Airport Expansion: The Malaysian Experience of KLIA2

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ABSTRACT

The paper describes the Malaysian experiences with airport expansion. Increase in international and domestic air travel has resulted in increased demand for airport facilities. In Malaysia, the rise of low-cost air travel has had the government revising the current capacity of the international airport provision. This research relates the experiences of major expansion phases of the second Kuala Lumpur International Airport, which is also known as KLIA2. It dwells into the anticipated environmental impacts of such expansion.

Impacts such as noise and air pollution have been identified with airport expansion. Points at which expansions are occurring rapidly and landuse changes are severed have, therefore, been identified as sampling locations. Both noise and particulate matter levels are recorded using various airborne particulate matter samplers as and noise dosimeter as data capture devises. These data are also analysed in a controlled laboratory environment.

Whilst more data collection and analyses are currently carried out, the preliminary findings suggested that increased intensity of construction activities and landuse changes have direct relationships with noise and particulate matter levels. It is hoped that the study findings will assist in providing a better insight into the intangible costs and benefits derived from an airport expansion.

KEYWORDS: Airport, expansion, environmental impacts

CLASSIFICATION: Aviation Case Study, Aviation Infrastructure, Environmental Issues in Air Transport Industry.

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INTRODUCTION

This paper aims at identifying current and impacts of airport expansion, using the KLIA2 as a case study. Air travel is the fastest growing mode of transportation, becoming ever more popular nowadays. Economic growth and globalisation have seen demand for air travel grow rapidly, and all the economic and demographic evidence points to this trend accelerating. Each mode of transport has a fundamentally different infrastructure, operations, and often has some unique regulations of its (Rodrigue et al., 2006). Additionally, planning and constructing new airport infrastructure takes an extremely long time and history has shown the construction of new airports and the expansion of existing ones to be highly controversial to the community as well as the environment. The growing pervasiveness of air travel can be seen by airport infrastructure upgrading and the increasing numbers of airports today. The aviation system produces significant economic and social benefits to communities around the world. Yet for airports, in particular, and the aviation system, in general, to continue spurring economic growth both locally and globally, must deal with the environmental and community planning challenges it now faces in an innovative and sustainable approach to the world.

Currently, public opinion and political administrations have alerted to the safety of the areas surrounding airports and the negative impacts and issues produced by airport developments. Although they create jobs opportunity and bring in money to local and national economies, airports also create noise, pollution and transport problems as well as taking up vast tracts of land. Studies have also shown aircraft noise, particularly at night, can have damaging health effects on those continually exposed to it. As such, proposals for new airports or to expand existing ones invariably generate massive public controversy, and require the balancing of economic against environmental concerns.

Additionally to opposition arising from disturbance caused by aircraft noise, other major issues raised in complaints to airports include local air quality, congestion and accidents on local roads and fear of air risk (Thomas, 1995). It would seem reasonable to assume that if local people cannot see a reason to tolerate the nuisance caused by airport

operations, they are more likely to object to airport growth. Malaysia, particularly under the Civil Aviation Act (1969), aircraft and airport authorities are cleared from paying compensation for nuisance noise only if the aircraft and airport authorities are operated in conformance with international civil aviation procedures (DOE,2004). Under (Environmental Impact Assessment) Order, (1987), the construction of the airport must have an airstrip of 2,500 metres or longer.

Malaysia will have its largest RM 2 billion LCCT terminal by 2013. This new LCCT terminal, also known as KLIA2 will be able to accommodate 30 million low cost passengers with provision to expand to 45 million passengers a year (MAHB, 2011). The development of airport expansion like Kuala Lumpur International Airport 2(KLIA2) was due to the demand of the region and development. Hailed as the largest purpose-built dedicated terminal for low-cost carriers in the world, the 242,000sq m facility is slated as one of the four key drivers behind MAHB's ambition to hit RM2.14 billion (US$710 million) in non-aeronautical revenues by 2014. The new low-cost carrier terminal (LCCT) or KLIA2 will mark the nation's growth and leadership in aviation globally and serve as an economic stimulus for the country.

AIRPORT PLANNING AS A SYSTEMATIC PROCESS

Airport networks become one of the important assets in a country that constitute a massive investment of public funds. Airport planning is a systematic process used to establish guidelines for the efficient development of airports that is consistent with local, state and national goals. A key objective of airport planning is to assure the effective use of airport resources in order to satisfy aviation demand in a financially feasible manner (AIP Guide, 2010). Three basic interdependent elements of airport planning are airlines, airport and territory. Airlines been determine the achievement of the airport and subsequently give an economic growth on the territory. Territorial features affect airport performance and attract particular types of the airline. In return, those surrounding airport areas were highly exposed to tension (Sánchez, 2007). Analysis of the interaction between the airport and the territory should be made in a comprehensive manner, considering the airline's route pattern, airport development and territorial impacts (AIP Guide, 2010).

Neufville and Odoni (2003) suggested that airport planning forecasts are always incorrect, since planners and managers have to face the realities of the deregulation and competition era, making forecasting somewhat undependable. Therefore, responsible airport planning anticipates a wide range of possible futures, giving airport managers and operators the authority to dynamically adjust their plans and designs so that over time they can accommodate the variety of possibilities that may occur. Future methodologies for forecasting air traffic should be based on the role and viability of specific airlines at particular airports.

Airport Master Plan

Airport master plan is the concept of the ultimate development of a specific airport, graphically presented with written report to effectively convey the research and logic from which the plan was evolved (ICAO Manual). Long-term development concept of an airport is an embodiment of the airport's strategic framework and concept depicted graphically and documents the data and logic upon which the plan is based. Guidelines for future airport development is important to satisfy aviation demands in a financially feasible manner, while addressing aviation, environmental and socioeconomic issues in the local community Based on AIP Guidelines (2010), an airport master plan represents the airport's blueprint for long-term development. A few of the goals of a master plan are:

i. To provide a graphic representation of existing airport features, future airport development and anticipated land use.
ii. To establish a realistic schedule for implementation of the proposed development.
iii. To identify an realistic financial plan to support the development
iv. To validate the plan technically and procedurally through investigation of concepts and alternatives on technical, economic and environmental grounds.
v. To prepare and present a plan to the public that adequately addresses all relevant issues and satisfies local, state and federal regulations.
vi. To establish a framework for a continuous planning process.

Airports are multi-faceted facilities, impacting a wide spectrum of people and businesses (ICAO Manual). The airport master plan need for consultation and coordination of planning with stakeholders concerned:

i. Airlines
ii. National and local government planners
iii. Government control authorities (immigration, customs, health)
iv. National and local transport authorities
v. Aircraft and equipment manufacturers
vi. International aviation agencies and businesses
vii. Concessionaires
viii. Local business and residential communities

A good Airport Master Plan represents the most efficient framework with flexibility, expandability and optimum balance of all individual airport services to provide the required capacity for aircraft, pax, cargo and vehicular movements with max facilitation for pax, operator and staff at lowest capital and operating costs and max revenue (ICAO Manual). This will generate higher capacity and efficiency through a series of compromises than would otherwise be attained without reconciliation of individual facilities plans. The master plan need to be annually adjusted according to prevailing conditions. Regular evaluation and modification (for example very five years) could change dictates in economic, operational,

environmental and financial conditions. The airport operation need to be forecast in order to produce the master plan that fit the demand (refer Figure 1).

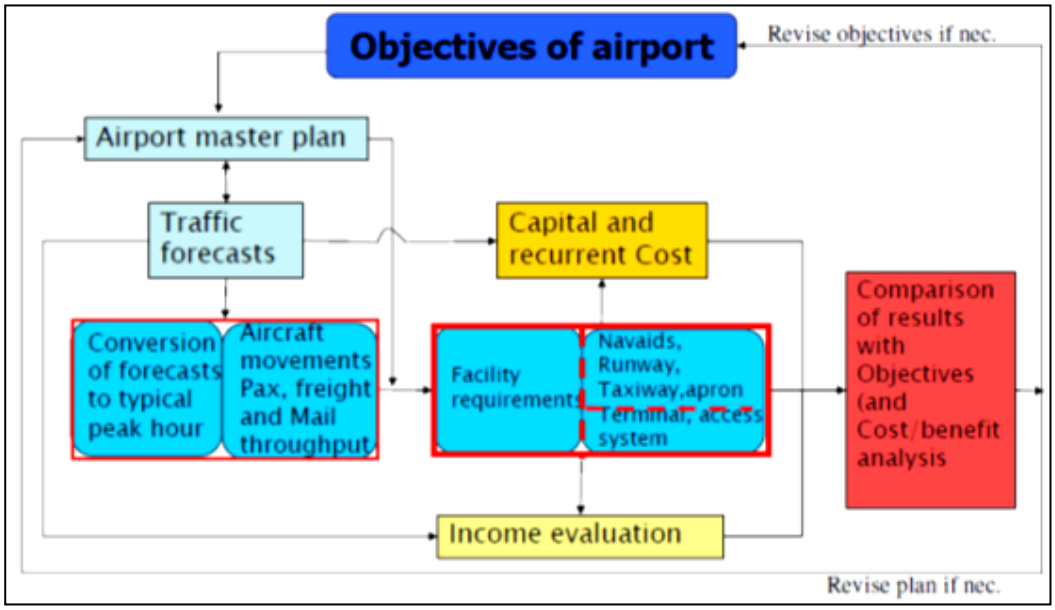

Figure 1: Forecast Relationship versus Master Plan

(Source: ICAO Manual)

Airfield Configurations and Guidelines

As been highlighted by the ICAO Manual, the airfield configurations are based on:

i. Runway Configuration- (Orientation and Number of runways)
ii. Taxiway Layout
iii. Terminal / Apron Area
iv. Aircraft Parking Configuration
v. Cargo Terminal

Fundamentally, airport expansion refers to an addition of runways. Development of new runways depends on the volume of aircraft movements. The orientation of runway depends on direction of prevailing winds, where it should be oriented in the direction of the prevailing wind and not excessively exposed to the cross wind. The runways should be oriented so that the aircraft may be able to land at least 95% of the time with cross wind components. The runway length is influenced by temperature, runway slope, airport altitude, runway pavement condition, and visibility (ICAO Manual). In addition, the airspace around airport should remain free of obstacles to permit safe aircraft operations. Aircraft are not directed over populated areas and must avoid obstructions.

Furthermore, in airport site selection, it is very important to ensure that the airport expansion is compatible to the area and surrounding. The airport selection is to determine the purpose for which airport is required and consider forecast future demands of the operational

and economic as well as the quantity and type of traffic (ICAO Manual). There are several major steps in considering the airport site selection which are:

i. Selection of site that provides adequate space and size and suitable locations to serve the residents and commerce.
ii. Evaluation of feasibility of possible locations through the forecast period from economic, geographic, engineering and aeronautical standpoints.

Enlarging the airport capacity should also consider the management of the environmental impact on surrounding areas. Externalities created by infrastructure projects in Europe were assessed by the Environmental Impact Assessment (EIA) after they were completed (Sánchez, 2007). This subsequent assessment was often turned into a method for justifying decisions that had already been made.

AIRPORT INFRASTRUCTURE UPGRADING

As demand for air transportation continues to grow, it will become increasingly difficult to accommodate the resulting traffic levels without significantly expanding airport infrastructure. However, many larger airports are already constrained in their ability to expand, and surrounding communities often strongly resist the construction of additional runways. As for demand management, some regions have succeeded in general aviation that are less expensive to improve and that have the least environmental impacts. The oil price, flu epidemics, and financial and economic woes further add to the volatility of aviation demand development (Kwakkel, Walker, & Marchau, 2009). The demand management approach also might be relevant in addressing congestion at major commercial service airports (Bolczak et al., 2007).

More studies are needed to document the effectiveness of demand management, and to develop guidelines so that this approach can be better understood. Furthermore, airport ground access, facility development, and project funding will continue to be important challenges for aviation planners because of the complex institutional environment. Commercial service airports typically serve passengers and freight from a wide geographical area. Many local government jurisdictions and other agencies, including transit and rail authorities, environmental agencies, and transportation departments, have responsibilities that overlap and affect airport ground access (Gosling G, 1999). The appropriate future role of each mode must be defined, and connectivity between modes must be addressed.

Aviation Growth in Malaysia: A case study of Kuala Lumpur International Airport 2 (KLIA2)

Airports are engines for economic activity, create direct and indirect employment and may act as innovative centres for new environmental technologies within a region. Moreover, modern airports function as intermodal transport nodes and incorporate hotels, shopping facilities, office space, conference rooms and leisure facilities. As such, they are recognized as clusters from a general spatial perspective and “airport cities” in specific if they show the

qualitative features of a city: density, access, quality, environment services (Güller and Güller, 2003).

Airport expansion gives an impact to the economic growth of the region. Basically, air connectivity increases with the number of destinations served and the frequency of flights along these routes. In return, the region becomes attractive, invites foreign investment and increases potential for business competence, and eventually generates a virtuous cycle of connectivity and economic growth. Connectivity is generated by an airport's ability to attract passengers, and also the efficiency and availability of routes provided to international locations by the growing complexity of air networks and the importance of hub airports for economic development of the region (BCC, 2009). Looking at the bigger picture beyond the real-estate crunch and the threat it poses to the general aviation relievers in terms of potential closures, there is a clear need across the board for more capacity at the nation's busiest airports. With sales picking up, more than a thousand aircraft are being added to the overall fleet every year, and operators are flying more than ever before, will increase pressure on airport infrastructures for runway extensions (Elser D, 2006).

As for Malaysia, the expansion of KLIA airport aims to meets demand of passengers in future and generate economic growth to the region. The GDP of economic activity at current prices from year 2006-2010 shows steady increases from year to years on transportation, storage and a communication (refer Table 1). Therefore, analysis on the interaction between airport and territory should be made in a comprehensive manner, considering the airline's route pattern, airport development and territorial impacts (AIP Guide, 2010). The present site for KLIA2 was selected based on the recommendation in the National Airport Master Plan (NAMP) (2008) after a detailed and comprehensive study involving all stakeholders including Ministry of Transport, Department of Civil Aviation, Ministry of Finance, Ministry of Home Affairs and all airlines. The original KLIA Master Plan was reviewed so as to take into account the latest development in the aviation industry such as growth of low fare airlines and their specific requirements, rationalisation of routes, liberalisation of air service agreements and aviation security requirements. Major issues such as location, soil condition, landside connectivity and existing infrastructure were also taken into consideration in the study (MAHB, 2011).

Table 1: Gross Domestic Product by Kind of Economic Activity at Current Prices, 2006-2010, Malaysia RM (Million)

Gross Domestic Product by Kind of Economic Activity at Current Prices, 2006- 2010, Malaysia RM (Million)	
Transport, Storage, and Communication	
2006	38,882
2007	42,652
2008	46,205
2009	46,649
2010	50,802

(Source: Department of Statistics)

The development of airport like Kuala Lumpur International Airport (KLIA) as one of Southeast Asia's largest airports was due to the need of the region and development. Designed to be a regional hub, the KLIA is built with features that allow flexibility for future expansion, well into the next century. Table 2 shows that the air traffic statistics from year 2008 until 2011. It shows that number of passengers for domestic and international increased by year. Therefore, airport planning is responsible to anticipate a wide range of possible futures, giving airport managers and operators the authority to dynamically adjust their plans and designs so that over time they can accommodate the variety of possibilities that may occur. Future methodologies in forecasting air traffic should be based on the role and viability of specific airlines at particular airports. The economic growth and globalisation have seen demand for air travel grow rapidly in the last 20 years, and the economic and demographic evidence points to this trend accelerating (Burghouwt,2007) .

Table 2: Air Traffic Statistics by year (2008-2011*)

Air Traffic Statistics					
No. of Passengers		**2008**	**2009**	**2010**	***2011**
Domestic	Million	27.5	29.1	31.1	33.2
International	Million	21.4	23.5	28.0	29.9
TOTAL (including transit)	Million	48.9	52.6	59.1	63.1

**2011= Projection*

(Source: Department of Statistics)

As development of airport infrastructure has become the major thrust area now, Government of Malaysia has taken a number of initiatives to encourage private sector participation in development, modernization and upgradation of airport infrastructure. At the same time, planning and constructing new infrastructure takes an extremely long time and history has shown the construction of new airports and the expansion of existing ones to be highly controversial. The air transport industry is growing faster than what we are currently produce and introduce both technological and operational advances which can reduce the environmental impact at source.

Airport operators need to begin to plan now for the long term, to visualise the ultimate runway, apron and terminal infrastructure which can be realistically anticipated for a particular site, and the ground transport infrastructure likely to be needed to serve it in order to meet anticipated demand and to address environmental constraints. Some of the planning issues that can be identified are demand management and landslide access (Gosling, 1999). In resolving conflicting and competing demands for land the aim should be the three-dimensional progress namely physical, economic and social, both at present and in the future. In these circumstances, we have warned against destruction of the earth.

The relocation of Malaysia's premier gateway will not affect the proximity of the airport to the nation's administrative center. In fact, the hub of administration will be closer with its relocation in Putrajaya, just 20 minutes away from KLIA, Sepang. All the government agencies and ministries were placed in Putrajaya makes the administrative works be more effective and efficient. Further, foreign delegations to Malaysia also benefited.

Having established itself as one of Asia's leading airports since opening in the summer of 1998, the multi-award-winning KLIA has enjoyed rapid passenger growth (refer Figure 2). KLIA can be said amongst the best performing airports in the region in 2009-2010. In fact, in the first nine months of 2010, the airport handled 24.8 million passengers, a 17% year-on-year increase – with the low-cost sector enjoying growth of 18.5%. In order to cater continuously increasing demand, the temporary Low-Cost Carrier Terminal (LCCT) was constructed in 2006, but as it approaches its capacity of 15 million annual passengers, 2012 will see the introduction of the brand new, permanent facility.

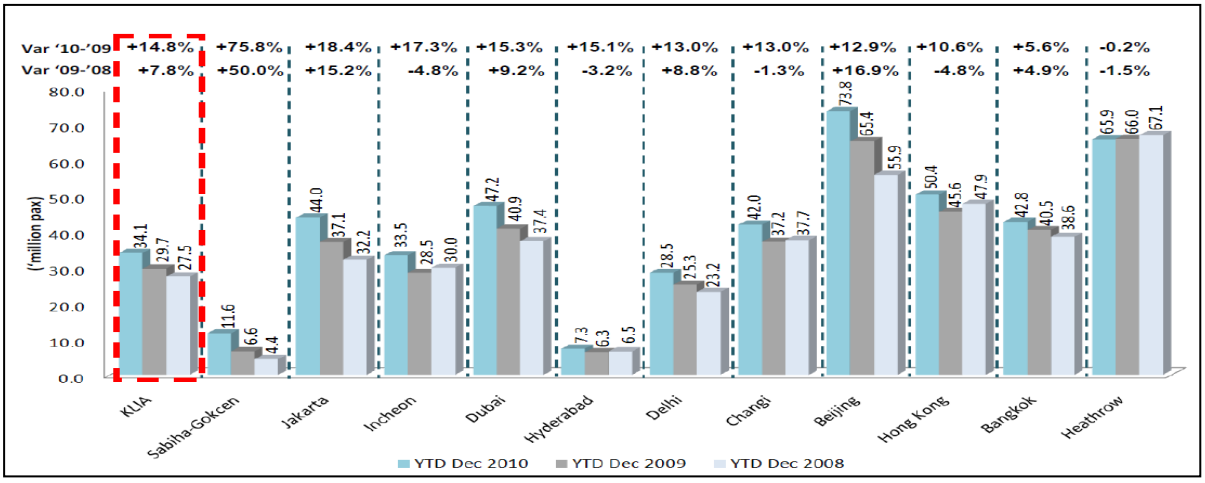

Figure 2: KLIA amongst the best performing airports in the region in 2008-2010
(Source: Malaysia Airports Holdings Berhad (MAHB) Power Point, 2011)

Malaysia's very own low-cost carrier, AirAsia, has grown in correlation with KLIA itself and the investment by Malaysia Airports Holdings Berhad (MAHB) is largely a direct result of the airline's aggressive expansion. KLIA 2 is predominantly for AirAsia but also open to the possibility of other low-cost airlines eventually operating from the facility. It's being constructed to cater the expansion of AirAsia services which targeted by the end of next year, the existing LCCT will handle 15 million passengers (ACI Europe, 2011). Airport expansions are costly, complex, and controversial. The key component of this project is the construction of a new runway. KLIA2 will be the much talked about budget terminal LCCT in Kuala Lumpur for 2012. This modern airport is also set to open by April 2013 and according to owners, Malaysia Airport Holdings Berhad (MAHB), the total cost to build this new LCCT is estimated at RM4 Billion which is currently achieving 52% completion. Located just two kilometers from the main KLIA Terminal, KLIA2 will be the largest Low Cost Carrier Terminal in the region of Southeast Asia with a total area of 242,000 square meters (refer Figure 3). There will be a total of 68 aircraft parking bay while the new budget

terminal will cater to around 30 million passengers. There will also be a third runway which is located 1.5 km from the second runway (refer Figure 4).

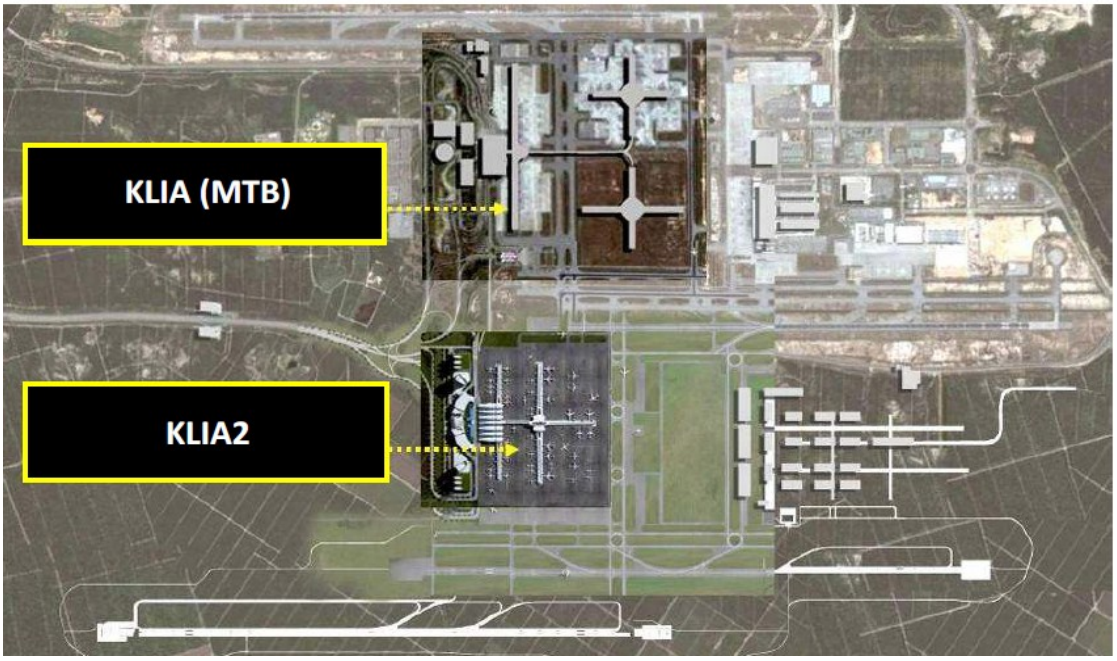

Figure 3: Construction of permanent second terminal to replace current LCCT
(Source: Malaysia Airports Holdings Berhad (MAHB) Power Point, 2011)

	MTB	LCCT	New KLIA2
Positioning	✈ International airport ✈ "Life style" concept	✈ Temporary low-cost carriers airport	✈ Permanent low-cost carriers airport ✈ "Commercial-driven" concept - positioning airport as new shopping destination
Passenger Type	✈ Business travellers ✈ International tourists ✈ Major airline: MH	✈ Domestic travellers ✈ International tourists mainly short-haul ✈ Major airline: Air Asia	✈ Domestic travellers ✈ International tourists ✈ Major airline: Air Asia/Air Asia X
Size	✈ Up to 25m of passengers ✈ 2010 - 18.7m passengers	✈ Up to 15m of passengers ✈ 2010 - 15.4m passengers	✈ Up to 30m of passengers (Phase I) ✈ Up to 45m of passengers (Phase II)
Layout and Design	✈ Total space 480K sq.m ✈ Commercial space 19.4K sq.m (4%) ✈ Operational-driven layout - commercial space constraint	✈ Total space 64K sq.m ✈ Commercial space 8.9K sq.m (14%) ✈ Temporary design - not enough space for retailing and F&B	✈ Proposed total space 240K sq.m ✈ Proposed to have approximately 20% of commercial space ✈ Commercial-driven layout- maximising space utilisation and passenger flows
Tenant Structure	✈ Focusing on duty-free and travel retailing especially high-end fashion products	✈ Focusing on F&B	✈ Good balance between retailing and F&B - capturing medium purchasing power group
Contract Structure and Policies	✈ Standardised contract - "landlord vs tenant" relationship	✈ Standardised contract - "landlord vs tenant" relationship	✈ Customised contract - enhancing partnership and mutual benefits for MAHB and Tenants

Figure 4: Comparison – MTB, LCCT & KLIA2
(Source: Malaysia Airports Holdings Berhad (MAHB) Power Point, 2011)

The development of KLIA Sepang is to be implemented in three phases:

➢ PHASE 1 (1998 - 2003)

Phase 1 call for the construction of facilities to handle 25 million passengers (about 80 flights per hour) and 1.2 million tonnes of cargo per annum. The major facilities to be constructed include

- Two 2.5-mile parallel runways (4000m x 60m)
- A mega terminal building with a satellite - 83 aircraft stands (contact and remote).
- Sixty contact piers, 20 remote parking bays with 80 aircraft parking positions, one mega terminal, one satellite, two runways and other facilities will be made available to accommodate a throughput of 25 million passengers per annum. The runways will be on a staggered configuration 2535m apart to allow for simultaneous operation. The runways will be equipped with Category II navigational and lighting aids and will be complemented by a taxiway system for the efficient and expeditious flow of aircraft on the ground.
- The terminal building, designated to allow for its expansion for the next two phases. All domestic, Singapore and mixed flights will be served from a pier connected to the main terminal, while all other international flights will be served by a four-armed satellite building located in the main parking apron. An automated people-mover shuttle system will link the terminal and the satellite building. This system is designed for a maximum waiting time of five minutes.

➢ PHASE 2 (2003 - 2008)

To handle 35 million passengers per annum by 2008.

➢ PHASE 3 (2008 & beyond)

Further expansion of the airport to handle 45 million passengers per annum by 2013. There is sufficient land and capacity to develop facilities to handle up to 100 million passengers a year, four runways by the year 2020 and two mega-terminals, each with two linked satellite buildings.

Items	Provisional (Feb 2009) RM 2.0 Billion	Revised RM 3.6-3.9 Billion
1. Terminal building	GFA – 150,000 m²	GFA – 257,000 m²
2. Aircraft stands	Area – 500,000 m² 50 semi contact stands	Area – 803,709 m² 68 gates & 8 remote stands (80 aerobridges)
3. Earthworks	Area – 4.85 mil m²	Area – 11.19 mil m²
4. Runway 3, Taxiway Pavement & AGL System	Code C Length : 2.50 km, Width: 45m	Code E Length: 3.96 km, Width: 60m
5. DCA Facilities	Apron Control Tower Height : 77 m	Air Traffic Control Tower Height : 93 m
6. Public Infrastructure	Length : 8km With 1.5 km elevated road	Length : 15 km with 5.4km elevated road

Table 3 : Major Upgrades in Specifications

(Source: Malaysia Airports Holdings Berhad (MAHB) Power Point, 2011)

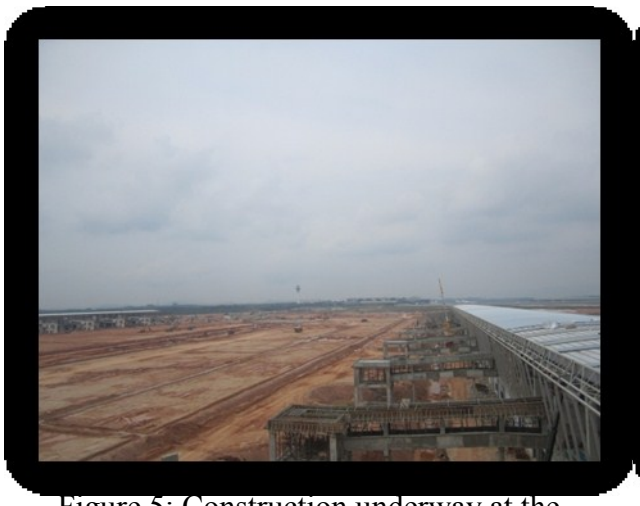

Figure 5: Construction underway at the site (KLIA 2)

(Source: Site visit, 2012)

Figure 6: Construction underway at the site (KLIA 2)

(Source: Site visit, 2012)

Figure 7: Construction underway at the site (KLIA 2)

(Source: Site visit, 2012)

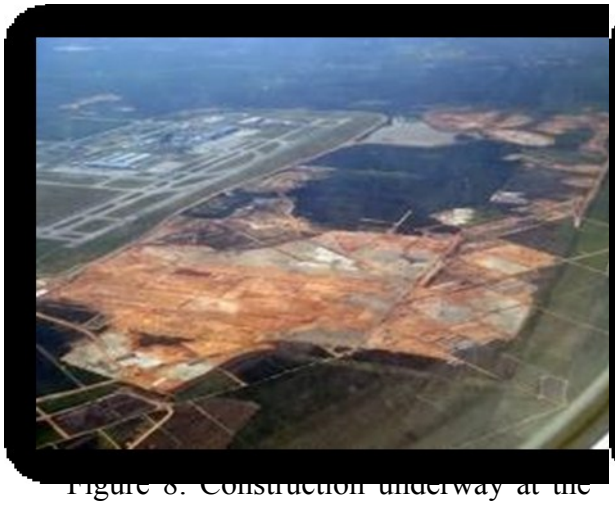

Figure 8: Construction underway at the site (KLIA 2)

Figure 9: An artist impression of the terminal (KLIA 2)

(Source: http://www.yoyooh.com/2011/06/klia-2-the-latest-lcct-terminal)

According to the MB of MAHB, there is a portion of 6,750 acre land was set aside for development adjacent to KLIA. Dubbed the KLIA Aeropolis, it is categorized under the wholesale and retail initiative under the National Key Economic Areas (NKEA). The KLIA2 area will be transformed as a catalyst for tourism, leisure and employment, thereby diversifying the airport city. Completion of the 50 acre development is scheduled for 2013 and there will be other phases in the development of KLIA Aeropolis which would include a commercial business district which houses office parks, retail/commercial centres, an auto mall, exposition/convention center, medical center, training center complex and service apartments. There are also plans to build golf courses, a boutique hotel and a theme park as well as agro-tourism tracts of land (refer Figure 10 & 11).

Figure 10: An artist impression of the terminal (KLIA 2)

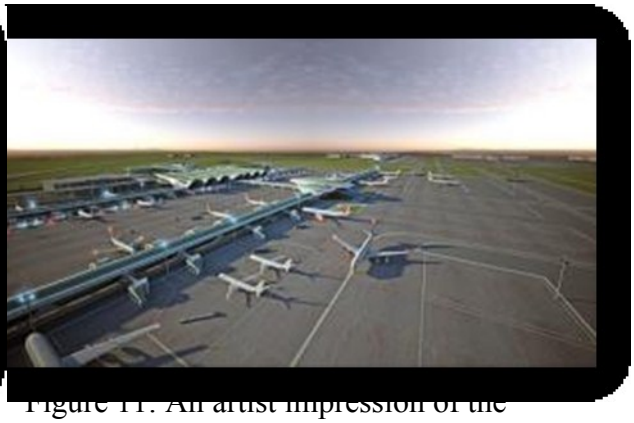

Figure 11: An artist impression of the terminal (KLIA 2)

(Source: http://www.yoyooh.com/2011/06/klia-2-the-latest-lcct-terminal)

IMPACTS AND CURRENT ISSUES OF AIRPORT EXPANSION

Environmental Impact

Environmental protection has come to play a major role in the strategy and development plans of many airports around the world and is also recognized by the Airport Council International (ACI) which represents 1679 airports in 177 countries (Schrenk et al., 2009). Airport planning and development projects that include Federal involvement require an environmental review.

Growth in air transportation resulted in highly pollutant emissions mainly from aviation activities. In addition, progress on noise reduction has slowed. Although it depends on the metric used, estimates suggest that millions of people are adversely affected by these side effects of aviation. Because of these factors and the rising value placed on environmental quality, there are increasing constraints on the mobility, economic vitality and security of the nation. Airport expansion plans have been delayed and canceled due to local air quality, water quality and community noise impacts (Aviation Environment Report, 2004).

Airport expansion is important in order to satisfy aviation demand in a financially feasible manner. Recent developments in civil aviation can be attributed to an increasingly globalized society in which mobility over long distances becomes ever more important. Based on Luther (2007), airport operations involve a range of activities that affect the environment, including:

i. The operation of aircraft;
ii. The operation of airport and passenger vehicles, and airport ground service equipment (GSE);
iii. Cleaning and maintenance of aircraft and motor vehicles;
iv. Deicing and anti-icing of aircraft and airfields;
v. Fueling and fuel storage of aircraft and vehicles;
vi. Airport facility operations and maintenance; and
vii. Construction.

Noise fears over airport expansion

Despite improvements and expansion of the airport, noise continues to be a significant problem because:-

i. The amount of air traffic is growing,
ii. The number of airliners and corporate jets is increasing, and
iii. Airline traffic and noise is concentrated at a small number of airports that are also likely to be among the largest airports.

Noise is derived from the Latin word “nausea” implying ‘unwanted sound’ or ‘sound that is loud, unpleasant or unexpected’ (Singh and Davar, 2004). Noise originates from human activities, especially the urbanization and the developments of transport and industry. Noise pollution and its consequent influence over the environment and life quality of human beings may be considered a ‘‘hot topic’’ in scientific research. Many noise surveys treating the problem of noise pollution in many cities throughout the world have been conducted (Zannin, et al. 2001). In some surveys, noise impact was treated as a stress inductor, and in consequence, the role of noise as a risk factor for human health is discussed. Maschke (2007) argues that the induced stress by noise has a psychosocial component. Such studies are almost non-existent in Brazil (Zannin et al.,2002).

Table 4: Environmental Noise

Environmental Noise	
Weakest sound heard	0dB
Whisper Quiet Library	30dB
Normal conversation (3-5')	60-70dB
Telephone dial tone	80dB
City Traffic (inside car)	85dB
Train whistle at 500', Truck Traffic	90dB
Subway train at 200'	95dB
Level at which sustained exposure may result in hearing loss	90 - 95dB
Power mower at 3'	107dB
Snowmobile, Motorcycle	100dB
Power saw at 3'	110dB
Sandblasting, Loud Rock Concert	115dB
Pain begins	125dB
Pneumatic riveter at 4'	125dB
Even short term exposure can cause permanent damage - Loudest recommended exposure WITH hearing protection	140dB
Jet engine at 100', Gun Blast	140dB
Death of hearing tissue	180dB
Loudest sound possible	194dB

(Source: www.gcaudio.com/resources/howtos/loudness.html)

In addition, aircraft noise is related to the frequency and noisiness of aircraft movements and the proximity of communities relative to the airport's arrival and departure routes (Upham P. et al., 2003). The control and monitoring of aircraft noise are issues that have received significant attention, and aircraft and engine manufacturers have made significant technological improvements over the years. However, the benefits of such actions have been offset by the growth in air travel such that today most of the world's major airports have operational constraints or capacity limits based upon aircraft noise. For an example, Luton Airport's proposal to expand the number of passengers to 18 million a year has had local residents fearing the worst as they expect the noise pollution that comes from planes to increase and give their lives hell (White, 2012).

When unwanted sound created by human beings hits human ears and disturbs the environment, noise pollution is created (Chandioa, Brohi and Memon, 2010). Chiefly, noise pollution comes from barking dogs, loud music, vehicles, aircraft and rail transport, air-conditioners, factories, amplified music and construction work. All transportation systems create noise pollution (Nelson, 1982). Noise pollution is measured in decibels (Miglani,

2011). When noise is at 45 decibels, no human being can sleep. Even at "calm" places, noise level does not fall below 60dB (Singh and Davar, 2004). Furthermore, at 120 decibels the ear is in pain while hearing begins to be damaged at 85 decibels.

The urban population is much more affected by noise pollution. However, small town/villages along side roads or industries are also victim of this problem. Noise is becoming an increasingly omnipresent, yet unnoticed form of pollution even in developed countries. Chandioa, et al. (2010) added that in addition to the growing level of air and water pollution, road traffic noise pollution has been recognized as a rising new threat to the inhabitants of cities.

As population increases the requirements for goods, services and transportation also increase. Each of us requires transportation mainly to move from one place to another to find food, recreation and places to work (Yusoff and Ishak, 2005). Kiernan, V. (1997) discovered that an even relatively low level of noise affects human health adversely. It may cause hypertension, disrupt sleep and/or hinder cognitive development in children. The effects of excessive noise could be so severe that either there is a permanent loss of memory or a psychiatric disorder (Bond, 1996). Thus, there are many adverse effects of excessive noise or sudden exposures to noises (Singh and Davar 2004).

Noise impact of air traffic and its growth, and from demographic information calculate the number of people who are or would be exposed to noise disturbance as the airport grows. This gives an indication of the potential noise sensitivity of a particular airport, although there are very significant social and cultural factors that affect the perception of what is nuisance (Moss et al., 1997). For example, it is likely that increasing affluence tends to bring less tolerance of environmental disturbance, such that levels of noise that are considered acceptable today may result in community opposition in the future.

Due to the expansion of Heathrow Airport in London, based on Aviation Environment Federation Report (2006), the 57 dBA in 2004 contour enclosed an area of 117 km2, and a population of 240,000. At the inner core were 1,500 people who suffered 32 times as much noise as triggers 'serious annoyance' for them. This shows that the noise from the airport expansion those give an impact to the community.

One of the most severe problems is that of aircraft noise in and around an airport. Laying out runways so that air traffic patterns occur minimally over heavily populated areas is a practice now widely employed during runway expansion and when building new airports. Controlling the land use around an airport also helps reduce the interference of aircraft noise with the public. Noise abatement procedures during takeoff and landing make for quieter airport operations (Upham et al., 2003). Such procedures consist of a faster takeoff speed quickly followed by slowing the engine once airborne over a populated area, then returning the engines to full speed and resuming normal flight operations. This lessens the amount of engine noise over the populated area without adversely affecting the flight. Improvements in engine design have also been a successful factor in reducing aircraft noise.

Declining of air quality level due to airport expansion

Aviation deals with air pollution, sometimes euphemistically called 'air quality'. It is also sometime termed 'local air pollution' or 'local air quality', indicating that it is pollution which impacts in restricted areas, more or less close to where the emissions occur. This is in contrast to emissions of gases such as carbon dioxide, which do not cause local effects, but which are important on a continental or global scale. Major sources of pollution are ground transport, aircraft emissions and apron activities such as aircraft refueling (Taylor, 1995). Airport operations may produce various regulated pollutants, including volatile organic compounds (VOCs), carbon monoxide (CO), and particulate matter (PM) (Luther, 2007). The emissions of carbon dioxide from an individual flight will depend on many different factors including distance travelled, weather conditions (head or tail wind), cargo load, passenger load and flight altitude (Christian, 2005). Because globalization and the concomitant increase in air travel has been accompanied by rising energy consumption and emissions, environmental protection and efforts to prevent climate change have become the modern scientific challenge of our times. The pollutants that aircraft produce are no different to those produced by other man-made sources of combustion. However, jet engines produce relatively few particulates, concentrations of these tending to be dominated by road traffic and sometimes by non-transport sources.

In addition, aircraft emissions are a significant source of emissions at an airport, and largely outside the control of the airport, emission reductions will likely have to be made in operations or processes that the airport does control**.** Although aircraft contribute a large share of emissions, groundside operations and infrastructure also produce a significant amount of pollution. Moreover, the emissions associated with such operations continue to grow as airports evolve into city-like hubs of economic activities – airport cities. In order to approve expansion and infrastructure upgrading of airport, it would be essential to show that concentrations of NO_2 will not only fall below the legal limit of 40 $\mu g/m^3$ but remain below that level despite the addition of more planes and the associated road traffic (AEF, 2006). Airport operations may produce various regulated pollutants, including volatile organic compounds (VOCs), carbon monoxide (CO), and particulate matter (PM) (Luther, 2007). In addition to carbon emissions, other major environmental concerns at most airports include noise (refer Table 1), local air quality, ground and surface water and soil quality, recycling and sustainability as well as habitat and wildlife management (Schrenk et al., 2009).

Air pollution is the introduction of chemicals, particulate matter, or biological materials that cause harm or discomfort to humans or other living organisms, or cause damage to the natural environment or built environment, into the atmosphere. Stratospheric ozone depletion due to air pollution has long been recognized as a threat to human health as well as to the Earth's ecosystems. A substance in the air that can cause harm to humans and the environment is known as an air pollutant. Pollutants can be in the form of solid particles, liquid droplets, or gases. In addition, they may be natural or man-made (EPA, 2011).

Pollutants can be classified as primary or secondary. Usually, primary pollutants are directly emitted from a process, such as ash from a volcanic eruption, the carbon monoxide gas from a motor vehicle exhaust or sulfur dioxide released from factories. Secondary pollutants are not emitted directly. Rather, they form in the air when primary pollutants react or interact (EPA, 2011). An important example of a secondary pollutant is ground level ozone as one of the many secondary pollutants that make up photochemical smog. Some pollutants may be both primary and secondary: that is, they are both emitted directly and formed from other primary pollutants.

Like all human activities involving combustion, most forms of aviation release carbon dioxide (CO2) and other greenhouse gases into the Earth's atmosphere, contributing to the acceleration of global warming (Anderson, 2008) and (in the case of CO2) ocean acidification (McNeil and Matear, 2008). In addition to the CO2 released by most aircraft in flight through the burning of fuels such as Jet-A (turbine aircraft) or Avgas (piston aircraft), the aviation industry also contributes greenhouse gas emissions from ground airport vehicles and those used by passengers and staff to access airports, as well as through emissions generated by the production of energy used in airport buildings, the manufacture of aircraft and the construction of airport infrastructure (McNeil and Matear, 2008).

While the principal greenhouse gas emission from powered aircraft in flight is CO2, other emissions may include nitric oxide and nitrogen dioxide, (together termed oxides of nitrogen or NOx), water vapour and particulates (soot and sulfate particles), sulfur oxides, carbon monoxide (which bonds with oxygen to become CO2 immediately upon release), incompletely burned hydrocarbons, tetra-ethyl lead (piston aircraft only), and radicals such as hydroxyl, depending on the type of aircraft in use (Luther, 2007). Subsonic aircraft-in-flight contribute to climate change in four ways:

i. Carbon dioxide (CO2)

   CO2 emissions from aircraft-in-flight are the most significant and best understood element of aviation's total contribution to climate change. The level and effects of CO2 emissions are currently believed to be broadly the same regardless of altitude (i.e. they have the same atmospheric effects as ground based emissions). In 1992, emissions of CO2 from aircraft were estimated at around 2% of all such anthropogenic emissions, and that year the atmospheric concentration of CO2 attributable to aviation was around 1% of the total anthropogenic increase since the industrial revolution, having accumulated primarily over just the last 50 years.

ii. Oxides of nitrogen (NOx)

   At the high altitudes flown by large jet airliners around the tropopause, emissions of NOx are particularly effective in forming ozone (O3) in the upper troposphere. High altitude (8-13km) NOx emissions result in greater concentrations of O3 than surface NOx emissions, and these in turn have a greater global warming effect. The effect of O3 concentrations are regional and local (as opposed to CO2 emissions, which are global).

iii. Particulates

Least significant is the release of soot and sulfate particles. Soot absorbs heat and has a warming effect; sulfate particles reflect radiation and have a small cooling effect. In addition, they can influence the formation and properties of clouds. All aircraft powered by combustion will release some amount of soot.

(Source: www.wikipedia.com)

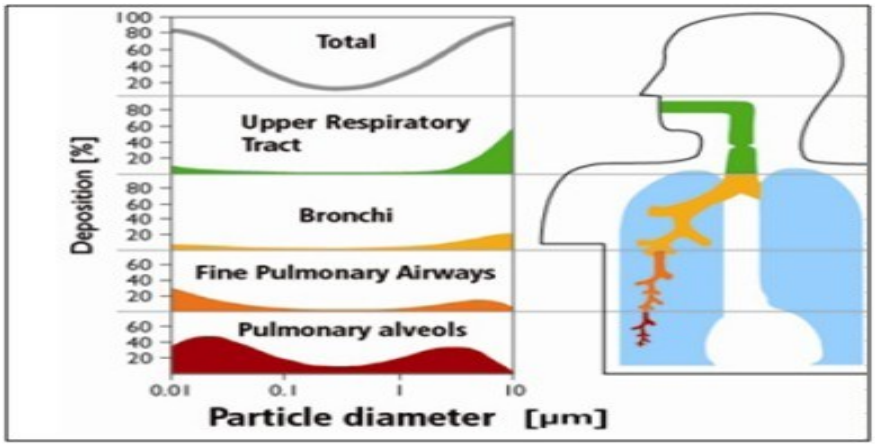

Figure 12: Impact of particle to the human

(Source: http://www.icao.int/icao/en/env2010/)

Emissions of passenger aircraft per passenger kilometre vary extensively, according to variables such as the size of the aircraft, the number of passengers on board, and the altitude and distance of the journey as the practical effect of emissions at high altitudes may be greater than those of emissions at low altitudes. The central case estimate is that aviation's contribution could grow to 5% of the total contribution by 2050 if action is not taken to tackle these emissions, though the highest scenario is 15% (IPCC, 1999).

Aircraft engine fuel efficiency has improved 70 percent per passenger kilometer since the 1960s (IATA, 2004). The newest, most sophisticated commercial engines have very high combustion temperatures, which results in lower carbon emissions, but higher nitrogen oxide emissions. As engine performance improves, abating nitrogen emissions, the primary issue related to aircraft air emissions, especially as air travel expands in coming years, will be fuel consumption. In addition to technological solutions, operational measures, infrastructure and Air Traffic Control (ATC) enhancements, and market-based measures are being considered as incentives to further limit emissions from aviation. In principle, such measures could achieve emissions reductions at a lower cost and in a more flexible manner than traditional regulatory measures.

Community Severity

Airports are engines for economic activity, create direct and indirect employment and may act as innovative centres for new technologies within a region. Moreover, modern

airports function as intermodal transport nodes and incorporate hotels, shopping facilities, office space, conference rooms and leisure facilities. As such, they are recognized as clusters from a general spatial perspective and “airport cities” in specific if they show the qualitative features of a city: density, access, quality, environment services (Güller & Güller, 2003). In fact, they are major changes to the land use and activities surrounding the airport to adapt with the development. This may lead to an impact to the community severity.

However, airport operations involve a range of activities that affect the environment and community. In general, the pollution caused by airport expansion may lead to the health effects. Research by (Maliszewska, 1999) shows that air pollution of emission contributes 3-20% of total human exposure to Polycyclic Aromatic Hydrocarbons (PAHs) and comes in second position (after food) as a source of these pollutants for humans.

Increasingly, airports are asked by various agencies and communities surrounding to analyze the health impacts of aircraft and other airport-related sources of air toxics, also known as hazardous air pollutants (HAPs). This information is needed primarily when conducting an environmental review pursuant to National Environmental Policy Act (NEPA) and at the request of local or state agencies (Luther, 2007). In addition, there are some association between aircraft noise exposure and high blood pressure (Houthuijs & Wiechen, 2006). The airport service also gave a sleep disturbance caused by nighttimes’ air traffic (Fast, 2004).

CASE STUDY OF AIRPORT PLANNING

Changi International Airport

Changi International Airport, located at the eastern edge of Singapore, was officially opened on 29 December 1981. It was built mainly on reclaimed land near where originally the World War II Changi airbase had stood. When it first opened, the airport had several firsts, including being the world's largest airport and having the world's largest column-free hanger at 20,000 sq m. From the day it opened, the airport has won many accolades including several firsts. This include, when it opened, being the world's largest airport and having the world's largest column-free hanger at 20,000 sq m (Morton, 2001). The airport has won many accolades most often the "Best Airport in the World", a title given by various unrelated organisations such as Airport World, Business Traveller, and OAG Worldwide. Initially there was only the Skytrain providing convenient travel between the terminals. When the Changi Airport MRT Station was opened on 8 February 2002, passengers gained ease of travel from the airport right into the heart of town in air-conditioned comfort.

The airport has a development policy of always building capacity ahead of demand to avoid congestion problems common in major airports and to maintain high service standards. While the original master plan detailed plans for two passenger terminals, provisions were made for further expansion, including the allocation of space for a third terminal planned to have a physical configuration mirroring that of Terminal 2. Originally planned for completion

in 2006, the date was postponed by two years after global economic downturn delayed growth of air traffic in the airport. Changing needs in the aviation industry led to reviews in the master plan, resulting in the decision to cater to the high-end as well as budget sectors of the air travel industry. Although the pioneering airport to conceptualise and construct a Budget Terminal in Asia, it became operational on 26 March 2006, and was officially opened on 31 October 2006. Recently Changi Airport has announced plans to reduce consumption of electricity and use recycled water at its terminal buildings over the next three years, as part of its contribution towards environmental sustainability (WIDN News, 2010).

Figure 13: Baggage collection point; the Green Wall comprises 25 species of climbing plants.

Figure 14: Butterfly garden, Terminal 3

(Source: www.wikipedia.com)

It has been found that the Changi Aiport has producing a plan in order to reduce consumption of electricity and use recycled water at its terminal buildings, as part of its contribution towards environmental sustainability. Therefore this study will investigate the best way to enhance the airport planning and expansion in Malaysia in order to reduce the impact of the expansion to the community as well as the environment. As for this study only concerning on noise and air quality issue due to airport expansion, the future study can be concentrated on detrimental impact to the community.

CONCLUSION

Issues relating to the sustainability of aviation are relatively under researched. Sustainable development seeks to balance social, economic and environmental objectives in order to secure the well-being of present and future generations. These objectives are interdependent and thus equally important. Finding the optimum balance means that difficult choices sometimes have to be made and concessions may be required. Aviation is a good example of this: it is a consumer of non-renewable resources, a contributor to climate change and local noise problems but at the same time it makes a very valuable and unique contribution to the sustainable development of our global society. Even though the airport expansion is very important to cater the demand, however, there are some policies and strategies that need to be done to balance the need and the future. Public demand for air travel

is continually growing. Efforts within the industry to improve the environmental performance of its economic activities, however, must and will continue. Our study will focus on the environmental impacts of the KLIA 2 construction which is currently just started. The study basically at the study methodology stage as this research aims to assess the development impacts of airport infrastructure upgrading towards the environment and community. These will include the evaluation to formulate better recommendations. This study only focused on the two types in quantifying the impacts of airport developments namely particulate matter (PM) and noise levels at KLIA 2. Hence, all the findings were being pertinent to the specific scope.

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