400m in 2005 [Ming Pao, 2007].

Efforts have been initiated to take a serious look into this “invisible wall” problem among the various involved parties. As a result, there have been some recent relaxations. CAD has recently announced to the press that aircraft can now operate at a lower altitude between 11pm and 7am when entering or exiting the “wall”. This could reduce 7 minutes of flight time and save 40 nm of flight distance [Ming Pao, 2007]. The vertical separation distance in China’s upper space (within 8,900m to 12,500m) will be reduced from 600m to 300m for Reduced Vertical Separation Minima (RVSM) certified aircraft in late November this year [CAAC, 2007]. Despite the effort, the PRD airspace usage is still very constrained. IATA estimated that an extra 15-20% operating capacity could be provided to the region by restructuring the airspace [Cathay Pacific, 2007]. We consider studying the management of airspace in the US and Europe may be useful for our situation. In the case of EURCONTROL, National Air Traffic Services UK (NATS) and US Terminal Control Centres (TRACON), we have found that a flexible use of military/civil airspace is often the key for enhancing airspace capacity for airports operating in close proximity within a region. With the restructuring of PRD airspace, it would allow HKIA to handle more flights and therefore further enhance runway capacity.

## 6.4 Time Schedule--Planning for the Third Runway ?

Given these enhancement measures, it is possible that the current parallel runways of HKIA could achieve an ultimate capacity of 80 movements per hour and could sustain its operation for several more years. According to HKIA’s more conservative forecast of traffic demand growth of 3% annually, the ultimate capacity will be reached by 2020. However, if we assume the 5% (based on ICAO forecast) and 7%

(based on HKIA historical growth), we estimate that HKIA will reach its capacity by 2015 and 2012 respectively instead.

Based on the above and experiences by other international airports on building new runways (see Chapter 5), it can take 10 years or more to plan and build a new runway under the current social and political environment in Hong Kong. In general terms, it will take about 2 years for detailed planning, design, and feasibility studies. It can take another 4-5 years for public consultation, undertaking Environmental Impact Assessment (EIA) and funding arrangement. Any unforeseen public inquiry might further delay this consultation process. After that, it will take another 4-5 more years for the actual construction until completion. The public's concern on environmental issues and the political climate could be the key for determining the actual duration of the project.

To be realistic, one should allow for a longer and more flexible consultation period for the third runway. Looking at some recent examples in Hong Kong, the recent case of judiciary review on the EIA permit for the new aviation fuel storage facility at Tuen Mun has suggested that it would require the Government a much longer period to complete all necessary procedures and consultations as well.

The conservative 3% growth scenario suggested that the ultimate capacity would be reached around 2019-2020. And the third runway should be ready for operation by then. Failure to meet traffic demand amid the high growth and highly competitive environment in the PRD region can incur substantial economic losses to Hong Kong which may not be easily reversible (see Chapter 8). However, if we agree that the 5% traffic growth is a more reasonable assumption, despite the fact that it is still below our historical growth in recent years, the ultimate capacity of the two-runway HKIA will be reached before 2015 - only about eight years away. The time schedule is extremely tight, even if the preliminary planning and feasibility studies are already underway.

Very recently, Heathrow also provided a case for reference. On 13th August 2007, a group of British citizens had engaged in a week-long protest against the building of the third runway, three months before the formal release of the Consultation Document *'Adding Capacity At Heathrow Airport'* (see 5.1 Heathrow Case Studies). Although they were banned from campaigning at Heathrow by the police subsequently [BBC, 2007], this reflects that as in most airport infrastructure projects, there are many different stakeholders with conflicting interest on the subject whose concerns needs to be taken into account in order to have a smooth process. Hence, careful planning and design would be a crucial element. Sufficient flexibility and time must be allowed for during the planning process. Also, one should always be mindful of the importance of environmental issues (please see Chapter 7 for further discussion) in the decision process of building a new runway, particularly in this age of global warming and social responsibilities.

## Figure 6.3: Proposed Schedule for HKIA Third Runway Development Under 7% Growth (for reference only)

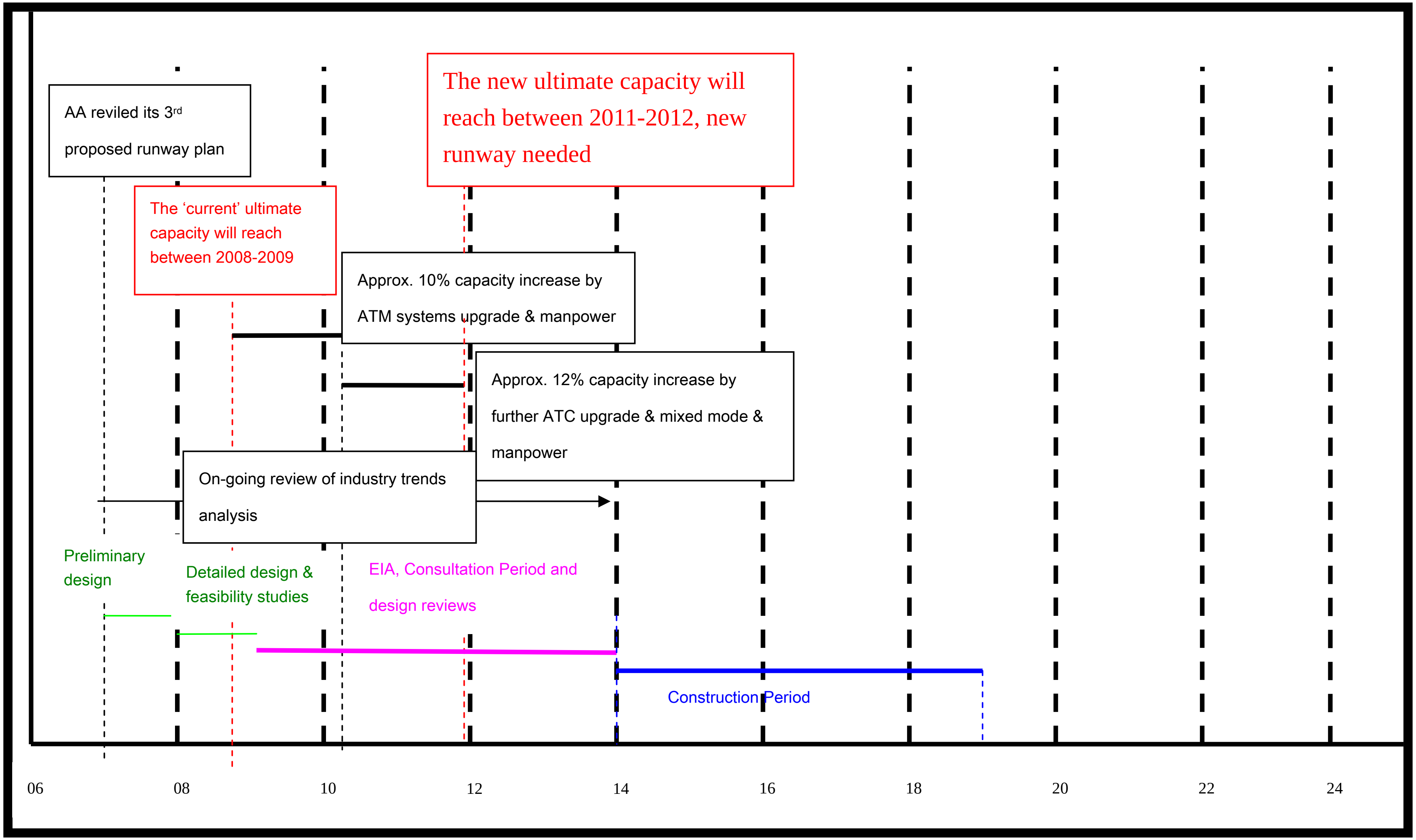


Figure 6.4: Proposed Schedule for HKIA Third Runway Development Under 5% Growth (for reference only)

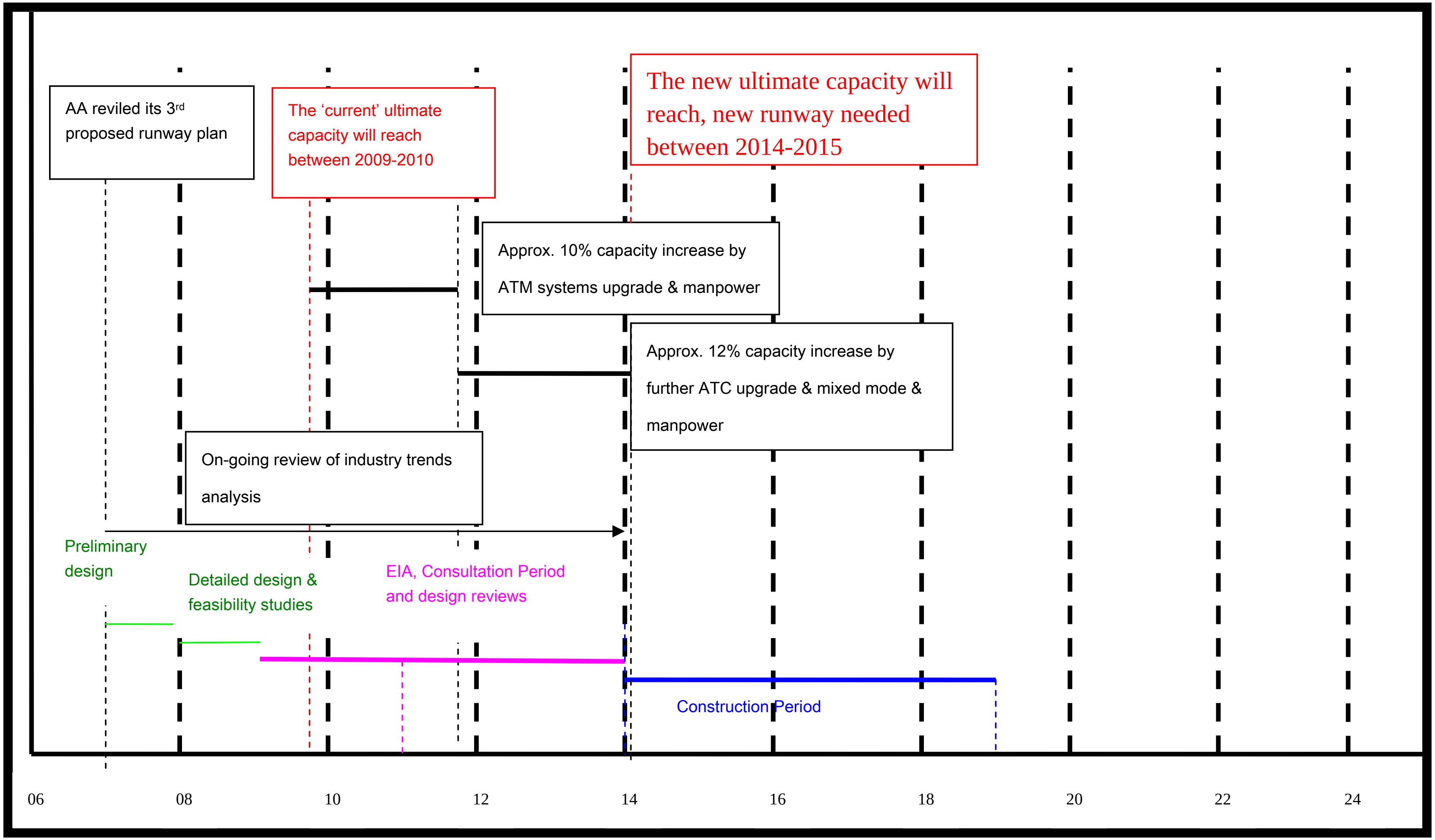
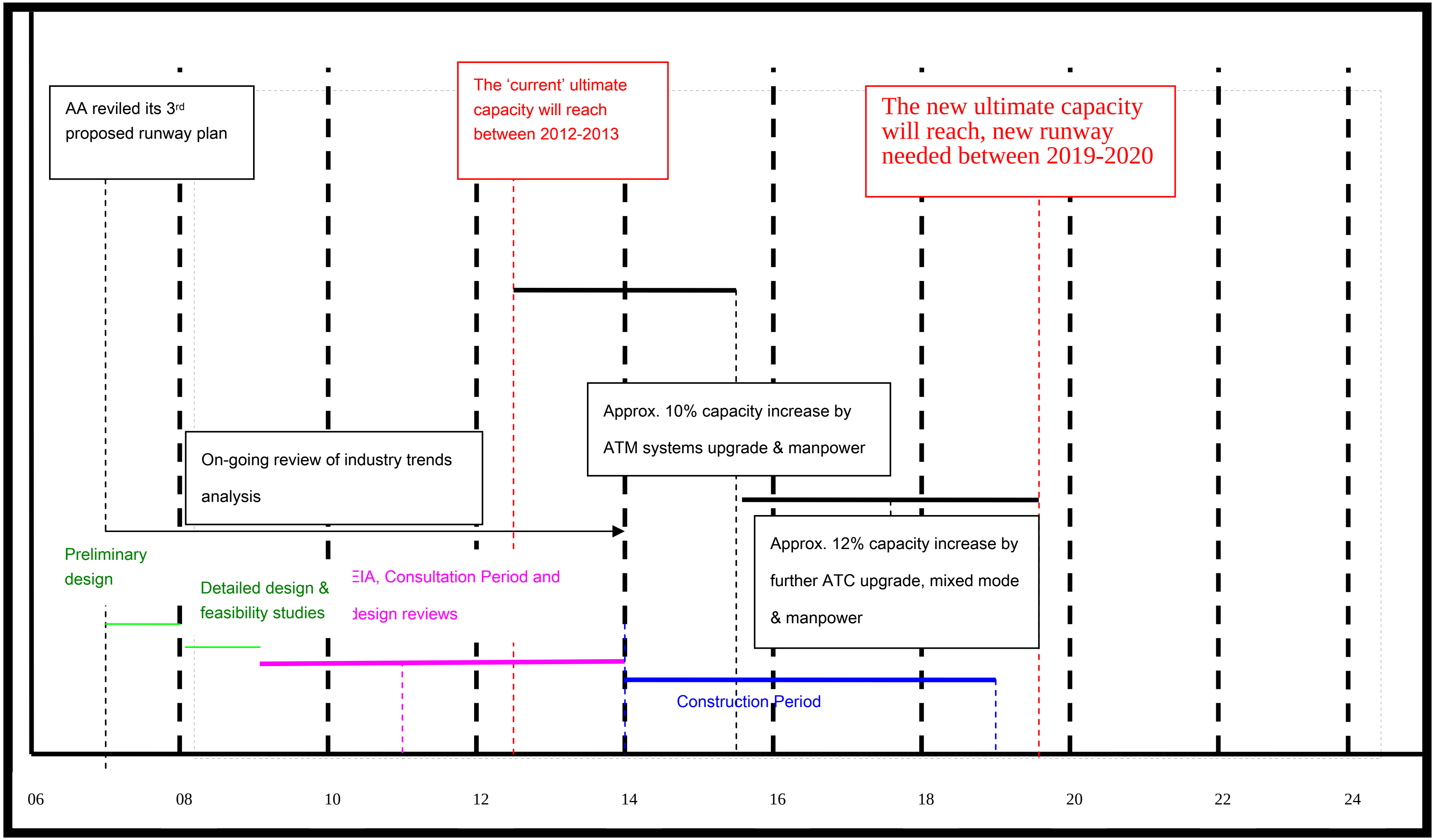


Figure 6.5: Proposed Schedule for HKIA Third Runway Development Under 3% Growth (for reference only)



## 6.5 Conclusions

(1) Given the various possible ATM and ATC enhancement measures, it is possible that the parallel runways of HKIA could achieve an ultimate capacity of up to 80 movements per hour and could sustain its operation for several more years before eventual saturation.

(2) According to HKIA's more conservative forecast of traffic demand growth of 3% annually, the ultimate capacity could be reached by 2019/20. However, if we assume the more realistic 5% and 7% growth rates, HKIA would reach its capacity by 2014/15 and 2011/12 respectively instead, which is only 7 and 4 years from now respectively.

(3) Under the current political and social environment in Hong Kong, it can easily take at least 10 years to build a new runway. In general terms, it would take about 2 years for detailed planning and design, prepare another 4-5 years for public consultation, undertaking EIA and funding arrangement and the possibilities of legal challenges from the public, then another 4-5 more years for the actual construction until completion. With the more realistic growth estimates, assuming that we are committed to the third runway at this point in time, we will still suffer at least 3 to 6 years of saturation of our airport while potentially losing business and market share to alternative airports in the region.

(4) The public's concerns on environmental issues would be the key for possible delays of the project. One should allow for a longer and more flexible consultation period for the third runway. Planning ahead will be the first and crucial step to avoid any potential losses of opportunities in the global aviation industry.

# Chapter 7 Building of the Third Runway—Issues and Problems

In this section, we will highlight the issues regarding the building of a new runway. We will also briefly examine how Hong Kong's unique features would affect these operational issues in terms of the runway configurations, and the increasing environmental concerns towards airport expansion by the public.

## 7.1 Airport Design and Runway Configuration

Airport is a complex transportation system serving aircraft, passengers, cargo and other modes of transport, and airport design has a great influence in an airport's capacity. The runway is the most vital component of the *Airside facilities*. Regarding runways, there can be different configurations. International gateway hubs generally have at least two runways, and some airports have four or even more. For example, Boston Logan Airport has 5 runways and Amsterdam Schiphol Airport has 6 (see figure 7.1 and 7.2). Other than the number of runways, airport capacity also depends on other factors such as runway separation distance, runway orientations, nearby terrain, weather conditions, the ATC technology & ATM procedures, and the types of aircraft being served.


Fig 7.1: Boston Logan Airport

Figure 7.1 on the left shows the runway configuration of Boston Logan Airport, Despite 5 runways are available, Only 3 runways can be used at any one time because of the runway intersect with one another. The 3 runways that are being used are known as the '*Active Runways*' of an airport. From the number of runways, the differences in orientations and runway lengths, one can see that Boston airport handles a high aircraft mix and its overall demand is quite high.

Fig 7.2: Amsterdam Schiphol Airport

Figure 7.2 on the right shows the runway layout for Amsterdam Schiphol Airport. Being one of the major hubs in Europe, the airport handles large amount of heavy wide-body aircrafts. Only 3 runways can be used at any one time. The major reasons for Schiphol having so many runways is because of the airport's severe cross-wind problem, hence despite the low-level of small aircraft activities, the airport still have a considerable amount of runways for safety consideration. Schiphol has the most runways in comparison with other European hubs.


[Photo courtesy of Google Earth, 2007]

Hubs that involve high aircraft mix (aircraft varies with size and engine power), like Boston Logan, may have a variety of runway orientations and lengths. But this is less common to see such a complex layout of runways in most other major airports outside of the US, as airports with intersecting runways are often more challenging to operate from an air traffic management (ATM) point of view.

A number of major airports and most secondary airports have only one runway. Due to limitations on land availability, it is also unlikely that most of these major airports will ever add second runways. An example of this is the London Gatwick Airport. Although the airport has two parallel runways, it actually operates as a single-runway airport: the shorter one is normally used as a taxiway for the other one, except at times when 08R/26L is closed down for maintenance and repairs. Both runways cannot be used at the same time because of insufficient separation between them. It can take up to 15 minutes to change over from one runway to the other. Single-runway airports may be able to handle surprisingly large numbers of passengers if the mix of aircraft is dominated by wide-body aircraft. London/Gatwick had 34.2 million passengers in 2006 and is ranked 25$^{th}$ in the world [ACI, 2007].

Many hub airports consist of two parallel runways. The separation between runways varied. The FAA includes 22 different layouts in their Advisory Circular 150/5060-5 ‘Airport Capacity and Delay’, which provided suggestions on how an airport’s runway spacing and configuration could affect airport capacity. These guidelines, however, do not take into account of important factors such as runway exit design, taxiway layout, terminal locations, airport meteorological & geographical profiles and terminal/runway development balance. These features of airport design do not affect the capacity to the same magnitude as runway alignment, but their impact can be cumulative and considerable. Based on FAA’s approximation, for an airport like HKIA with a runway separation distance of 1,525m (5,000’) between the original two runways, a new 3$^{rd}$ parallel runway with a separation distance of 213m (700’) to 762m (2,499’) could add around 21% extra capacity to an airport. [FAA, 2007]

For parallel runways, the FAA has the following classifications: *close-spaced*, *medium-spaced* and *wide-spaced*. According to the Administration’s analysis, the wider the runway centerline separation, the greater would be the capacity (under

Instrument Flight Rules- IFR). HKIA is having the wide-spaced configuration (1,525m separation). Wide-spaced runways are sometimes known as the independent/simultaneous parallel runways. This wide-spaced configuration provides the land between the two runways for the location of terminal complex. A wide-spaced layout with balanced landside/airside development can also avoid aircraft crossing the other runway back to the apron area after landing or to the active runway before take-off. Runway crossing may result in increase surface delays and taxi time, as well as air traffic controllers' workload.

## 7.2 The Configuration of the Third Runway with a Fourth Runway Consideration

In the 'HKIA 2025' Report, the third runway was outlined as a wide-spaced parallel runway to the north of the current 07L/25R runway. It could allow spacing for new terminals and other airside facilities between. However, details assessment of the actual capacity would need to be carried out to estimate how much extra capacity this third runway under such configuration could actually provide, also how long this 3-runways airport configuration could sustain our development. The orientation of HKIA's current runways was based on careful meteorological considerations in order to take the advantage of wind directions to aid take-off and landing, and the constraints imposed by the near by mountains and terrain. At the same time, it would have minimized the effect of crosswind on aircraft. The effect of crosswind on HKIA operation is very small under this orientation [CAD, 2007]. It is likely that the new runway will be based on the same orientation (RWY 07L/25R and 07R/25L), just as illustrated in 'HKIA 2025'. If we are to proceed with building a third runway for Hong Kong, we must carefully consider whether parallel configuration of the third runway should be closely spaced or widely spaced from the current North runway.

Like Tokyo Narita and Osaka Kansai, HKIA is situated on a man-made island. The development cost can be very expensive due to the massive land reclamation efforts. In the construction of the third runway, a close-spaced configuration will have the obvious advantage of less cost and shorter time, and the technical and social challenges will also be likely to be much smaller. Many airports, e.g. Manchester, Frankfurt, Paris Charles de-Gaulle and a number of other airports in the US, are capable of achieving relatively high capacity with close-spaced runways.

Wide-spaced runways could avoid the crossing problem. More space between the old and the new runway would provide more parking and servicing facilities such as terminals and gates. Aircraft could be independently served on the new space. This large area between the runways could provide space for new terminals and ancillary infrastructures. The wide-spaced configuration could also provide more added capacity than the close-spaced configuration based on studies by FAA and worldwide experience. Due to the large demand on land, not a lot of airports in the world are able to have 3 wide-spaced runways at their airports. The FAA studies also doesn't have a capacity assessment on a three wide-spaced runways.

However, Beijing Capital Airport does provide us with useful reference on the capacity of a wide-spaced third runway. Like HKIA, the Capital Airport was originally a wide-spaced parallel runway airport. Beijing Capital Airport has just completed their new third runway (wide-spaced) and will become operational soon. The CAAC has tested the new runway in late September this year and a simultaneous approach and take-off of all the three runways were successfully performed. According to CAAC, this is the first of its kind in Asia [Beijing Morning Post, 2007]. Together with the Terminal 3 (situated between the second and the third runway, similar to Option A in Fig. 7.3) going into operation in February next year, the Capital Airport Controlling Office predicts an increase of arrival and departure capacity from the current 80 movements/hour to 105 to 110 movements/hour [China Daily, 2007]. This gives an approximated 38% extra capacity to the current Capital Airport. The results of a capacity modeling test of the potential wide-spaced third runway at Taipei Taoyun International Airport also shows that with balanced facilities development between the third and current runways, it is capable of achieving a practical capacity of 115 movements/hour, with the ultimate of 123 movements/hour [AirPlan, 1998]. These figures contrast favourably with the 21% increase for a close-spaced configuration as indicated by the FAA advisory circular mentioned in the previous section.

While it may be premature to conclude that a close-spaced or a wide-spaced configuration is more economical or even optimal solution to our current airport capacity problem, we would like to diverge a bit here and consider the scenario where HKIA may need to build a fourth runway sometime in the future. This is not entirely far-fetched if we look at the growth rates forecasted for our region (see Chapter 3) and the increase in capacity by the third runway, and should not be immediately ruled out if we are to maintain HKIA as the "*center of international and regional aviation*" as stipulated by the Basic Law of Hong Kong.

Figure 7.3 depicts the various parallel configurations with 4 runways. While it will be difficult to have conclusive evidence to show the advantage/disadvantage between options C, D, and E due to the complexity of the analysis, we believe that such analysis, however preliminary, may be useful to help shed additional light between option A and option B in the consideration of the third runway configuration. A crude review of the configurations will show that option D, other than being extremely expensive economically, may likely provide an insurmountable challenge in it's environmental impact assessments and, which it's added benefit of extra capacity and possibility of a third terminal facility may not be able to overcome the above challenges.

Option B may be seen as a "less-risky" approach as the initial outlay and environmental impact will be significantly less than option A, if we're looking at the possibility of having 4 runways eventually. With reference to HKIA 2025's third runway configuration as depicted in Fig. 4.1, a staggered configuration seems to be suggested, which seems to fit in well with the surrounding terrain and the marine ecological activities (see Fig. 7.3). However, such staggering may further exacerbate the "invisible wall" constraints on aircraft's flight paths to the west of the new runway, a problem which needs further exploration. Notwithstanding the above, according to the guidelines stipulated in FAA Advisory Circular 150/5300-13 'Airport Design' CHG 5 , a clear advantage in staggering this new runway allows for the simultaneous operation of approach AND departure on the two neighbouring runways even with a close-spaced configuration as depicted in Option B [FAA, 1997]. Thus, even with a close-spaced configuration for the third runway, Option E can allow for the operation of the 4-runway airport almost similar to two separate airports, with the exception of simultaneous approaches using the current North runway and the third runway (which will then require a wide-spaced configuration between them). The above are very preliminary assessment of the various configurations in Fig. 7.3. We suggest that further research should be conducted to explore these options as we contemplate on the configurations of the third runway.

Careful determination of the economic benefits and cost will need to be conducted under various scenarios before a clearer picture can emerge for the third runway, comparing the technical, economic, and environmental considerations of the various options presented in Fig 7.3. The analysis will be complex, and we believe that the fourth runway framework suggested here may provide for a more comprehensive and interesting analysis for the third runway configuration option.

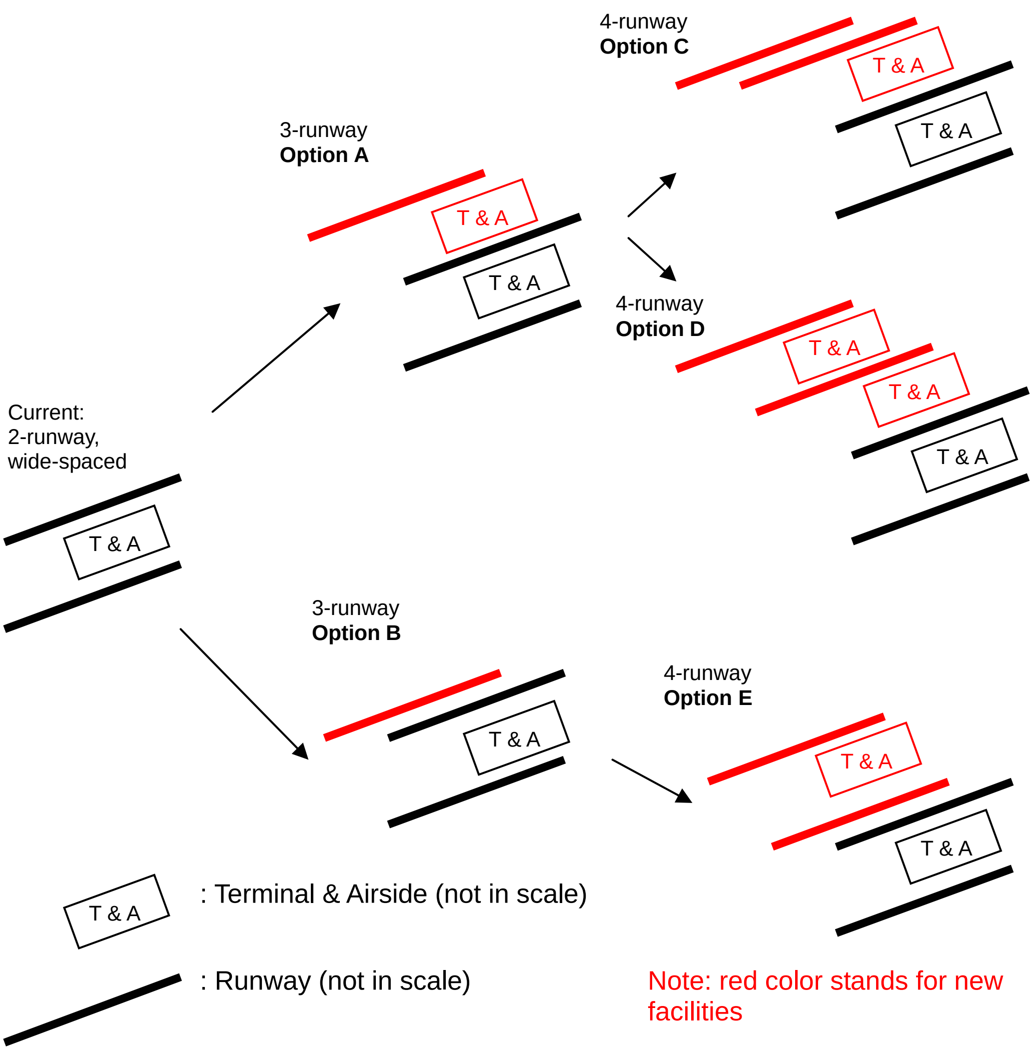



Fig 7.3 4th Runway Configuration Options.

## 7.3 Environmental Issues for the Third Runway

One of the most significant obstical to the consideration of the third runway for HKIA will likely be its impact on the environment, as we believe that the economic case for the added capacity is already a strong one based on our preliminary analysis in Chapter 8. With the increase in the awareness of environmental issues affecting our daily life, this has often been the stumbling block for most major infrastructure projects, as can be seen in the three case studies of runway construction in Chapter 5.

### 7.3.1 The New Environmental Impact Assessment Ordinance (EIAO) and the Third Runway

In Hong Kong, the new Environmental Impact Assessment Ordinance (EIAO) has become effective since 1st April 1998. Designated projects specified under Schedule 2 of the Ordinance, unless exempted, must follow the statutory environmental impact assessment process and require environmental permits for their construction and operation. According to Schedule 2, airport development projects are designated projects [EPD, 2007].

AAHK is required to submit a project feasibility study and an environmental scoping report to the Environmental Protection Department (EPD). Based on the EIAO, a project profile and an application for EIA study brief are required at this initial statutory stage. The EIA is required by EPD to make the decision on whether the proposed development is environmentally feasible. If yes, then a detailed EIA report will be undertaken and be published for public review and consultation which will last for 30 days normally. Public opinions will then be taken and reviewed by the Advisory Council on The Environment. This process normally takes 60 days, after which the Council will give their recommendation to the EPD on whether an environmental permit would be granted. Related parties may file an appeal to object the Council's decision under the EIAO while others are barred from such appeals. However, the general public and other non-governmental organizations could demand a Judiciary Review on legal grounds as well.

This final stage could become very unpredictable under the current political and social conditions in Hong Kong, where judicial reviews are sought frequently. As an example, HKIA submitted an EIA (EIAO Register Number AEIAR-062-2002) for its proposed permanent aviation fuel facility (PAFF) in Tuen Mun in May 2002. Subsequently, the Environmental Permit was granted in August 2002. The applicant obviously has little reason to appeal the decision which is “favorable” to its application. However, this decision was submitted for Judicial Review by a third party, resulting in the Court of Final Appeal repealing the Permit in July 2006. HKIA subsequently submitted another EIA which was then approved in May 2007 [EPD, 2007]. This has been nearly five years since the first permit was granted.

Beside this new planning procedure, the environmental impacts of the construction and operation of the HKIA third runway would be largely similar to the initial HKIA project (except the terrestrial ecology). A description on the work involved for the initial HKIA project can be found in Plant et. al., describing about the detail and extensive efforts by AAHK (called PAA – Provisional Airport Authority back then) in ensuring the environment is being protected throughout the construction phase of the Chek Lap Kok Airport. We will examine each of these four environmental issues in the following sections:

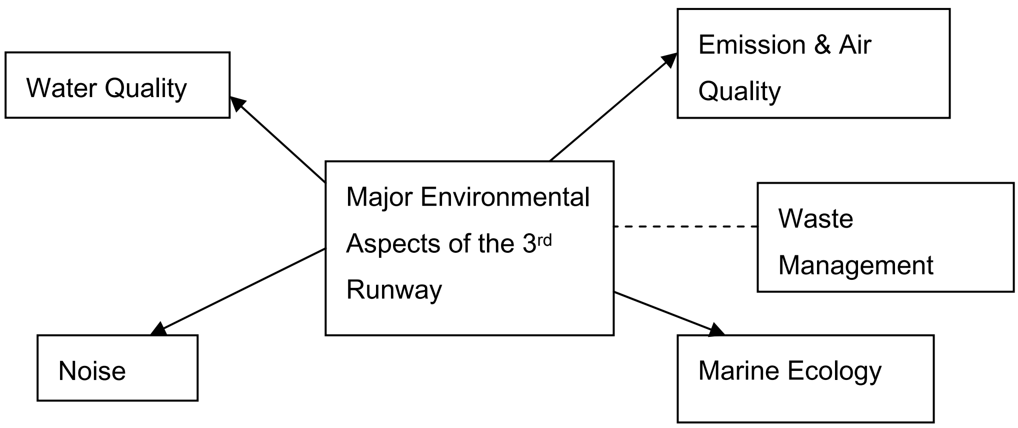



Fig 7.4 Major Environmental Aspects of HKIA and the 3rd Runway Construction

These impacts could be generated during the construction period and after it comes into operations.

### 7.3.2 Noise

There are two categories of noise pollution: air and ground. Increased airport capacity inevitably would mean more aircraft movements. Aircraft noise has traditionally been considered as the most notorious environmental problem created around airports. The situation has changed in recent years due to the development of advanced aircraft engines with significantly reduced noise levels, and noise abatement operating procedures. Aircraft types nowadays are typically 20dB quieter than aircraft of 30 years ago. Stringent noise certification standards were included in the Environmental Protection Annex 16 of the Chicago Convention. Despite all the technical improvement, the community still tend to treat this as public enemy number one. Impacts could range from impaired hearing to psychological annoyances. The effects could often be mitigated through the reduction of aircraft noise at the source, careful land-use planning and management measures, noise abatement operational procedures such as the day/night preferred noise routes (PNR), local noise-related operating restrictions and through community noise insulations projects.

Regarding ground noise, sources can come from the aircraft auxiliary power units[1], airside vehicles and aircraft engine testing. It has the same impact as air noise. Mitigation measures would include ground-based fixed electrical ground power (FEGP), efficient ground operation, dedicated apron area for engine testing and noisy aircraft.

Effective communication between the community and airport operator is always important in airport planning. Some airport operators have even provided funding to neighboring communities, so that they can employ professionals to address airport-related issues. In the case of Florida Palm Beach/International Airport, the position of 'noise officer' was established by the airport operator to act as an impartial facilitator of the negotiating process between the airport and community groups. Although this officer is on the airport's payroll, he or she does not take sides in disputes and attempts to address the concerns of all stakeholders [Sylvan, 2000]

AAHK has been very successful in managing its environmental impact and has gained

[1] Commonly known as APU- this is a small turbine unit located at the tail section of the aircraft that allows electrical power generation when on ground when engines are not running

tremendous experience during the initial phase of the Chek Lap Kok planning and construction. The HKIA is also located now in a much more remote location away from the major urban areas. We believe that the construction and operation of the third runway should not present significant new challenge to AAHK in managing the noise and its impact.

### 7.3.3 Emission

Aircraft produce emissions of carbon dioxide, carbon monoxide, nitrogen oxide, sulphur oxide, and other hydrocarbons. Many of these emissions are considered greenhouse gases which affects climate and contributes to global warming. Although the total amount of emission is relatively small, estimated to be around 2% of all greenhouse gas emissions [Graham, 2003], the emission of such gases at high altitude greatly magnifies its greenhouse gas effects. It is also anticipated that the growth of aviation traffic in the coming decades will bring about significant increases of such emissions from aircraft, despite potential technological advances in fuel efficiency.

Given the growing public awareness of global warming and the resulting potential devastating scenarios for humankind, public concern and their perception on the magnitude of the problem on the environmental threat from aircraft emissions has been growing in recent years. Ground transport to the airport, aircraft emissions and ground activity are also emission sources at the airport. Beside the global warming effect, aircraft emissions and noise could also be perceived to affect the community's health around the airport area. We consider this to be a more sensitive issue which the third runway proposal must adequately address in order to minimize the delays which can result from prolonged inquiries and unnecessary bad publicity from public outcry.

### 7.3.4 Water Pollution and Marine Ecology

Water pollution at airports can occur for a number of different reasons, from domestic sewage, airport-related effluents and construction erosion. The water pollution issue is especially important for Hong Kong’s case as massive reclamation will be involved. One of the more sensitive issues would be the impact on the Chinese White Dolphins, which are protected under the Wild Animal Protection Ordinance (Cap 170) and the Animals and Plants (Protection of Endangered Species) Ordinance (Cap 187) in Hong Kong. Marine parks have been established by the Agriculture, Fisheries and Conservation Department to the northwest of Lantau Island for the protection of these dolphins. Many of the Chinese White Dolphin's habitats are near estuaries, such as those in the western waters of Hong Kong where the Pearl River joins the South China Sea, and there is a very large area of these waters between Lantau Island and Macau which has been designated as restricted areas by the Chinese Government to protect these Chinese White dolphins.

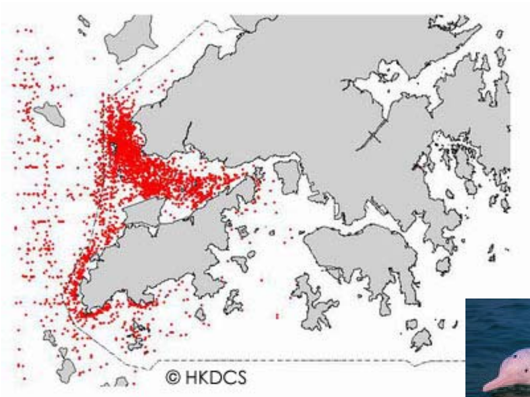



Fig 7.5 The diagram on the left shows the recorded locations where the Chinese white dolphins were found. The map clearly shows a vast majority of the species inhabit around the HKIA area. [HKDCS, 2007]

Physical removal of seabed causes damages to the natural communities in the area of the borrow pits, reclamation and dump sites. Clouds of suspended sediments would adversely affect sensitive marine life through decreased light penetration, clogging of respiratory apparatus and direct burial. This in turn could lead to a reduction of food supply for marine life higher up the food chain such as fish and dolphins [WWF, 2007].

HKIA adopted a 1 km exclusion zone for the Chinese White Dolphins during the initial airport construction phase. It was set up to ensure that their sensitive hearing would not be harmed during the blasting work. In Munich, the airport has a transition zone between the airport ground and the open countryside. It has developed into an ecological buffer zone supporting a wide range of plant and animal species between large monocultures within the airport perimeter and adjacent fields dedicated for agricultural uses. At Miami airport, the death of four manatees beneath the runway forced the airport operator to take serious action to protect this endangered species. At Manchester Airport, badgers were relocated and a rare breed of new tree had to be protected when the second runway was being built [Graham, 2003].


Fig 7.6 Sea Depth near HKIA. The deep water zones are mainly located near the 25R runway end. But the soft seabed of some part of the shallow region might also mean that further engineering work would be required for reclamation foundation [Lands Department, 2007].

Measures to minimize environmental impacts of the 3rd runway on water pollution and marine biology will not be straight forward. While the deep experience AAHK has in protecting the water resources and ecology around HKIA throughout it's planning and construction phases will be most helpful to ensure good results, recent examples of mass protest on conservation related issues and the failed exercise to reclaim parts of the Victoria Harbour to ease traffic congestion can be good cases for study. The potentially massive reclamation needed for the 3rd runway will likely be a hotly debated and highly publicized issue, with the conservation of the ecology and the plight of the Chinese White dolphins being foremost on the agenda.

## 7.4 Conclusion

In this chapter, we have discussed about the operational issues and challenges facing the third runway proposal. The wide-spaced configuration versus the close-spaced configuration will need careful research and analysis, and the suggestion to include an assessment of the $4^{th}$ runway scenarios may help to shed light on this issue.

Environmental issues are beginning to affect most aspects of airport operations- even the EU proposal on slot allocations suggests that environmental as well as physical capacity should be considered [Graham, 2003]. In spite of technological, operational, and other mitigation measures to minimize the environmental impacts, the growth rates being predicted for air transport will inevitably mean that environmental impacts will increase as a result. The aviation industry clearly faces a major challenge in the future, particularly when the impact of global warming is being directly felt by citizens around the world in terms of hotter summers and more severe storms and floods.

In the case of the third runway project, it is likely that the major obstacle would be addressing the environmental impact of this massive undertaking involving major reclamation in an area close the protection zones for the Chinese White dolphins, and the issue of emission contribution to greenhouse gases. The positive aspect in this equation would be the deep experience and good records of AAHK in the initial construction of the Chek Lap Kok Airport. However, recent conservation efforts in Hong Kong, and the legal challenges by third parties through the Judicial Review process can prove to be extremely time consuming process, potentially delaying a project which even if allowed to progress without such obstacles, may already be too late to meet the growing demands of the aviation sector in time to prevent the lost of business and significant market share to competing airports in the region. In this regard, early participation of the public, airlines, the airport operator and contractors on the project can prove to be crucial in bringing forth positive results. The environmental impacts of the airport expansion should never be underestimated and therefore a detailed assessment should be well-prepared to ensure the environmental-viability of any proposed development. Lastly, but most importantly, it will be critical for HKIA to consider and move forward all possible capacity improvement measures, working with the widest group of stakeholders (CAD, airlines, and consumers/general public) to demonstrate the urgency and commitment for capacity enhancement at HKIA, and that all alternatives has been fully exhausted. This will certainly help to strengthen the case as it goes through the environmental vetting process as dictated by the new EIAO.

# Chapter 8 Economic Impact Assessment of the Third Runway

What will be the economic impact of the third runway? We shall first investigate how the aviation sector contributes to Hong Kong and then provide approximations on how much the expansion of capacity brought by the new runway may contribute to Hong Kong economy. However, more traffic also incurs environmental costs. We will also attempt to provide an approximation of environmental impact in economic terms by the third runway.

## 8.1 Economic Contribution of Aviation Sector in Hong Kong

As well as being a generator of economic activities in its own right, an airport can also play a role in attracting and sustaining wider economic activity in its catchment area-both in terms of business and tourism development. This is the catalytic, magnetic, or spin-off impact. This impact can be defined as the employment, income, investment, and tax revenues generated by the wider role which an airport can play by being an economic magnet for the region it serves. Airports can give a company easy assess to other parts of the company as well as to suppliers and customers, and can offer speed and security for goods being transported.

The trend towards globalization, both in terms of multinational companies and also in terms of increased reliance on imported components and products, has increased the importance of locating in the vicinity of an international airport. High-value and low-weight products are heavily reliant on air travel for the transportation. The increasing reliance on just-in-time inventory systems for manufacturing and retailing industries has meant that air travel has become a critical element for a quick and efficient distribution system and rapid delivery times. In short, airports have become increasingly more importance for business operating in global marketplace [Graham, 2003].

### 8.1.1 Methodology and Estimation

Value added approach is used to estimate the economic contribution of aviation sector to Hong Kong economy. It captures both the direct and indirect benefits of the aviation industry, including air transport, services that are incidental to air transport, tourism, trade services, courier services, land transport supporting air cargoes and miscellaneous services that support the air cargoes. The former two sectors directly benefit from aviation, and the remaining five, which are supported by air transport services, indirectly benefit Hong Kong. The value added of each sector at current prices is compared with the GDP at factor cost (at current prices) denoted as GDP (f.c. and curr. p.). to estimate the direct and indirect effects of the aviation sector on the Hong Kong economy.

#### 8.1.1.1 Direct Benefits

Air Transport and Incidental Services

The air transport sector together with the air cargo forwarding services, travel agents, and airline ticket agents (outbound) contribute directly to the economy by providing flight services to air passengers and distributing cargo to various parts of the world. Air transport sector includes Hong Kong based airline and helicopter companies, and the local representative offices of overseas airline companies.

The value added of the air transport and air cargo forwarding services increases from HK$28.3 billion in 2000 to HK$40.2 billion in 2005, with an average annual growth rate of 7.3 % between 2000 and 2005. Its share of GDP (f.c. and curr. p.) increases from 2.25% in 2000 to 2.98% in 2005. For travel agents and airline ticket agents (outbound), its value added increases from HK$3.2 billion in 2000 to HK$4.0 billion in 2005, with an average annual growth rate of 4.6%. Its share of GDP (f.c. and curr. p.) increases from 0.25% in 2000 to 0.30% in 2005. As a result, the value added of all direct effects (air transport sector, air cargo forwarding services, travel agents and airline ticket agents (outbound)) increases from HK$31.5 billion in 2000 to HK$44.2 billion in 2005, with an average annual growth rate of 7.0%.

Table 8.1 Value Added of Air Transport and Incidental Services at Current Prices

Unit: HK$Mn (unless otherwise specified)

| | | **2000** | **2001** | **2002** | **2003** | **2004** | **2005**[i] |
|---|---|---|---|---|---|---|---|
| Air transport and air cargo forwarding services | Value added | 28,251 | 26,526 | 31,362 | 28,249 | 35,505 | 40,159 |
| | Share of GDP (f.c. and curr. p.) | 2.25% | 2.13% | 2.54% | 2.35% | 2.83% | 2.98% |
| Travel agents and airline ticket agents (outbound) | Value added | 3,200 | 3,200 | 3,000 | 2,500 | 3,200 | 4,000 |
| | Share of GDP (f.c. and curr. P.) | 0.25% | 0.26% | 0.24% | 0.21% | 0.25% | 0.30% |
| Total | Value added | 31,451 | 29,726 | 34,362 | 30,749 | 38,705 | 44,159 |
| | Share of GDP (f.c. and curr. p.) | 2.51% | 2.39% | 2.78% | 2.56% | 3.08% | 3.28% |

*Notes*:
i. The value added figures of air transport and air cargo forwarding services and the GDP at factor cost for 2005 will be adjusted by the Census and Statistics Department later on as more data become available.

*Sources*: Gross Domestic Product 2006; Homepage of Census and Statistics Department.

#### 8.1.1.2 Indirect Benefits

Tourism

Tourism is one of the four key industries in Hong Kong. The number of incoming visitors increases from 13.1 million in 2000 to 25.3 million in 2006, with an average annual growth rate of 11.6%. Because of the SARS, the number of incoming air travelers drops from 6.7 million in 2000 to 5.0 million in 2003. In 2004, there was a sharp rebound of 40.8% in incoming air travelers (7.0 million). In 2006, the number of incoming air travelers increased to 8.6 million.

Table 8.2 Visitor Arrivals by Mode of Transport

| | | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** |
|---|---|---|---|---|---|---|---|---|
| Air | No. | 6,709,473 | 6,530,112 | 6,891,389 | 4,981,116 | 7,014,535 | 7,803,229 | 8,625,585 |
| | | (10.7%) | (-2.7%) | (5.5%) | (-27.7%) | (40.8%) | (11.2%) | (10.5%) |
| | Share | 51.4% | 47.6% | 41.6% | 32.1% | 32.2% | 33.4% | 34.2% |
| Sea | No. | 2,096,018 | 2,148,705 | 2,509,423 | 2,205,677 | 2,826,909 | 2,788,116 | 3,075,709 |
| | | (4.8%) | (2.5%) | (16.8%) | (-12.1%) | (28.2 %) | (-1.4%) | (10.3%) |
| | Share | 16.0% | 15.6% | 15.1% | 14.2% | 13.0% | 11.9% | 12.2% |
| Land | No. | 4,253,986 | 5,046,515 | 7,165,570 | 8,350,046 | 11,969,186 | 12,768,072 | 13,549,830 |
| | | (30.2%) | (18.6%) | (42.0%) | (16.5%) | (43.3%) | (6.7%) | (6.1%) |
| | Share | 32.6% | 36.8% | 43.3% | 53.7% | 54.9% | 54.7% | 53.7% |
| Total | No. | 13,059,477 | 13,725,332 | 16,566,382 | 15,536,839 | 21,810,630 | 23,359,417 | 25,251,124 |
| | | (15.3%) | (5.1%) | (20.7%) | (-6.2%) | (40.4%) | (7.1%) | (8.1%) |

*Note:* Figures in parentheses are year-on-year change.
*Source:* A Statistical Review of Hong Kong Tourism 2006.

The value added of tourism that is indirectly brought in by the aviation sector is calculated by using the following equation:

$$\frac{\sum_{c=1}^{8}(V_{a,c} \times R_{o,c} \times E_{o,c} + V_{a,c} \times R_{s,c} \times E_{s,c})}{E_t} \times VA_{tourism}$$

where

(i) $V_a$ is the number of visitor arrivals by air;

(ii) $R_o$ is the overnight visitors as a percentage of total (total equals overnight and same-day in-town visitors);

(iii) C is country/city/continent of residence, which includes eight areas, namely (i) the Americas, (ii) Europe, Africa and the Middle East, (iii) Australia, NZ and S Pacific, (iv) North Asia, (v) South and Southeast Asia, (vi) Taiwan, (vii) Macau and (viii) Mainland China;

(iv) $R_s$ is the same-day in-town visitors as a percentage of total;

(v) $E_o$ is the overnight visitor per capita spending in Hong Kong;

(vi) $E_s$ is the same-day in-town visitor per capita spending in Hong Kong;

(vii) $E_t$ is the total destination consumption expenditure, which includes expenditure by overnight visitors, same-day in-town visitors, cruise passengers, servicemen, aircrew members, and transit/transfer passenger[2]; and

(viii) $VA_{tourism}$ is the value added (at current market prices) by inbound tourism with cross-boundary passenger transport excluded. We do not include cross-boundary passenger transport in our estimation because we already measure air passenger transport, of which it is one of the subcomponents, as a direct benefit. To avoid double-counting, we measure the value added by inbound tourism without taking into account cross-boundary passenger transport.

Furthermore, we have made the following two assumptions in estimation:

(i) Value added of tourism is directly proportional to the visitors spending; and

(ii) the relative share of overnight visitors and same-day in-town visitors are the same for all mode of transport

The value added of inbound tourism by air increases from HK$7.0 billion in 2000 to HK$7.7 billion in 2005, with an average annual growth rate of 1.9%. Its share of GDP (f.c. and curr.p.) slightly increases from 0.56% in 2000 to 0.57% in 2005.

[2] According to the Hong Kong Tourism Board, total tourism expenditure that is associated with inbound tourism is composed of total destination consumption expenditure and passenger international transportation expenditure. As we have already taken into account the later item in the air transport sector, we don not include this item in tourism sector.

Table 8.3 Value Added of Inbound Tourism by air at Current Prices

Unit: HK$Mn (unless otherwise specified)

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|
| Total spending of all visitors by air | 22,692 | 20,813 | 22,030 | 16,012 | 21,729 | 25,353 |
| Total tourism spending[i] | 45,747 | 46,050 | 57,798 | 55,163 | 69,559 | 79,395 |
| Contribution of aviation on tourism | 50% | 45% | 38% | 29% | 31% | 32% |
| Value added of inbound tourism[ii] | 14,100 | 13,700 | 17,300 | 14,400 | 20,100 | 24,100 |
| Value added of inbound tourism as a share of GDP (f.c. and curr. p.)[iii] | 1.12% | 1.10% | 1.40% | 1.20% | 1.60% | 1.79% |
| Value added of tourism brought by air transport | 6,994 | 6,192 | 6,594 | 4,180 | 6,279 | 7,696 |
| Value added of aviation-supported tourism as a share of GDP (f.c. and curr. p.)[iii] | 0.56% | 0.50% | 0.53% | 0.35% | 0.50% | 0.57% |

Notes

i. Passenger international transportation expenditure is not taken into account as it belongs to air transport in our studies.

ii. Cross-boundary passenger transport services are excluded as it is part of the value added by air transport.

iii. The 2005 GDP (f.c. and curr. p.) is subject to revision by the Census and Statistics Department.

Sources

A Statistical Review of Hong Kong Tourism (2000 – 2006)

Census and Statistics Department Homepage

Trade Services

Besides tourism, trading is one of the four pillar industries in Hong Kong also. As just-in-time service and immediate delivery are becoming more important, air transport can provide a speedy delivery service. Given the favorable geographical location of Hong Kong with a well-equipped airport, air cargo is of particular importance to the development of international trade in the PRD region. The equation that used in estimating the value added of trade service relating to the aviation sector is as follow:

$$\frac{DE^{*}{}_{Air} + M^{*}{}_{Air} \times \frac{RM}{M} + RE^{*}{}_{Air}}{DE^{*} + M^{*} \times \frac{RM}{M} + RE^{*}} \times VA_{Trade} \times Conventional\ Trade\ Ratio$$

Note:

* Hand carried and parcel posts are excluded

where

(i) $DE_{Air}$ is the domestic export value by air;

(ii) $M_{Air}$ is the import value by air;

(iii) $RE_{Air}$ is the re-export value by air;

(iv) DE, M, RE and RM are total domestic export value, total import value, total re-export value and total retained import value respectively;

(v) $VA_{trade}$ is the value added by import/export trade at current market prices; and

(vi) Conventional Trade Ratio is the proportion of conventional trade in total value added of import and export trade.

The value added by trade services that are related to the aviation sector increases from HK$40.7 billion in 2000 to HK$58.6 billion in 2005, with an average annual growth rate of 7.6%. Its share of GDP (f.c. and curr. p.) increases from 3.24% in 2000 to 4.35% in 2005.

Table 8.4 Value Added of Trade Services at Current Prices

Unit: HK$Mn (unless otherwise specified)

| | | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|
| Domestic exports | Value by air | 61,630 | 43,700 | 39,261 | 33,732 | 39,906 | 51,640 |
| | Total value[i] | 179,455 | 152,193 | 129,435 | 119,950 | 124,143 | 133,583 |
| | Value by air as a share of total | 34.34% | 28.71% | 30.33% | 28.12% | 32.15% | 38.66% |
| Retained imports | Value by air | 164,635 | 155,519 | 148,983 | 163,809 | 198,785 | 220,857 |
| | Total value[i] | 552,509 | 502,084 | 456,665 | 468,257 | 538,591 | 579,063 |
| | Value by air as a share of total | 29.80% | 30.97% | 32.62% | 34.98% | 36.91% | 38.14% |
| Re-exports | Value by air | 313,012 | 301,121 | 349,326 | 418,170 | 530,799 | 637,621 |
| | Total value[i] | 1,387,918 | 1,324,477 | 1,426,389 | 1,616,071 | 1,887,087 | 2,108,615 |
| | Value by air as a share of total | 22.55% | 22.74% | 24.49% | 25.88% | 28.13% | 30.24% |
| Overall | Value by air as a share of total | 25.44% | 25.29% | 26.71% | 27.93% | 30.18% | 32.26% |
| | VA of import/export[ii] | 159,887 | 155,910 | 154,722 | 156,227 | 168,659 | 181,680 |
| | VA import/export by air | 40,674 | 39,423 | 41,329 | 43,638 | 50,898 | 58,609 |
| | VA of import/export by air as a share of GDP (f.c. and curr. p.)[iii] | 3.24% | 3.17% | 3.35% | 3.63% | 4.05% | 4.35% |

Notes

i. Hand carried and parcel posts are excluded.

ii. Only the portion related to conventional trade is included. Offshore trade is excluded.

iii. Value added by import/export and GDP (f.c and curr. p.) for 2005 is subject to revision by Census and Statistics Department later

Sources

Census and Statistics Department Homepage

Hong Kong Monthly Digest of Statistics December 2003, March 2004, March 2005, March 2006 and Mar 2007

Data obtained from Census and Statistics Department through telephone

Courier Services

In Hong Kong, there are mainly two types of courier services, namely local and international courier services. In order to provide speedy delivery services across countries, air transport plays an important role. The value added of international courier services is estimated by using the following equation:

$$\frac{BR_{\text{Int'l Courier}}}{\text{BR \& I}_{\text{Comm}}} \times VA_{Comm}$$

where

(i) $BR_{\text{Int'l Courier}}$ is the business receipts of international courier services;

(ii) $BR\&I_{\text{Comm}}$ is the business receipts and other income of miscellaneous communication services (excluding telecommunication services); and

(iii) $VA_{\text{Comm}}$ is the value added of miscellaneous communication services (excluding telecommunication services).

Furthermore, the following two assumptions are made:

(i) Value added is directly proportional to business receipts; and

(ii) All value added from international express companies is related to air transport services. Although local delivery of international express companies may involve land and water transports, and companies may also provide other value-added services, like business solution, to their clients, some of them may be supported by or may support the aviation sector. We therefore for simplicity, assume that all value added from international courier companies is related to air transport services.

The value added of international courier services increases from HK$2.6 billion in 2000 to 3.0 billion in 2005, with an average annual growth rate of 2.7%. Its share of GDP (f.c. and curr. p.) increases from 0.21% in 2000 to 0.22% in 2005.

Table 8.5 Value Added of International Courier Services at Current Prices

Unit: HK$Mn (unless otherwise specified)

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|
| Business receipts of international courier services | 6,246.1 | 6,053.2 | 8,045.5 | 9,096.3 | 11,361.5 | 12,721.2 |
| Business receipts and income of miscellaneous communication services (excluding telecommunication services) | 7,266.7 | 7,203.5 | 9,039.3 | 10,170.5 | 12,186.0 | 13,951.7 |
| Business receipts of international courier services as a share of miscellaneous communication services (excluding telecommunication services) | 86% | 84% | 89% | 89% | 93% | 91% |
| VA of miscellaneous communication services (excluding telecommunication services) | 3,019.6 | 2,657.9 | 2,554.6 | 2,590.4 | 3,207.6 | 3,253.5 |
| VA of international courier services | 2,595.5 | 2,233.5 | 2,273.7 | 2,316.8 | 2,990.6 | 2,966.6 |
| VA of international courier services as a share of GDP (f.c. and curr. p.) | 0.21% | 0.18% | 0.18% | 0.19% | 0.24% | 0.22% |

Sources

Report on 2002 Annual Survey of Storage, Communication, Financing, Insurance and Business Services

Report on 2003 Annual Surveys of Storage, Communication, Banking, Financing, Insurance and Business Services

Report on 2004 Annual Surveys of Storage, Communication, Banking, Financing, Insurance and Business Services

Report on 2005 Annual Surveys of Storage, Communication, Banking, Financing, Insurance and Business Services

Data obtained from Census and Statistics Department through telephone

## Land Transport Supporting Air Cargo Operations

Trade sector has long been the key industry in Hong Kong supporting economic growth. Re-exports are amongst the most important form of trade as a result of the favorable geographical location of Hong Kong. Hong Kong is playing a role of connecting Mainland China and the rest of the world. Land transport is therefore supporting the air cargo activity by transporting re-exports into and out of Mainland China.

The value added of land transport supporting air cargoes is estimated by using the following equation:

Air to Land

$$VA_{LFT} \times \frac{RE^{*}{}_{Land}}{(M + DE + RE)^{*}{}_{Land}} \times \frac{M^{*}{}_{Air}}{M^{*}{}_{Air} + M^{*}{}_{Sea}}$$

Land to Air

$$VA_{LFT} \times \frac{M^{*}{}_{Land} \times \left(1 - \frac{RM}{M}\right)}{(M + DE + RE)^{*}{}_{Land}} \times \frac{RE^{*}{}_{Air}}{RE^{*}{}_{Air} + RE^{*}{}_{Sea}}$$

Note:

* Hand carried and parcel posts are excluded

where

(i) Land, Air and Sea are the mode of transport of goods;

(ii) RE, DE, RM and M refer to re-exports value, domestic exports value, retained imports value and imports value respectively

The value added of land transport supporting air cargoes increases from HK$1.9 billion in 2000 to HK$2.6 billion in 2005, with an average annual growth rate of 6.3%. Its share of GDP (f.c. and curr. p.) increases from 0.1502% in 2000 to 0.1900% in 2005.

Table 8.6 Value Added of Land Transport Supporting Air Cargo Operations at Current Prices

Unit: HK$Mn (unless otherwise specified)

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|
| VA land freight transport supporting re-exports (air-to-land) | 1,063 | 1,024 | 1,144 | 1,333 | 1,590 | 1,524 |
| VA of land freight transport supporting re-exports (land-to-air) | 822 | 738 | 796 | 877 | 1,043 | 1,033 |
| VA of land freight transport supporting air cargo | 1,885 | 1,761 | 1,940 | 2,210 | 2,633 | 2,557 |
| VA of land freight transport supporting air cargo as a share of GDP (f.c. and curr. p.) | 0.1502% | 0.1416% | 0.1571% | 0.1837% | 0.2096% | 0.1900% |

**Notes**

i. GDP (f.c and curr. p.) for 2005 is subject to revision by Census and Statistics Department later

Sources

Report on 2002 Annual Survey of Transport and Related Services

Report on 2003 Annual Survey of Transport and Related Services

Report on 2004 Annual Survey of Transport and Related Services

Report on 2005 Annual Survey of Transport and Related Services

Report on 2006 Annual Survey of Transport and Related Services

Summary Statistics on Port Traffic of Hong Kong January 2007

Census and Statistics Department Homepage

Miscellaneous Services Supporting Air Cargo Operations

The value added of miscellaneous services supporting air cargoes is estimated by using the following equation.

$$\frac{DE^{*}{}_{Air} + M^{*}{}_{Air} \times \frac{RM}{M} + RE^{*}{}_{Air}}{DE^{*} + M^{*} \times \frac{RM}{M} + RE^{*}}\left(VA_{Packin\ and\ crating\ services} + VA_{Cargo\ inspection,\ sampling\ and\ weighing\ services} + VA_{Storage}\right)$$

Note:

* Hand carried and parcel posts are excluded

where

(i) Air is the mode of transport of goods;

(ii) RE, DE, RM and M refer to re-exports value, domestic exports value, retained imports value and imports value respectively;

(iii) $VA_{\text{Packing and crating services}}$, $VA_{\text{Cargo inspection, sampling and weighing services}}$ and $VA_{\text{Storage}}$ refer to the value added of packing and crating services, cargo inspection, sampling and weighing services and storage respectively.

The value added of miscellaneous services supporting air cargoes increases from HK$0.4 billion in 2000 to HK$0.7 billion in 2005, with an average annual growth rate of 11.6%. Its share of GDP (f.c. and curr. p.) slightly increases from 0.03% in 2000 to 0.05% in 2005.

Table 8.7 Value added of miscellaneous services supporting air cargoes at current prices

Unit: HK$Mn (unless otherwise specified)

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|
| VA of packing and crating services supporting air cargoes | 10 | 4 | 15 | 15 | 24 | 45 |
| VA of cargo inspection, sampling and weighing services supporting air cargoes | 64 | 44 | 69 | 98 | 99 | 126 |
| VA of storage supporting air cargoes | 330 | 279 | 263 | 291 | 347 | 527 |
| VA of miscellaneous services supporting air cargoes | 404 | 328 | 347 | 404 | 471 | 698 |
| VA of miscellaneous services supporting air cargoes as a share of GDP (f.c. and curr. p.) | 0.03% | 0.03% | 0.03% | 0.03% | 0.04% | 0.05% |

Sources

Homepage of Census and Statistics Department.

Data obtained from Census and Statistics Department through telephone

#### 8.1.1.3 Total Benefits

By considering all the aviation-related activities, the total economic contribution of the aviation industry is 116.7 billion (direct benefit: 44.2 billion; indirect benefit: 72.5 billion), which contributes a significant portion of 8.67% (direct benefit: 3.28%; indirect benefit: 5.39%) to local GDP (f.c. and curr. p.) in 2005,

Table 8.8 Value Added of the Aviation Industry at Current Prices

Unit: HK$Mn (unless otherwise specified)

| | | | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|
| Direct benefit | Air Transport and incidental services | Value added | 31,451 | 29,726 | 34,362 | 30,749 | 38,705 | 44,159 |
| | | Share of GDP (f.c. and curr. p.) | 2.51% | 2.39% | 2.78% | 2.56% | 3.08% | 3.28% |
| Indirect benefit | Tourism | Value added | 6,994 | 6,192 | 6,594 | 4,180 | 6,279 | 7,696 |
| | | Share of GDP (f.c. and curr. p.) | 0.56% | 0.50% | 0.53% | 0.35% | 0.50% | 0.57% |
| | Trade services | Value added | 40,674 | 39,423 | 41,329 | 43,638 | 50,898 | 58,609 |
| | | Share of GDP (f.c. and curr. p.) | 3.24% | 3.17% | 3.35% | 3.63% | 4.05% | 4.35% |
| | International courier services | Value added | 2,596 | 2,234 | 2,274 | 2,317 | 2,991 | 2,967 |
| | | Share of GDP (f.c. and curr. p.) | 0.21% | 0.18% | 0.18% | 0.19% | 0.24% | 0.22% |
| | Land transport supporting air cargoes | Value added | 1,885 | 1,761 | 1,940 | 2,210 | 2,633 | 2,557 |
| | | Share of GDP (f.c. and curr. p.) | 0.15% | 0.14% | 0.16% | 0.18% | 0.21% | 0.19% |
| | Miscellaneous services supporting air cargoes | Value added | 404 | 328 | 347 | 404 | 471 | 698 |
| | | Share of GDP (f.c. and curr. p.) | 0.03% | 0.03% | 0.03% | 0.03% | 0.04% | 0.05% |
| Overall | | Value added | 84,004 | 79,663 | 86,845 | 83,498 | 101,976 | 116,686 |
| | | Share of GDP (f.c. and curr. p.) | 6.69% | 6.40% | 7.03% | 6.94% | 8.12% | 8.67% |
| GDP (f.c. and curr. p) | | . | 1,255,348 | 1,244,271 | 1,234,949 | 1,203,034 | 1,256,209 | 1,346,020 |

## 8.2 Economic Impact of the third Runway

The present capacity of the runways in HKIA is 54 movements per hour. However, if possible ATM and ATC enhancement measures are implemented, the capacity can be increased to 80 movements per hour without the addition of third runway (i.e. 415,388 aircraft movements per year at most). However, the airport capacity will be saturated in 2019 to 2020, 2014 to 2015 and 2011 to 2012 if the annual traffic growth is 3%, 5% and 7% respectively and therefore, a third runway is needed to handle the extra flights at that time.

Using our estimation of economic contribution by aviation sector in Hong Kong in 2005 and the assumption that the third runway can start to operate from the beginning of 2019, we can provide an approximation of how much the third runway may contribute to Hong Kong economy. Besides, Table 8.10 and Table 8.11 provide us an idea on what the runway and airport capacity will be under different configurations of the third runway.

Table 8.9 Economic Assessment of Aviation Sector in 2005

| | 2005 |
|---|---|
| Number of aircraft movement | 259,700 |
| VA per flight (in HK$million) (in 2005HK$) | 0.4493 |
| Direct portion | 0.1700 |
| Indirect portion | 0.2793 |
| Overall VA of aviation (in HK$million) (in 2005HK$) | 116,686 |
| Direct portion | 44,159 |
| Indirect portion | 72,527 |
| Note: | |
| (i) Total may not sum up due to rounding | |
| (ii) The number of aircraft movement includes passenger flights and cargo flights only, non-revenue flight is excluded | |
| Source: | |
| *Homepage of Hong Kong International Airport* | |

Table 8.10 Projected runway capacity under different scenarios

| Scenario | Runway capacity (movements per hour) |
|---|---|
| With possible ATM and ATC enhancement measures are implemented before the addition of third runway | 80 |
| With 20% increase in runway capacity after the third runway is built *(Closed-spaced configuration)* | 80*(1+20%) = 96 |
| With 30% increase in runway capacity after the third runway is built *("Middle-of-the-road" benchmark)* | 80*(1+30%) = 104 |
| With 40% increase in runway capacity after the third runway is built *(Wide-spaced configuration)* | 80*(1+40%) = 112 |

Table 8.11 Projected ultimate capacity of the airport (annual aircraft movements) under different scenarios

| | Ultimate capacity of the airport (movements) |
|---|---|
| With possible ATM and ATC enhancement measures implemented before the addition of third runway | (280387/54)*80 = 415,388 |
| With 20% increase in runway capacity after the third runway is built *(Closed-spaced configuration)* | (280387/54)*96 = 498,466 |
| With 30% increase in runway capacity after the third runway is built *("Middle-of-the-road" benchmark)* | (280387/54)*104 = 540,005 |
| With 40% increase in runway capacity after the third runway is built *(Wide-spaced configuration)* | (280387/54)*112 = 581,543 |

Note:

(i) 280,387 refers to the 2006 aircraft movements of Hong Kong International Airport

(ii) 54 refers to the present runway capacity

*Scenario 1: The addition of third runway to HKIA can increase the runway capacity by 20%*

Under the assumption of 3% annual growth in traffic, zero discount rate and the VA per flight (in 2005 HK$) is HK$0.1700 million (direct benefits), the third runway can contribute an addition of HK$1.5 billion (in 2005 HK$) in 2020 by handling an extra of 8,722 flights a year. In 2025, the extra contribution will be accumulated to HK$42.7 billion (in 2005 HK$).

If the annual traffic growth is increased to 7% with same assumptions, the third runway can contribute an addition of HK$4.9 billion (in 2005 HK$) in 2019 by handling an extra of 29,077 flights a year. In 2025, the extra contribution will be accumulated to HK$85.8 billion (in 2005 HK$).

Table 8.12 Hong Kong International Airport's Aircraft Movements Projection (Scenario 1)

| | **3% annual growth in traffic** | **5% annual growth in traffic** | **7% annual growth in traffic** |
|---|---|---|---|
| 2006 | 280,387 | 280,387 | 280,387 |
| 2007 | 288,799 | 294,406 | 300,014 |
| 2008 | 297,463 | 309,127 | 321,015 |
| 2009 | 306,386 | 324,583 | 343,486 |
| 2010 | 315,578 | 340,812 | 367,530 |
| 2011 | 325,045 | 357,853 | **393,257** |
| 2012 | 334,797 | 375,745 | **415,388** |
| 2013 | 344,841 | 394,533 | 415,388 |
| 2014 | 355,186 | **414,259** | 415,388 |
| 2015 | 365,841 | **415,388** | 415,388 |
| 2016 | 376,817 | 415,388 | 415,388 |
| 2017 | 388,121 | 415,388 | 415,388 |
| 2018 | 399,765 | 415,388 | 415,388 |
| 2019 | **411,758** | 436,157 | 444,465 |
| 2020 | **424,110** | 457,965 | 475,578 |
| 2021 | 436,834 | 480,864 | 498,466 |
| 2022 | 449,939 | 498,466 | 498,466 |
| 2023 | 463,437 | 498,466 | 498,466 |
| 2024 | 477,340 | 498,466 | 498,466 |
| 2025 | 491,660 | 498,466 | 498,466 |
| 2026 | 498,466 | 498,466 | 498,466 |

Table 8.13 Number of additional aircraft that can be handled in that particular year if the third runway is built (Scenario 1)

| | 3% annual growth in traffic | 5% annual growth in traffic | 7% annual growth in traffic |
|---|---|---|---|
| 2019 | - | 20,769 | 29,077 |
| 2020 | 8,722 | 42,577 | 60,190 |
| 2021 | 21,446 | 65,476 | 83,078 |
| 2022 | 34,551 | 83,078 | 83,078 |
| 2023 | 48,049 | 83,078 | 83,078 |
| 2024 | 61,952 | 83,078 | 83,078 |
| 2025 | 76,272 | 83,078 | 83,078 |
| 2026 | 83,078 | 83,078 | 83,078 |

Table 8.14 Accumulated value added brought in by the addition of third runway (in 2005 HK$ million with zero discount rate) (Scenario 1)

| | 3% annual growth in traffic | | | 5% annual growth in traffic | | | 7% annual growth in traffic | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Direct** | **Indirect** | **Total** | **Direct** | **Indirect** | **Total** | **Direct** | **Indirect** | **Total** |
| **2019** | | | | 3,532 | 5,800 | 9,332 | 4,944 | 8,120 | 13,065 |
| **2020** | 1,483 | 2,436 | 3,919 | 10,771 | 17,691 | 28,462 | 15,179 | 24,930 | 40,109 |
| **2021** | 5,130 | 8,425 | 13,555 | 21,905 | 35,976 | 57,881 | 29,305 | 48,131 | 77,436 |
| **2022** | 11,005 | 18,074 | 29,079 | 36,031 | 59,178 | 95,209 | 43,432 | 71,333 | 114,764 |
| **2023** | 19,175 | 31,493 | 50,668 | 50,158 | 82,379 | 132,537 | 57,558 | 94,534 | 152,092 |
| **2024** | 29,709 | 48,795 | 78,504 | 64,284 | 105,581 | 169,865 | 71,685 | 117,735 | 189,420 |
| **2025** | 42,678 | 70,095 | 112,774 | 78,411 | 128,782 | 207,193 | 85,811 | 140,937 | 226,748 |
| **2026** | 56,805 | 93,297 | 150,101 | 92,537 | 151,983 | 244,520 | 99,938 | 164,138 | 264,076 |

*Scenario 2: The addition of third runway to HKIA can increase the runway capacity by 30%*

Under the assumption of 3% annual growth in traffic, zero discount rate and the VA per flight (in 2005 HK$) is HK$0.1700 million (direct benefits), the third runway can contribute an addition of HK$1.5 billion (in 2005 HK$) in 2020 by handling an extra of 8,722 flights a year. In 2025, the extra contribution will be accumulated to HK$42.7 billion (in 2005 HK$).

If the annual traffic growth is increased to 7% with same assumptions, the third runway can contribute an addition of HK$4.9 billion (in 2005 HK$) in 2019 by handling an extra of 29,077 flights a year. In 2025, the extra contribution will be accumulated to HK$115.8 billion (in 2005 HK$).

Table 8.15 Hong Kong International Airport's Aircraft Movements Projection (Scenario 2)

| | **3% annual growth in traffic** | **5% annual growth in traffic** | **7% annual growth in traffic** |
|---|---|---|---|
| 2006 | 280,387 | 280,387 | 280,387 |
| 2007 | 288,799 | 294,406 | 300,014 |
| 2008 | 297,463 | 309,127 | 321,015 |
| 2009 | 306,386 | 324,583 | 343,486 |
| 2010 | 315,578 | 340,812 | 367,530 |
| 2011 | 325,045 | 357,853 | **393,257** |
| 2012 | 334,797 | 375,745 | **415,388** |
| 2013 | 344,841 | 394,533 | 415,388 |
| 2014 | 355,186 | **414,259** | 415,388 |
| 2015 | 365,841 | **415,388** | 415,388 |
| 2016 | 376,817 | 415,388 | 415,388 |
| 2017 | 388,121 | 415,388 | 415,388 |
| 2018 | 399,765 | 415,388 | 415,388 |
| 2019 | **411,758** | 436,157 | 444,465 |
| 2020 | **424,110** | 457,965 | 475,578 |
| 2021 | 436,834 | 480,864 | 508,868 |
| 2022 | 449,939 | 504,907 | 540,005 |
| 2023 | 463,437 | 530,152 | 540,005 |
| 2024 | 477,340 | 540,005 | 540,005 |
| 2025 | 491,660 | 540,005 | 540,005 |
| 2026 | 506,410 | 540,005 | 540,005 |
| 2027 | 521,602 | 540,005 | 540,005 |
| 2028 | 537,250 | 540,005 | 540,005 |
| 2029 | 540,005 | 540,005 | 540,005 |

Table 8.16 Number of additional aircraft that can be handled in that particular year if the third runway is built (Scenario 2)

| | **3% annual growth in traffic** | **5% annual growth in traffic** | **7% annual growth in traffic** |
|---|---|---|---|
| 2019 | - | 20,769 | 29,077 |
| 2020 | 8,722 | 42,577 | 60,190 |
| 2021 | 21,446 | 65,476 | 93,480 |
| 2022 | 34,551 | 89,519 | 124,617 |
| 2023 | 48,049 | 114,764 | 124,617 |
| 2024 | 61,952 | 124,617 | 124,617 |
| 2025 | 76,272 | 124,617 | 124,617 |
| 2026 | 91,022 | 124,617 | 124,617 |
| 2027 | 106,214 | 124,617 | 124,617 |
| 2028 | 121,862 | 124,617 | 124,617 |
| 2029 | 124,617 | 124,617 | 124,617 |

Table 8.17 Accumulated value added brought in by the addition of third runway (in 2005 HK$ million and zero discount rate) (Scenario 2)

| | 3% annual growth in traffic | | | 5% annual growth in traffic | | | 7% annual growth in traffic | | |
|---|---|---|---|---|---|---|---|---|---|
| | Direct | Indirect | Total | Direct | Indirect | Total | Direct | Indirect | Total |
| 2019 | | | | 3,532 | 5,800 | 9,332 | 4,944 | 8,120 | 13,065 |
| 2020 | 1,483 | 2,436 | 3,919 | 10,771 | 17,691 | 28,462 | 15,179 | 24,930 | 40,109 |
| 2021 | 5,130 | 8,425 | 13,555 | 21,905 | 35,976 | 57,881 | 31,074 | 51,036 | 82,110 |
| 2022 | 11,005 | 18,074 | 29,079 | 37,126 | 60,977 | 98,103 | 52,264 | 85,838 | 138,102 |
| 2023 | 19,175 | 31,493 | 50,668 | 56,641 | 93,027 | 149,668 | 73,453 | 120,640 | 194,094 |
| 2024 | 29,709 | 48,795 | 78,503 | 77,830 | 127,829 | 205,659 | 94,643 | 155,442 | 250,085 |
| 2025 | 42,678 | 70,095 | 112,774 | 99,020 | 162,631 | 261,651 | 115,833 | 190,244 | 306,077 |
| 2026 | 58,156 | 95,515 | 153,671 | 120,210 | 197,433 | 317,643 | 137,022 | 225,047 | 362,069 |
| 2027 | 76,216 | 125,178 | 201,394 | 141,399 | 232,235 | 373,635 | 158,212 | 259,849 | 418,061 |
| 2028 | 96,938 | 159,211 | 256,148 | 162,589 | 267,037 | 429,626 | 179,402 | 294,651 | 474,053 |
| 2029 | 118,127 | 194,013 | 312,140 | 183,779 | 301,839 | 485,618 | 200,592 | 329,453 | 530,044 |

*Scenario 3: The addition of third runway to HKIA can increase the runway capacity by 40%*

Under the assumption of 3% annual growth in traffic, zero discount rate and the VA per flight (in 2005 HK$) is HK$0.1700 million (direct benefits), the third runway can contribute an addition of HK$1.5 billion (in 2005 HK$) in 2020 by handling an extra of 8,722 flights a year. In 2025, the extra contribution will be accumulated to HK$42.7 billion (in 2005 HK$).

If the annual traffic growth is increased to 7% with same assumptions, the third runway can contribute an addition of HK$4.9 billion (in 2005 HK$) in 2019 by handling an extra of 29,077 flights a year. In 2025, the extra contribution will be accumulated to HK$137.8 billion (in 2005 HK$).

Table 8.18 Hong Kong International Airport's Aircraft Movements Projection (Scenario 3)

| | **3% annual growth in traffic** | **5% annual growth in traffic** | **7% annual growth in traffic** |
|---|---|---|---|
| 2006 | 280,387 | 280,387 | 280,387 |
| 2007 | 288,799 | 294,406 | 300,014 |
| 2008 | 297,463 | 309,127 | 321,015 |
| 2009 | 306,386 | 324,583 | 343,486 |
| 2010 | 315,578 | 340,812 | 367,530 |
| 2011 | 325,045 | 357,853 | **393,257** |
| 2012 | 334,797 | 375,745 | **415,388** |
| 2013 | 344,841 | 394,533 | 415,388 |
| 2014 | 355,186 | **414,259** | 415,388 |
| 2015 | 365,841 | **415,388** | 415,388 |
| 2016 | 376,817 | 415,388 | 415,388 |
| 2017 | 388,121 | 415,388 | 415,388 |
| 2018 | 399,765 | 415,388 | 415,388 |
| 2019 | **411,758** | 436,157 | 444,465 |
| 2020 | **424,110** | 457,965 | 475,578 |
| 2021 | 436,834 | 480,864 | 508,868 |
| 2022 | 449,939 | 504,907 | 544,489 |
| 2023 | 463,437 | 530,152 | 581,543 |
| 2024 | 477,340 | 556,660 | 581,543 |
| 2025 | 491,660 | 581,543 | 581,543 |
| 2026 | 506,410 | 581,543 | 581,543 |
| 2027 | 521,602 | 581,543 | 581,543 |
| 2028 | 537,250 | 581,543 | 581,543 |
| 2029 | 553,368 | 581,543 | 581,543 |
| 2030 | 569,969 | 581,543 | 581,543 |
| 2031 | 581,543 | 581,543 | 581,543 |

Table 8.19 Number of additional aircraft that can be handled in that particular year if the third runway is built (Scenario 3)

| | **3% annual growth in traffic** | **5% annual growth in traffic** | **7% annual growth in traffic** |
|---|---|---|---|
| 2019 | - | 20,769 | 29,077 |
| 2020 | 8,722 | 42,577 | 60,190 |
| 2021 | 21,446 | 65,476 | 93,480 |
| 2022 | 34,551 | 89,519 | 129,101 |
| 2023 | 48,049 | 114,764 | 166,155 |
| 2024 | 61,952 | 141,272 | 166,155 |
| 2025 | 76,272 | 166,155 | 166,155 |
| 2026 | 91,022 | 166,155 | 166,155 |
| 2027 | 106,214 | 166,155 | 166,155 |
| 2028 | 121,862 | 166,155 | 166,155 |
| 2029 | 137,980 | 166,155 | 166,155 |
| 2030 | 154,581 | 166,155 | 166,155 |
| 2031 | 166,155 | 166,155 | 166,155 |

Table 8.20 Accumulated value added brought in by the addition of third runway (in 2005 HK$ million and zero discount rate) (Scenario 3)

| | 3% annual growth in traffic | | | 5% annual growth in traffic | | | 7% annual growth in traffic | | |
|---|---|---|---|---|---|---|---|---|---|
| | Direct | Indirect | Total | Direct | Indirect | Total | Direct | Indirect | Total |
| 2019 | | | | 3,532 | 5,800 | 9,332 | 4,944 | 8,120 | 13,065 |
| 2020 | 1,483 | 2,436 | 3,919 | 10,771 | 17,691 | 28,462 | 15,179 | 24,930 | 40,108 |
| 2021 | 5,130 | 8,425 | 13,555 | 21,905 | 35,976 | 57,881 | 31,074 | 51,036 | 82,110 |
| 2022 | 11,005 | 18,074 | 29,079 | 37,126 | 60,977 | 98,103 | 53,026 | 87,090 | 140,117 |
| 2023 | 19,175 | 31,493 | 50,668 | 56,641 | 93,027 | 149,668 | 81,279 | 133,493 | 214,772 |
| 2024 | 29,709 | 48,795 | 78,504 | 80,662 | 132,480 | 213,143 | 109,532 | 179,895 | 289,427 |
| 2025 | 42,678 | 70,095 | 112,774 | 108,915 | 178,883 | 287,798 | 137,784 | 226,298 | 364,082 |
| 2026 | 58,156 | 95,515 | 153,671 | 137,168 | 225,285 | 362,453 | 166,037 | 272,700 | 438,738 |
| 2027 | 76,216 | 125,178 | 201,394 | 165,421 | 271,688 | 437,108 | 194,290 | 319,103 | 513,393 |
| 2028 | 96,938 | 159,211 | 256,148 | 193,673 | 318,090 | 511,763 | 222,543 | 365,505 | 588,048 |
| 2029 | 120,399 | 197,745 | 318,144 | 221,926 | 364,493 | 586,419 | 250,795 | 411,908 | 662,703 |
| 2030 | 146,684 | 240,915 | 387,599 | 250,179 | 410,895 | 661,074 | 279,048 | 458,310 | 737,358 |
| 2031 | 174,937 | 287,317 | 462,254 | 278,432 | 457,298 | 735,729 | 307,301 | 504,713 | 812,014 |

In conclusion, although these are just some approximations under restrictive assumptions on economic and market environments, it did provide us some ideas how the third runway would impact the local economy. As the gateways to an increasingly global market, airports are the arteries through which commerce flows and economic growth is stimulated. Airports stimulate trillions of dollars in all the industries or communities which build, maintain and operate them. It is important for us to provide adequate facilities to foster future growth in air logistics and air travel, which makes runway an essential part of the airport infrastructures to facilitating the free flow of capital and goods, and enhances the choices of consumers.

## 8.3 Economic Evaluation of Environmental Impact

The increase of flights enables the aviation sector to contribute more to Hong Kong economy. However, its impact on the environment increases also. The burning of aviation fuel emits carbon dioxide ($CO_2$) and nitrogen oxide ($NO_X$). Both of these are estimated to contribute to global warming and climate change (Oxford Economic Forecasting, 2006). Besides, the increased flights will also produce extra noise to the environment. In the following sections, we'll estimate the impact of the increased flights on the environmental side by mainly using the information provided in *Standard Inputs for EUROCONTROL Cost Benefit Analyses 2007 edition* of EUROCONTROL[3]. This estimation can only provide a preliminary reference for the environmental impact of the added flights since the figures need to be adjusted under different situations such as the amount of fuel carried by the aircraft, age of the aircraft and occupancy rate of the aircraft, etc. Furthermore, as the data is extracted from a European study, figures may need to be adjusted also as the social, environmental, and economic conditions between Europe and Hong Kong can be different.

[3] This document can be downloaded from http://www.eurocontrol.int/ecosoc/public/standard_page/cba.html

### 8.3.1 Costs of Pollutants

There are many types of aircraft flying into and out of HKIA, with A330 (15.3%), B747-400 (14.5%) and A320 (13.5%) being the three main aircraft types. Due to data limitation, we can only estimate the cost of pollution caused by about 77% of the 2006 aircraft movements and the types of aircraft involved is bolded in Table 8.21. Using the percentage distribution of the types of aircraft of incoming scheduled passenger flights per weeks that provided by the Hong Kong Tourism Board, we break down the 2006 aircraft movements provided by the Civil Aviation Department into different types of aircraft also, and the result is given in Table 8.21.

Table 8.21 Aircraft Movements Analyzed by Aircraft Type

| Aircraft Type | Number of Incoming Scheduled Passenger Flights per Weeks in 2006 | % distribution of aircraft type per Week | Estimated Number of Aircraft Movements in Hong Kong in 2006[4] |
|---|---|---|---|
| A300-600 | 9 | 0.4 | 1,115 |
| **A310** | **19** | **0.8** | **2,353** |
| **A319** | **45** | **2.0** | **5,573** |
| A320-200 | 7 | 0.3 | 867 |
| **A320** | **306** | **13.5** | **37,897** |
| **A321** | **94** | **4.2** | **11,642** |
| **A330-200** | **38** | **1.7** | **4,706** |
| **A330-300** | **195** | **8.6** | **24,150** |
| A330 | 347 | 15.3 | 42,975 |
| **A340-300** | **118** | **5.2** | **14,614** |
| **A340-500** | **7** | **0.3** | **867** |
| **A340-600** | **36** | **1.6** | **4,458** |
| A340 | 10 | 0.4 | 1,238 |
| B717-200 | 5 | 0.2 | 619 |
| **B737-200** | **11** | **0.5** | **1,362** |
| **B737-300** | **73** | **3.2** | **9,041** |
| **B737-400** | **7** | **0.3** | **867** |
| **B737-800** | **113** | **5.0** | **13,995** |
| B737 | 9 | 0.4 | 1,115 |
| **B747-300** | **12** | **0.5** | **1,486** |
| **B747-400** | **328** | **14.5** | **40,621** |
| B747-400M | 32 | 1.4 | 3,963 |
| B747 | 49 | 2.2 | 6,068 |
| **B757-200** | **14** | **0.6** | **1,734** |
| B757 | 3 | 0.1 | 372 |
| **B767-300** | **56** | **2.5** | **6,935** |
| **B777-200** | **121** | **5.3** | **14,985** |
| **B777-300** | **124** | **5.5** | **15,357** |
| **DC10** | **2** | **0.1** | **248** |
| EMB 145LI | 2 | 0.1 | 248 |
| Embraer 170 | 41 | 1.8 | 5,078 |
| **MD11** | **3** | **0.1** | **372** |
| MD82 | 7 | 0.3 | 867 |
| **MD90** | **21** | **0.9** | **2,601** |
| **Total** | **2,264** | **100.0** | **280,387** |

*Source: A Statistical Review of Hong Kong Tourism 2006; Homepage of Civil Aviation Department*

Table 8.22 shows the Landing and Take-off Cycle (LTO) emission factors of carbon dioxide and nitrogen oxide of different types of aircraft. Among all the recorded

[4] The number is estimated by applying the percentage distribution of aircraft type per week to the total aircraft movements of Hong Kong in 2006.

aircrafts, 747-300 has the largest LTO emission factors of carbon dioxide (11,080 kg/LTO) and nitrogen oxide (65.00 kg/LTO) while A319 has the smallest LTO emission factors of carbon dioxide (2,310 kg/LTO) and 737-100/200 has the smallest LTO emission factors of nitrogen oxide (6.74 kg/LTO)

Table 8.22 Landing and Take-off Cycle (LTO) Emission Factors for Different Aircraft

| | $CO_2$ (kg/LTO) | $NO_X$ (kg/LTO) |
|---|---|---|
| A300 | 5,450 | 25.86 |
| A310 | 4,760 | 19.46 |
| A319 | 2,310 | 8.73 |
| A320 | 2,440 | 9.01 |
| A321 | 3,020 | 16.72 |
| A330-200/300 | 7,050 | 35.57 |
| A340-200 | 5,890 | 28.31 |
| A340-300 | 6,380 | 34.81 |
| A340-500/600 | 10,660 | 64.45 |
| 707 | 5,890 | 10.96 |
| 717 | 2,140 | 6.68 |
| 727-100 | 3,970 | 9.23 |
| 727-200 | 4,610 | 11.97 |
| 737-100/200 | 2,740 | 6.74 |
| 737-300/400/500 | 2,480 | 7.19 |
| 737-600 | 2,280 | 7.66 |
| 737-700 | 2,460 | 9.12 |
| 737-800/900 | 2,780 | 12.30 |
| 747-100 | 10,140 | 49.17 |
| 747-200 | 11,370 | 49.52 |
| 747-300 | 11,080 | 65.00 |
| 747-400 | 10,240 | 42.88 |
| 757-200 | 4,320 | 23.43 |
| 757-300 | 4,630 | 17.85 |
| 767-200 | 4,620 | 23.76 |
| 767-300 | 5,610 | 28.19 |
| 767-400 | 5,520 | 24.80 |
| 777-200/300 | 8,100 | 52.81 |
| DC-10 | 7,290 | 35.65 |
| DC-8-50/60/70 | 5,360 | 15.62 |
| DC-9 | 2,650 | 6.16 |
| L-1011 | 7,300 | 31.64 |
| MD11 | 7,290 | 35.65 |
| MD90 | 2,760 | 10.76 |

*Source: 2006 IPCC Guidelines for National Greenhouse Gas Inventories*

In table 8.23, costs of carbon dioxide and nitrogen oxide is shown. The cost of carbon dioxide ranges between €11 and €55 per 1000 kg and the cost of nitrogen oxide ranges between €1.4 and €6.6 per kg. Accordingly, we are able to compute the estimated costs of pollutants of each type of aircraft as reported in table 8.24. Using the above, the total cost of pollutants of the 77% aircraft movements in 2006 is estimated to range between €23,478,865 and €114,798,950 (all monetary figures in this section are given in 2001 € price) (see Table 8.25).

Table 8.23 Cost of Pollutants in 2001

| | Low | Medium | High |
|---|---|---|---|
| $CO_2$ (per 1000 kg) | €11.0 | €33.1 | €55.0 |
| $NO_X$ (per kg) | €1.4 | €4.0 | €6.6 |

Source: "Economic incentives to control the global environmental impact of European aviation / Level of the incentive", CE, Solutions for environment, economy and technology, Delft, The Netherlands. Draft preliminary study, 2 May 2001 (extracted from *Standard Inputs for EUROCONTROL Cost Benefit Analyses 2007 edition*)

Table 8.24 Costs of Pollutants Imposed by Different Types of Aircraft to Environment

| | $CO_2$ (in €) | | | $NO_X$ (in €) | | | Total (in €) | | |
|---|---|---|---|---|---|---|---|---|---|
| Type of aircraft | Low | Medium | High | Low | Medium | High | Low | Medium | High |
| A310 | 52.4 | 157.6 | 261.8 | 27.2 | 77.8 | 128.4 | 79.6 | 235.4 | 390.2 |
| A319 | 25.4 | 76.5 | 127.1 | 12.2 | 34.9 | 57.6 | 37.6 | 111.4 | 184.7 |
| A320 | 26.8 | 80.8 | 134.2 | 12.6 | 36.0 | 59.5 | 39.5 | 116.8 | 193.7 |
| A321 | 33.2 | 100.0 | 166.1 | 23.4 | 66.9 | 110.4 | 56.6 | 166.8 | 276.5 |
| A330-200 | 77.6 | 233.4 | 387.8 | 49.8 | 142.3 | 234.8 | 127.3 | 375.6 | 622.5 |
| A330-300 | 77.6 | 233.4 | 387.8 | 49.8 | 142.3 | 234.8 | 127.3 | 375.6 | 622.5 |
| A340-300 | 70.2 | 211.2 | 350.9 | 48.7 | 139.2 | 229.7 | 118.9 | 350.4 | 580.6 |
| A340-500 | 117.3 | 352.8 | 586.3 | 90.2 | 257.8 | 425.4 | 207.5 | 610.6 | 1011.7 |
| A340-600 | 117.3 | 352.8 | 586.3 | 90.2 | 257.8 | 425.4 | 207.5 | 610.6 | 1011.7 |
| B737-200 | 30.1 | 90.7 | 150.7 | 9.4 | 27.0 | 44.5 | 39.6 | 117.7 | 195.2 |
| B737-300 | 27.3 | 82.1 | 136.4 | 10.1 | 28.8 | 47.5 | 37.3 | 110.8 | 183.9 |
| B737-400 | 27.3 | 82.1 | 136.4 | 10.1 | 28.8 | 47.5 | 37.3 | 110.8 | 183.9 |
| B737-800 | 30.6 | 92.0 | 152.9 | 17.2 | 49.2 | 81.2 | 47.8 | 141.2 | 234.1 |
| B747-300 | 121.9 | 366.7 | 609.4 | 91.0 | 260.0 | 429.0 | 212.9 | 626.7 | 1038.4 |
| B747-400 | 112.6 | 338.9 | 563.2 | 60.0 | 171.5 | 283.0 | 172.7 | 510.5 | 846.2 |
| B757-200 | 47.5 | 143.0 | 237.6 | 32.8 | 93.7 | 154.6 | 80.3 | 236.7 | 392.2 |
| B767-300 | 61.7 | 185.7 | 308.6 | 39.5 | 112.8 | 186.1 | 101.2 | 298.5 | 494.6 |
| B777-200 | 89.1 | 268.1 | 445.5 | 73.9 | 211.2 | 348.5 | 163.0 | 479.4 | 794.0 |
| B777-300 | 89.1 | 268.1 | 445.5 | 73.9 | 211.2 | 348.5 | 163.0 | 479.4 | 794.0 |
| DC10 | 80.2 | 241.3 | 401.0 | 49.9 | 142.6 | 235.3 | 130.1 | 383.9 | 636.2 |
| MD11 | 80.2 | 241.3 | 401.0 | 49.9 | 142.6 | 235.3 | 130.1 | 383.9 | 636.2 |
| MD90 | 30.4 | 91.4 | 151.8 | 15.1 | 43.0 | 71.0 | 45.4 | 134.4 | 222.8 |

Table 8.25 Total Cost of Pollutants Imposed by Selected Aircrafts in 2006 in Hong Kong (in 2001 € price)

| Type of aircraft | Low | Medium | High |
|---|---|---|---|
| A310 | 187,314 | 553,904 | 918,253 |
| A319 | 209,726 | 620,733 | 1,029,166 |
| A320 | 1,495,182 | 4,426,501 | 7,339,327 |
| A321 | 659,235 | 1,942,293 | 3,218,319 |
| A330-200 | 599,318 | 1,767,792 | 2,929,630 |
| A330-300 | 3,075,447 | 9,071,563 | 15,033,628 |
| A340-300 | 1,737,787 | 5,120,942 | 8,485,450 |
| A340-500 | 179,877 | 529,382 | 877,038 |
| A340-600 | 925,084 | 2,722,535 | 4,510,481 |
| B737-200 | 53,915 | 160,281 | 265,900 |
| B737-300 | 337,636 | 1,002,149 | 1,662,177 |
| B737-400 | 32,376 | 96,096 | 159,387 |
| B737-800 | 668,941 | 1,976,287 | 3,275,851 |
| B747-300 | 316,372 | 931,442 | 1,543,218 |
| B747-400 | 7,014,185 | 20,735,782 | 34,374,186 |
| B757-200 | 139,266 | 410,421 | 680,079 |
| B767-300 | 701,693 | 2,069,867 | 3,430,261 |
| B777-200 | 2,443,121 | 7,183,226 | 11,899,055 |
| B777-300 | 2,503,694 | 7,361,323 | 12,194,073 |
| DC10 | 32,225 | 95,089 | 157,591 |
| MD11 | 48,337 | 142,633 | 236,387 |
| MD90 | 118,137 | 349,532 | 579,492 |
| **Total** | **23,478,865** | **69,269,772** | **114,798,950** |

We will provide approximations on the amount of environmental costs caused by capacity expansion in three scenarios.

*Scenario 1: The addition of third runway to HKIA can increase the runway capacity by 20%*

In scenario 1, assuming the composition of types of aircraft in 2020 remains unchanged, the estimated total pollutants cost p.a. by the additional aircrafts (include selected type of aircrafts only) will range between €730,357 and €3,571,052; between €5,304,426 and €25,935,775; and between €7,474,982 and €36,548,617 under the assumption of 3%, 5% and 7% of annual traffic growth respectively. In 2025, take the 5% annual traffic growth and the medium cost with zero discount rate as reference, the cost of pollutants will be accumulated to €113,923,426 (c.f. €15,649,666 in 2020) (Table 8.27).

Table 8.26 Additional amount of carbon dioxide and nitrogen oxide emitted by the extra flights in that particular year if the third runway is built (include 77% of total flights only) (scenario 1)

| | **3% annual growth in traffic** | | **5% annual growth in traffic** | | **7% annual growth in traffic** | |
|---|---|---|---|---|---|---|
| | $CO_2$ | $NO_X$ | $CO_2$ | $NO_X$ | $CO_2$ | $NO_X$ |
| 2019 | | | 96,934,445 | 480,616 | 135,710,091 | 672,871 |
| 2020 | 40,707,893 | 201,836 | 198,718,180 | 985,275 | 280,922,735 | 1,392,858 |
| 2021 | 100,094,185 | 496,282 | 305,593,902 | 1,515,181 | 387,747,117 | 1,922,510 |
| 2022 | 161,258,704 | 799,545 | 387,747,117 | 1,922,510 | 387,747,117 | 1,922,510 |
| 2023 | 224,257,459 | 1,111,903 | 387,747,117 | 1,922,510 | 387,747,117 | 1,922,510 |
| 2024 | 289,146,457 | 1,433,632 | 387,747,117 | 1,922,510 | 387,747,117 | 1,922,510 |
| 2025 | 355,981,705 | 1,765,012 | 387,747,117 | 1,922,510 | 387,747,117 | 1,922,510 |
| 2026 | 387,747,117 | 1,922,510 | 387,747,117 | 1,922,510 | 387,747,117 | 1,922,510 |

Table 8.27 Accumulated cost of pollutants in 2001 € price with zero discount rate (include 77% of total flights only) (scenario 1)

| | **3% annual growth in traffic** | | | **5% annual growth in traffic** | | | **7% annual growth in traffic** | | |
|---|---|---|---|---|---|---|---|---|---|
| | Low | Medium | High | Low | Medium | High | Low | Medium | High |
| 2019 | | | | 1,739,141 | 5,130,994 | 8,503,460 | 2,434,830 | 7,183,488 | 11,905,004 |
| 2020 | 730,357 | 2,154,775 | 3,571,052 | 5,304,426 | 15,649,666 | 25,935,775 | 7,474,982 | 22,053,463 | 36,548,617 |
| 2021 | 2,526,188 | 7,453,021 | 12,351,693 | 10,787,213 | 31,825,548 | 52,743,634 | 14,431,714 | 42,577,932 | 70,563,274 |
| 2022 | 5,419,397 | 15,988,864 | 26,497,919 | 17,743,945 | 52,350,018 | 86,758,292 | 21,388,446 | 63,102,402 | 104,577,932 |
| 2023 | 9,442,893 | 27,859,398 | 46,170,639 | 24,700,677 | 72,874,487 | 120,772,949 | 28,345,179 | 83,626,871 | 138,592,589 |
| 2024 | 14,630,589 | 43,164,674 | 71,535,665 | 31,657,409 | 93,398,957 | 154,787,606 | 35,301,911 | 104,151,341 | 172,607,247 |
| 2025 | 21,017,404 | 62,007,716 | 102,763,738 | 38,614,142 | 113,923,426 | 188,802,264 | 42,258,643 | 124,675,810 | 206,621,904 |
| 2026 | 27,974,137 | 82,532,186 | 136,778,396 | 45,570,874 | 134,447,896 | 222,816,921 | 49,215,375 | 145,200,280 | 240,636,561 |

*Scenario 2: The addition of third runway to HKIA can increase the runway capacity by 30%*

In scenario 2, assuming the composition of types of aircraft in 2020 remains unchanged, the estimated total pollutants cost p.a. by the additional aircrafts (include selected type of aircrafts only) will range between €730,357 and €3,571,052; between €5,304,426 and €25,935,775; and between €7,474,982 and €36,548,617 under the assumption of 3%, 5% and 7% of annual traffic growth respectively. In 2025, take the 5% annual traffic growth and the medium cost with zero discount rate as reference, the cost of pollutants will be accumulated to €143,867,191 (c.f. €15,649,666 in 2020) (Table 8.29).

Table 8.28 Additional amount of carbon dioxide and nitrogen oxide emitted by the extra flights in that particular year if the third runway is built (include 77% of total flights only) (Scenario 2)

| | **3% annual growth in traffic** | | **5% annual growth in traffic** | | **7% annual growth in traffic** | |
|---|---|---|---|---|---|---|
| | $CO_2$ | $NO_X$ | $CO_2$ | $NO_X$ | $CO_2$ | $NO_X$ |
| 2019 | | | 96,934,445 | 480,616 | 135,710,091 | 672,871 |
| 2020 | 40,707,893 | 201,836 | 198,718,180 | 985,275 | 280,922,735 | 1,392,858 |
| 2021 | 100,094,185 | 496,282 | 305,593,902 | 1,515,181 | 436,296,016 | 2,163,223 |
| 2022 | 161,258,704 | 799,545 | 417,808,976 | 2,071,561 | 581,620,675 | 2,883,765 |
| 2023 | 224,257,459 | 1,111,903 | 535,634,104 | 2,655,756 | 581,620,675 | 2,883,765 |
| 2024 | 289,146,457 | 1,433,632 | 581,620,675 | 2,883,765 | 581,620,675 | 2,883,765 |
| 2025 | 355,981,705 | 1,765,012 | 581,620,675 | 2,883,765 | 581,620,675 | 2,883,765 |
| 2026 | 424,823,877 | 2,106,342 | 581,620,675 | 2,883,765 | 581,620,675 | 2,883,765 |
| 2027 | 495,728,980 | 2,457,900 | 581,620,675 | 2,883,765 | 581,620,675 | 2,883,765 |
| 2028 | 568,762,357 | 2,820,011 | 581,620,675 | 2,883,765 | 581,620,675 | 2,883,765 |
| 2029 | 581,620,675 | 2,883,765 | 581,620,675 | 2,883,765 | 581,620,675 | 2,883,765 |

Table 8.29 Accumulated cost of pollutants in 2001 € price with zero discount rate (include 77% of total flights only) (scenario 2)

| | **3% annual growth in traffic** | | | **5% annual growth in traffic** | | | **7% annual growth in traffic** | | |
|---|---|---|---|---|---|---|---|---|---|
| | Low | Medium | High | Low | Medium | High | Low | Medium | High |
| 2019 | | | | 1,739,141 | 5,130,994 | 8,503,460 | 2,434,830 | 7,183,488 | 11,905,004 |
| 2020 | 730,357 | 2,154,775 | 3,571,052 | 5,304,426 | 15,649,666 | 25,935,775 | 7,474,982 | 22,053,463 | 36,548,617 |
| 2021 | 2,526,188 | 7,453,021 | 12,351,693 | 10,787,213 | 31,825,548 | 52,743,634 | 15,302,750 | 45,147,753 | 74,822,170 |
| 2022 | 5,419,397 | 15,988,864 | 26,497,919 | 18,283,297 | 53,941,269 | 89,395,430 | 25,737,848 | 75,934,457 | 125,844,156 |
| 2023 | 9,442,893 | 27,859,398 | 46,170,639 | 27,893,330 | 82,293,782 | 136,383,296 | 36,172,947 | 106,721,161 | 176,866,142 |
| 2024 | 14,630,589 | 43,164,674 | 71,535,665 | 38,328,429 | 113,080,486 | 187,405,282 | 46,608,045 | 137,507,866 | 227,888,128 |
| 2025 | 21,017,404 | 62,007,716 | 102,763,738 | 48,763,527 | 143,867,191 | 238,427,268 | 57,043,144 | 168,294,570 | 278,910,114 |
| 2026 | 28,639,346 | 84,494,754 | 140,030,909 | 59,198,626 | 174,653,895 | 289,449,254 | 67,478,242 | 199,081,274 | 329,932,100 |
| 2027 | 37,533,425 | 110,734,984 | 183,518,143 | 69,633,724 | 205,440,599 | 340,471,240 | 77,913,341 | 229,867,979 | 380,954,086 |
| 2028 | 47,737,826 | 140,841,062 | 233,412,145 | 80,068,822 | 236,227,304 | 391,493,226 | 88,348,439 | 260,654,683 | 431,976,072 |
| 2029 | 58,172,924 | 171,627,766 | 284,434,131 | 90,503,921 | 267,014,008 | 442,515,213 | 98,783,537 | 291,441,387 | 482,998,059 |

*Scenario 3: The addition of third runway to HKIA can increase the runway capacity by 40%*

In scenario 3, assuming the composition of types of aircraft in 2020 remains unchanged, the estimated total pollutants cost p.a. by the additional aircrafts (include selected type of aircrafts only) will range between €730,357 and €3,571,052; between €5,304,426 and €25,935,775; and between €7,474,982 and €36,548,617 under the assumption of 3%, 5% and 7% of annual traffic growth respectively. In 2025, take the 5% annual traffic growth and the medium cost with zero discount rate as reference, the cost of pollutants will be accumulated to €158,243,800 (c.f. €15,649,666 in 2020) (Table 8.31).

Table 8.30 Additional amount of carbon dioxide and nitrogen oxide emitted by the extra flights in that particular year if the third runway is built (include 77% of total flights only) (Scenario 3)

| | **3% annual growth in traffic** | | **5% annual growth in traffic** | | **7% annual growth in traffic** | |
|---|---|---|---|---|---|---|
| | $CO_2$ | $NO_X$ | $CO_2$ | $NO_X$ | $CO_2$ | $NO_X$ |
| 2019 | | | 96,934,445 | 480,616 | 135,710,091 | 672,871 |
| 2020 | 40,707,893 | 201,836 | 198,718,180 | 985,275 | 280,922,735 | 1,392,858 |
| 2021 | 100,094,185 | 496,282 | 305,593,902 | 1,515,181 | 436,296,016 | 2,163,223 |
| 2022 | 161,258,704 | 799,545 | 417,808,976 | 2,071,561 | 602,548,695 | 2,987,529 |
| 2023 | 224,257,459 | 1,111,903 | 535,634,104 | 2,655,756 | 775,489,566 | 3,844,996 |
| 2024 | 289,146,457 | 1,433,632 | 659,353,988 | 3,269,178 | 775,489,566 | 3,844,996 |
| 2025 | 355,981,705 | 1,765,012 | 775,489,566 | 3,844,996 | 775,489,566 | 3,844,996 |
| 2026 | 424,823,877 | 2,106,342 | 775,489,566 | 3,844,996 | 775,489,566 | 3,844,996 |
| 2027 | 495,728,980 | 2,457,900 | 775,489,566 | 3,844,996 | 775,489,566 | 3,844,996 |
| 2028 | 568,762,357 | 2,820,011 | 775,489,566 | 3,844,996 | 775,489,566 | 3,844,996 |
| 2029 | 643,989,349 | 3,192,998 | 775,489,566 | 3,844,996 | 775,489,566 | 3,844,996 |
| 2030 | 721,470,630 | 3,577,162 | 775,489,566 | 3,844,996 | 775,489,566 | 3,844,996 |
| 2031 | 775,489,566 | 3,844,996 | 775,489,566 | 3,844,996 | 775,489,566 | 3,844,996 |

Table 8.31 Accumulated cost of pollutants in 2001 € price with zero discount rate (include 77% of total flights only) (scenario 3)

| | **3% annual growth in traffic** | | | **5% annual growth in traffic** | | | **7% annual growth in traffic** | | |
|---|---|---|---|---|---|---|---|---|---|
| | Low | Medium | High | Low | Medium | High | Low | Medium | High |
| 2019 | | | | 1,739,141 | 5,130,994 | 8,503,460 | 2,434,830 | 7,183,488 | 11,905,004 |
| 2020 | 730,357 | 2,154,775 | 3,571,052 | 5,304,426 | 15,649,666 | 25,935,775 | 7,474,982 | 22,053,463 | 36,548,617 |
| 2021 | 2,526,188 | 7,453,021 | 12,351,693 | 10,787,213 | 31,825,548 | 52,743,634 | 15,302,750 | 45,147,753 | 74,822,170 |
| 2022 | 5,419,397 | 15,988,864 | 26,497,919 | 18,283,297 | 53,941,269 | 89,395,430 | 26,113,326 | 77,042,230 | 127,680,039 |
| 2023 | 9,442,893 | 27,859,398 | 46,170,639 | 27,893,330 | 82,293,782 | 136,383,296 | 40,026,706 | 118,090,919 | 195,708,939 |
| 2024 | 14,630,589 | 43,164,674 | 71,535,665 | 39,723,073 | 117,195,111 | 194,224,340 | 53,940,086 | 159,139,608 | 263,737,839 |
| 2025 | 21,017,404 | 62,007,716 | 102,763,738 | 53,636,453 | 158,243,800 | 262,253,240 | 67,853,465 | 200,188,296 | 331,766,738 |
| 2026 | 28,639,346 | 84,494,754 | 140,030,909 | 67,549,833 | 199,292,488 | 330,282,139 | 81,766,845 | 241,236,985 | 399,795,638 |
| 2027 | 37,533,425 | 110,734,984 | 183,518,143 | 81,463,212 | 240,341,177 | 398,311,039 | 95,680,224 | 282,285,674 | 467,824,538 |
| 2028 | 47,737,826 | 140,841,062 | 233,412,145 | 95,376,592 | 281,389,866 | 466,339,939 | 109,593,604 | 323,334,362 | 535,853,438 |
| 2029 | 59,291,906 | 174,929,101 | 289,905,346 | 109,289,971 | 322,438,554 | 534,368,839 | 123,506,984 | 364,383,051 | 603,882,337 |
| 2030 | 72,236,110 | 213,118,427 | 353,195,500 | 123,203,351 | 363,487,243 | 602,397,738 | 137,420,363 | 405,431,740 | 671,911,237 |
| 2031 | 86,149,489 | 254,167,115 | 421,224,399 | 137,116,731 | 404,535,931 | 670,426,638 | 151,333,743 | 446,480,428 | 739,940,137 |

### 8.3.2 Costs of Noise

By using *Valuing the External Costs of Aviation* of DETR, it is estimated that the noise costs (during landing or take-off) by each A310, A340, B737-400, 747-400 and B767-300 will be €63, €142, €63, €311 and €100 respectively. However, these figures should be used in caution as the figures are estimated by measuring householders' willingness to pay to reduce noise through house purchase prices. As suggested in *Standard Inputs for EUROCONTROL Cost Benefit Analyses 2007 edition*, the figures should be UK specific.

### 8.3.3 Congestion

If the capacity of the HKIA cannot cope with the growth of the demand, congestion will occur. Congestion not only imposes costs on both airlines and passengers, it also imposes costs to business, society and also environment.

Under congestion, aircraft may need to queue up in the air to wait for an available slot on the ground. During this period, airline has to pay for the extra fuel used. Besides, more air pollutants will be emitted from the burning of extra aviation fuel. Furthermore, if the congestion is serious, serious delay will make the airline to pay for the extra working hour to the staff, to re-arrange flight schedule and compensate for the loss of passengers, etc.

On the other hand, passengers may miss the connected flight and have to stay extra hours in the airport. For those business passengers, the loss may be even higher than average as the time cost is usually valued by using average earnings (Oxford Economic Forecasting, 2006). Furthermore, congestion will affect the reputation and the business opportunities of an airport. Congestion may induce passengers to consider using other nearby airports or alternate modes of transportation, and as a result, the number of flights to Hong Kong will reduce.

In order to estimate the congestion cost of airport, data on extra fuel used during congestion, airlines' extra costs to solve the problem raised by congestion, average delay of flights, proportion of business passengers and non-business passengers and the time value of each type of passengers, etc. will be needed. A complexity in projecting the congestion cost corresponding to the addition of the third runway will be in the non-linear behaviour of such delays as a function of the interplay between traffic growth and the capacity of the airport, which this report will not attempt to address.

## 8.4 Conclusion

Although the increase in HKIA's capacity allows the aviation sector to contribute more to Hong Kong economy, its potential negative impact to Hong Kong's environment should also be recognized. The effect of this impact may be more than the above mentioned issues which addressed only the environmental loss locally. Environmental impact and effects on neighbouring economies, and other issues such as noise pollution cost, and delay costs as mentioned above may also be important considerations. It should also be noted that the estimated 2020 pollution cost of €15,649,666, or HK$0.16 billion using 5% traffic growth rate, medium pollution cost, and an average runway capacity increase of 30 % (a "middle-of-the-road" benchmark), only covers 77% of the flights in Hong Kong. One can, under the assumption that the remaining 23% of flights generate similar levels of the various types of pollution, pro-rata the above amount to approximately HK$0.203 billion as the pollution cost. This, figure, as compared to the economic contribution to Hong Kong estimated in the previous section, again for the 30% runway capacity increase scenario, of HK$28.5 billion, can be considered to be "negligible" in numeric terms. Even when one considers the additional costs tagged on by considering noise pollution and delay costs, in view of the fact that the newer aircraft engines generate significantly less noise and pollutants, it is most likely that the cost of pollution and delay will be rather insignificant as compared to the economic values generated by the additional flights as a consequence of the additional runway, however configured. At third runway full capacity, the economic contribution of the runway and the costs of pollutants brought will be HK$56 billion p.a. and HK$0.4 billion p.a. respectively (under "middle-of-the-road" benchmark).

# Chapter 9 Conclusions and Policy Recommendations

The capacity of an airport is a very complex variable affected by a myriad of factors, from the more "controllable factors" such as infrastructures on the landside and the airside, and the kinds of technology, manpower, systems, and procedures adopted; to the "less-controllable factors" such as airspace and terrain surrounding an airport, the types of aircraft using the airport, and weather. Most of these factors are inter-related to some extent, which makes detail analysis in support of determining the capacity of an airport extremely complex. It is amid such limitations that we have attempted to take a preliminary look at this important and timely topic of the need for a third runway for Hong Kong. Thus, much of the estimations and computations can at best be looked upon as an attempt to place some rough indication or boundaries on the issues being considered. However, we do believe that the resulting analysis does provide some useful indication on the enormous need and economic benefits of expanded capacities at HKIA, the great urgency of the matter, and possible areas that needs attention in order to address our aviation capacity issue adequately.

In the following paragraphs, we summarize the key findings and recommendations for Hong Kong in addressing our need for expanded capacity through the construction of a third runway.

(1) Hong Kong clearly has a capacity problem, with congestion problems already being felt at current capacity of 54 movements/hour despite having two wide-spaced parallel runways. Relevant authorities should carefully assess what policies and measures could be implemented to enhance the current airport capacity, including the resolution of the PRD airspace problem and the "invisible-wall" limiting Hong Kong's flight paths and affecting our ATC flexibilities and our ultimate capacity. A detailed capacity assessment will be needed urgently and all major stakeholders in Hong Kong and China should be involved in finding the best solution.

(2) Assuming all these possible ATM and ATC enhancement measures would have been implemented, it is estimated that the current parallel runways of HKIA

could achieve an ultimate capacity of 80 movements per hour (from the current 54). According to HKIA's more conservative forecast of traffic demand growth of 3% annually, the ultimate capacity of 80 movements could be reached by 2019/20. However, if we assume a 5% or 7% growth rate , HKIA would reach its capacity by 2014/15 and 2011/12 respectively instead.

(3) Under the current political and social environment in Hong Kong, it could take 12 years to build a new runway, from the initial planning and design, through public consultation, construction, to completion. We will barely have the third runway ready before our capacity is to run out should we accept the "optimistic" estimation of a 3% growth rate in demand. Using the rates forecasted by most other institutions as provided in (2) above, we are already 3 to 6 years late in starting the initial planning and design stage. The need to immediately expedite the initial study and planning for the third runway is extremely urgent.

(4) By using the latest official statistics, we estimated that one additional flight would bring an economic contribution to Hong Kong by HK$0.45 million. Using a "middle-of-the-road" benchmark of 5% traffic growth rate, medium pollution cost, and an average runway capacity increase of 30 % for the third runway scenario, it is estimated that the annual economic contribution to Hong Kong's economy from a fully utilized 3rd runway would be HK$56.0 Billion. The corresponding estimation of the partial cost of pollution is approximately HK$0.4 Billion. Despite the fact that the partial estimation on the pollution cost only includes those of Carbon Dioxide and Nitrogen Oxide, we believe that the economic case for the expanded capacity through the construction of a third runway is overwhelming, when estimates of the construction cost for the third runway has been in the range of HK$30 – 50 Billion.

(5) Major obstacle in this process could be the vetting for the environmental impact of this project, particularly in the areas of greenhouse gas emissions and ecological impact to the oceans around HKIA, including the impact to the Chinese White dolphins. In order to strengthen it's case, it will be critical for HKIA to consider and move forward all possible capacity improvement measures as its earliest possible time, working with the widest group of stakeholders to demonstrate the urgency and commitment for capacity enhancement at HKIA, and that all alternatives has been fully exhausted. We should also be prepared for possible long and challenging process in attaining environmental approval for this project, and good preparation will be key in addressing the concerns of interested parties and the general public.

(6) Operational issues should be carefully considered for building the third runway. First and foremost would be the decision for a close-spaced configuration versus a wide-spaced configuration. In this consideration, it is suggested that exploring the potential configuration scenarios for a fourth runway of Hong Kong may be useful. The evaluation of these scenarios should take into considerations of associated airspace constraints in determining the optimal configuration of any additional runways.

(7) As the cost will be a major parameter, users will likely be concerned about potential higher charges in the future. While it is clear that this project brings substantial economic benefit to the Hong Kong economy, careful consideration should be placed on the financing arrangements so as to provide maximum benefits to all stakeholders while minimizing the resistance on financial arrangement grounds. We have not addressed this aspect of the third runway problem in this study.

(8) In view of the recently announced consideration of a linkage (by high speed rail) between the HKIA and Shenzhen's Bao'an Airport, the potential impact of such a linkage to the analysis presented in this report will need to be assessed. Not only will such a linkage impact on the passenger and cargo demand for HKIA in the future and possibly flight mix for the airports, the environmental impact of such major projects (such as the proposed

bridge-land interface point at HKIA for the Hong Kong-Zhuhai-Macau Bridge) within the same vicinity can be accumulative in nature, which may significantly increase the difficulty in the environmental vetting of these projects. Along these lines, we are also well advised that it may be useful to explore a more inclusive and coordinated development of the aviation infrastructures in the PRD for a more optimal development of this very important asset of South China's future.

(9) Last, but CERTAINLY NOT LEAST, the HKSAR Government should be committed to the establishment of a clear strategy and action plan commensurate with the forecasted high growth and the mandate placed upon us by the Basic Law in regards to aviation services so that future development of our aviation sector can be focused, effective, and well-coordinated among the stakeholders.

Hong Kong's aviation sector has seen and is forecasted to see steep growth in the demand for aviation services for the coming years, while there are 5 major airports potentially competing for business within a radius of about 140km. Worse still is that these airports also compete for a very restrictive airspace with segmented control, and that the HKIA is facing congestion as the operations are fast approaching the facilities' capacity. We are hopeful that our preliminary analysis will add impetus to establish a clear strategy and action plan for the aviation industry in Hong Kong, and to properly address the mandate given to us in the form of the our "mini-constitution" – the Basic Law of the HKSAR, in which we are to "provide conditions and take measures for maintenance of the status of Hong Kong as the centre of international and regional aviation". Our only alternative in not acting quickly to these issues is to find our infrastructures being overloaded within the not-too-distant future, our service providers not able to respond to the increasing demands for passenger and freight services, and in the process, losing market share and our leadership position in the region, and "missing the boat" in this "once-in-a-life-time" growth opportunity based on the "China story".

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