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INTEGRATING THE PLANNING OF AIRPORTS AND THE CITY: THE SINGAPORE STORY
Integrating the Planning of Airports and the City: The Singapore Story

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Integrating the Planning of Airports and the City: The Singapore Story

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Cover:
FOREWORD

Sited at the crossroads of major shipping sea lanes and being a centre of free trade, Singapore has been a strategic sea and air gateway for traders from around the world since its days as a British colonial trading post. However, while the country has also been fortunate to have good air connectivity along major air trunk routes, it did not become an important air junction by chance.

Early on, Singapore's first airports were set up for the protection of commercial interests and in defence of an important colonial seaport. Major parts of the island had not yet been developed and were covered in jungle. The airports were thus sited close to the fringes of the city centre instead of at the island's outermost fringes.

Post-independence, urban planners began to consider how airports could both leverage the growth in air traffic as well as safeguard the nation's air defence needs. Airports support economic activities by generating foreign trade, investments and tourism, while also facilitating the movement of cargo and people internationally.

Faced with other national priorities competing for land, such as housing, job creation, education and infrastructure, building a brand new and costly airport would be a huge undertaking. The choice to build Changi Airport and to reinforce air defence needs at the five air bases inherited from the British thus had far-reaching ramifications.

Today, as Singapore's limited land becomes increasingly built-up and used more intensively, the country faces the challenges of maintaining its status as a successful air hub and safeguarding national security, while continuing to grow its economy.
Integrating the Planning of Airports and the City: The Singapore Story

Drawing upon published research and new interviews, *Integrating the Planning of Airports and the City: The Singapore Story* documents the integrated approach taken to plan and coordinate Singapore’s airports and urban development. This Urban Systems Study demonstrates how judicious, long-term planning has enabled Singapore to accommodate its many airports and their associated constraints, while optimally making use of land near to and beyond the airports. These efforts will ensure dynamic economic growth and a better quality of life for citizens.

**Lim Hock San**  
President and CEO of United Industrial Corporation Limited  
Former Director-General of the Civil Aviation Authority of Singapore

**PREFACE**

The Centre for Liveable Cities’ (CLC) research in urban systems unpacks the systematic components that make up the city of Singapore, capturing knowledge not only within each of these systems, but also the threads that link these systems and how they make sense as a whole. The studies are scoped to venture deep into the key domain areas the Centre has identified under the Singapore Liveability Framework, attempting to answer two key questions: how Singapore has transformed itself into a highly liveable city over the last five decades, and how Singapore can build on our urban development experience to create knowledge and urban solutions for current and future challenges relevant to Singapore and other cities through applied research. *Integrating the Planning of Airports and the City: The Singapore Story* is the latest publication from the Urban Systems Studies (USS) series.

The research process involves close and rigorous engagement of CLC researchers with our stakeholder agencies, and oral history interviews with Singapore’s urban pioneers and leaders to gain insights into development processes and distil tacit knowledge that has been gleaned from planning and implementation, as well as the governance of Singapore. As a body of knowledge, the Urban Systems Studies, which cover aspects such as water, transport, housing, industrial infrastructure and sustainable environment, reveal not only the visible outcomes of Singapore’s development, but also the complex support structures of our urban achievements.

The Centre would like to thank the Civil Aviation Authority of Singapore, the Ministry of Transport, and all who have contributed their knowledge, expertise and time to make this publication possible. I wish you an enjoyable read.

**Khoo Teng Chye**  
Executive Director  
Centre for Liveable Cities
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THE SINGAPORE LIVEABILITY FRAMEWORK

The Singapore Liveability Framework is derived from Singapore’s urban development experience and is a useful guide for developing sustainable and liveable cities.

The general principles under Integrated Master Planning and Dynamic Urban Governance are reflected in the themes found in Integrating the Planning of Airports and the City: The Singapore Story.

Integrated Master Planning and Development

**Fight Productively**

By the late 1950s, it became vital for Singapore to have a well-functioning international airport with adequate capacity. Such an airport would allow the country to ride the wave of growth in air traffic, which became even more apparent in the 1960s.

At the time, there was debate about whether to expand the existing Paya Lebar Airport, or to build a new airport at Changi. Expanding Paya Lebar Airport would be more fiscally prudent and cost-effective, as it did not require the relocation of military facilities at Changi, nor the writing off of Paya Lebar Airport.

But in contrast, building the new international airport at Changi offered several advantages. Aircraft would not need to overfly densely populated residential areas, which would reduce noise pollution for residents. There would also be less height restrictions on future building developments, as aircraft bound for Changi Airport would be flying over water. Additionally, there would be less ground traffic congestion issues, given that the site at Changi would offer a clean slate of land to comprehensively develop the necessary infrastructure and facilities. Changi would also offer available land for long-term airport expansion.

After much debate, the government decided to proceed with building the new airport at Changi, initially with one runway. This eventually developed into today’s Changi International Airport.

(See “Advantages of Having the Airport at Changi”, page 23)

**Think Long Term**

Deciding on the Changi location for the new airport was just the beginning. Careful plans had to be drawn up to optimise land use and ensure adequate space for future expansion of the airport and its complementary facilities. These early considerations made the Terminals 4 and 5 of today possible.

To contribute to a city’s liveability, airports cannot remain separate and disconnected from the broader urban environment. Most successful airports are located not too near, but also not too far from the cities they serve. They must also be closely linked through physical transportation and logistics connections to meet local transportation needs. Besides connectivity, there should additionally be complementary and supporting land uses near the airport. This creates a good synergy between different activities and alleviates traffic congestion.
Fortunately for Singapore, Changi Airport offered a clean slate of land to comprehensively develop the necessary infrastructure and facilities. It has bolstered the country’s operational efficiency as a distribution centre for people and goods, and as a hub for transport and communications. Taking away from the Paya Lebar Airport experience, instead of having just one access road, Changi Airport was designed to be linked to the city by two highways. These were the East Coast Parkway and the Pan Island Expressway. Also, in anticipation of future needs, land was safeguarded for a Mass Rapid Transit (MRT) rail connection from the airport complex to the city.

(See “Leveraging Accessibility to the Airport for Urban Development”, page 39)

**Build in Flexibility**

As Singapore became more built-up, land-use trade-offs have become increasingly complex. To free up prime land in the northeast, which could accommodate up to 80,000 public and private homes, the government announced in 2013 that it would be closing down Paya Lebar Air Base and relocating its military facilities to other air bases. The move would also remove the height restrictions around Paya Lebar and its surroundings, permitting the construction of taller building in these areas.

With the decision to relocate Paya Lebar Air Base, the plan was to expand Tengah Air Base to host some of the facilities from Paya Lebar. This was not a small undertaking, as land had to be acquired and existing cemeteries needed to be exhumed. Yet these did not deter the move. In fact, with careful planning and advances in noise reduction solutions, the government can concurrently plan for new developments in and around Tengah. For instance, the upcoming Tengah New Town and Jurong Innovation District integrate both quality living and work spaces.

(See “Relocation of Paya Lebar Air Base”, page 68; and “Building Tengah New Town”, page 70)

The government has continuously reviewed its planning and development of infrastructure in tandem with the evolving needs of travellers. For example, Village Hotel Changi, Crowne Plaza and Aerotel were built near the airport to service a growing number of in-transit travellers.

(See “Positioning Singapore as an Air Hub to Promote Tourism and Air Logistics”, page 52)

**Execute Effectively**

The big transition of civil aviation operations from Paya Lebar Airport to Changi Airport was done in one night without any disruption to air transport services. The move involved extensive and meticulous planning and preparations. As a precaution, Paya Lebar Airport was kept as a contingency option. The plan was to divert planes to Paya Lebar if any faults or breakdowns occurred at Changi Airport, and to use buses to transport departing passengers over to Paya Lebar. Nonetheless, Changi began operations without a hitch, and no passengers had to be diverted to the former airport.

The government had not set out to make Changi Airport the best in the world when it first started operations. However, what worked in Singapore’s favour were the readily available spare capacity and the dedication of public service leaders such as Mr Sim Kee Boon. Mr Sim, mindful that a huge amount of taxpayers’ money was being invested in the public infrastructure, made running the airport well an important responsibility. At the same time, the airport management was increasing its efforts to provide better customer service and create better travel experiences for discerning travellers and Singaporeans alike. These pioneering standards of service excellence paved the way for Singapore’s airport to become one of the best in the world.

(See “Extensive Preparations for the Big Move to Changi Airport”, page 26)

**Innovate Systematically**

To ensure that it continues to deliver a superior passenger experience, Changi Airport couples technology with business innovation in initiatives such as the Fast and Seamless Travel that eliminates check-in queues and increases passenger check-in throughput; and the Arrival Flight Predictor that uses artificial intelligence to better predict aircraft landing times and enable other airport stakeholders to plan and deploy their resources to facilitate smoother passenger flow.

Such innovation has also allowed Singapore to be a competitive and renowned international air logistics hub. Facilities are regularly upgraded to meet the needs of businesses, such as dedicated climate control storage for perishables and pharmaceuticals, and 24-hour Free Trade Zone operations with expedited customs procedures. These enable improvements in the areas of productivity, efficiency and service standards.

(See “Positioning Singapore as an Air Hub to Promote Tourism and Air Logistics”, page 52)
Integrating the Planning of Airports and the City: The Singapore Story

Dynamic Urban Governance

Lead with Vision and Pragmatism

In February 1968, in anticipation of British withdrawal from Singapore, the government set up the Bases Economic Conversion Department (BECD) to maximise the use of British legacy infrastructure and to generate economic spinoffs. For instance, extensive studies and preparations were conducted to decide how to convert former British facilities for economic use. For the air bases that were left behind, immediate steps were taken to create a large-scale, competitive aerospace industry and compatible land uses for co-location.

On the civil aviation front, Singapore had ambitions to become an air hub as it sought to industrialise and build up its tourism and logistics industries. Resources were deployed for the development of major tourist infrastructure, such as airports and hotels. Singapore also strived to become a competitive transhipment and international logistics hub, offering comprehensive infrastructure, services, support, electronic data interchange (EDI) systems such as TradeNet, and free trade zone statuses.

(See “Positioning Singapore as an Air Hub to Promote Tourism and Air Logistics”, page 52)

Work with Markets

In 2007, the Changi Airport management was corporatised so that the reconstituted Civil Aviation Authority of Singapore (CAAS) could focus on being an aviation industry regulator, promoter and developer. On the other hand, Changi Airport Group (CAG) became responsible for the operational aspects of managing Changi Airport and the airport emergency services, as well as overseas investments. The CAG is presently run like a business entity: it can pursue business ventures and opportunities with greater flexibility, in response to industry changes and global market movements. It can also attract and retain top talent to compete with global airport operators. These developments show how Singapore is prepared to invest and take bold measures to stay ahead in the aviation business.

(See “Further Expansion of Changi Airport”, page 71)
We realise that our [airport’s] services must be both economical and efficient...if we can provide a better and cheaper entrepôt service for others than they can provide for themselves...our neighbours [will] continue to trade with us.”

Lim Yew Hock, Then Chief Minister of Singapore

SINGAPORE’S EARLY AIRPORTS: SELETAR, KALLANG AND PAYA LEBAR

The advent of commercial air transport and civil aviation has changed people’s way of life. With intercontinental travel, transit times were slashed. Important mail and goods could also be delivered rapidly, improving communications and facilitating trade.

Singapore was well positioned to take advantage of the revolution in aviation. Its colonial ties to the British and geographical position at the centre of Asia made it conducive to international aviation, on the one hand. On the other, its location along major sea lanes made it favourable for shipping.1

However, Singapore’s eventual development into an international air travel node did not happen by chance.

In the early years of air transport, the commercial viability of air routes was a huge concern. Airlines would call at specific locations only if they were confident of the demand for their services. Airport infrastructure was expensive, and building new airports was an uncertain endeavour that came with high risks. However, the potentially large benefits for the host countries were also immense. Meanwhile, air transport faced strong competition from the maritime and shipping industry. Shipping was cheaper than air, and although the journey took a longer time, it remained the most commercially viable option for transporting large quantities of people, bulky materials and goods.2

Singapore’s first airport was the Seletar Royal Air Force Station (RAF Seletar). Completed in 1928, it was the first British Royal Air Force base located east of India,3 and served as the headquarters of the RAF Far East Command. Military air bases such as RAF Seletar were important for the protection of British commercial interests during that time. In 1924, the annual value of trade by British vessels in the area protected by Singapore was estimated at £890,000,000.4

Apart from military aircraft, RAF Seletar catered to Singapore’s civil aviation needs. However, it was a modest airport, and its relatively distant location—15 miles (~24 km) north of the island’s city centre—made it inconvenient for operators and passengers alike.5 This was compounded by the lack of good land transportation access to the area.
Other than RAF Seletar, the British built Tengah and Sembawang Air Bases in 1939. This was in response to the escalating geopolitical tensions before the Second World War, and the looming threat facing the British Empire’s trade routes and interests in the Asia Pacific.

At the time, Sembawang was the site of the most intensive British military build-up. A world-class Naval Base was constructed there, complete with air support from RAF Sembawang and RAF Seletar. The command of these military assets was so impressive that Winston Churchill, then Prime Minister of the United Kingdom, referred to Singapore as the “Gibraltar of the East”, believing the country was an impregnable fortress.

Remarkably, the building of the fourth military airport, at Changi, was initiated in 1943 by the Imperial Japanese forces that occupied Singapore. Allied prisoners-of-war (POWs) were used as forced labourers, but upon Japanese surrender, the British completed the construction using imprisoned Japanese troops.

### Table 1: List of RAF Airports in Singapore

<table>
<thead>
<tr>
<th>#</th>
<th>Airport</th>
<th>Year Built</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RAF Seletar</td>
<td>1929</td>
</tr>
<tr>
<td>2</td>
<td>RAF Tengah</td>
<td>1939</td>
</tr>
<tr>
<td>3</td>
<td>RAF Sembawang</td>
<td>1939</td>
</tr>
<tr>
<td>4</td>
<td>RAF Changi [Later Changi Air Base (West)]</td>
<td>1946</td>
</tr>
</tbody>
</table>
The British themselves understood the need for a dedicated civilian airport. Wanting to seize on the rosy prospects of air travel, and the important role that Singapore could play as a gateway between England, the Far East and Australia, they started constructing Kallang Airport. This became Singapore’s first purpose-built civilian airport, built over a site covering 1.03 km² (103 ha) of tidal swamp. It was completed in 1937 at the cost of 9 million Straits Dollars.

Kallang Airport was conveniently located just two miles (~3.2 km) from the city centre, facilitating access for business travel.6 It was close to the sea and could serve seaplanes, which were commonplace then.7 Unfortunately, the Second World War broke out soon after, and Kallang Airport suffered wartime bombing damage and neglect. In February 1947, following the end of the War, the Department of Civil Aviation (DCA) and the Public Works Department (PWD) were tasked with its repairs and rehabilitation.8

In the interim, aeroplanes operating between Singapore, Britain and Australia were redirected to Seletar. Aircraft weighing more than 65,000 pounds (almost 30,000 kg) had to be diverted to the RAF airfield at Tengah, and later to Changi Air Base after it opened to civilian traffic.

Air traffic was directed back to Kallang in May 1948 after rehabilitation works were completed. By then, it became apparent that Kallang was not equipped to handle the newer, larger and heavier aircraft, and the sheer growth in air traffic volume. Kallang Airport’s runway thus had to be strengthened and extended from 350 to 2,500 metres to cope with the situation.9 While the works on the runway were ongoing, air traffic diversions were necessary, but costly and disruptive.10 Moreover, increased air traffic at Kallang caused other problems. Traffic congestion occurred at Mountbatten Road and Kallang Road whenever several aeroplanes landed at the same time. Further, the noise pollution caused by planes landing and taking off affected the quality of life of nearby residents.11 There were also concerns that the proximity of Kallang to the densely populated Geylang area would have disastrous consequences; for instance, if a plane were to crash nearby.12
Due to these concerns and the “colossal sum” involved in acquiring land from the heavily developed surroundings, further development of Kallang Airport was not considered. The more economical alternative was to build a new airport altogether. Therefore, in 1950, the colonial government began to search for an alternative site for a civilian airport—one that offered sufficient room for future expansion. The cost of acquiring the new site from existing residents and squatters would be adequately covered by the sale of the Kallang Airport site for subsequent private-sector development—an estimated 20 to 25 million Malayan dollars.

Changi was a site option for the new airport. From as early as 1946, plans had been made to develop the area into a joint civilian and military airport. However, these plans were abandoned in late 1948 because Changi’s location in eastern Singapore was considered too far from the city centre. Furthermore, there was the issue of unsatisfactory drainage, which would make the construction of a modern runway at Changi “exceptionally expensive, if not actually prohibitive”. The airfield then was “surrounded by swamp and soggy ground and had a deep, shifting subsoil”, and construction attempts were held up by the discovery of “heavily saturated clay at considerable and varying depths”. These conditions would hinder future expansion plans and increase costs.

With Changi deemed unsuitable, the need to find a site for the new airport grew ever more urgent. At a Legislative Council meeting in 1949, the then Governor emphasised the importance of air transport for Singapore. As a focal point of air communications in Southeast Asia, air transport would attract trade and commerce, and increase the revenues of the Colony.

Finally, in 1951, a decision—championed by Singapore’s civil aviation authorities and approved by the Colonial Office in London—was taken to build a new airport at Paya Lebar. Located eight kilometres northeast of the city centre, it was close to the city centre and well placed to take over commercial and civilian air services previously handled by Kallang Airport.
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Chapter 1

GROWING NEED FOR A BIGGER AND BETTER EQUIPPED AIRPORT

By the late 1950s, it became vital for Singapore to have a well-functioning international airport with adequate capacity. The airport would support the country’s role as an entrepôt for trade, tourism and foreign investments. Moreover, air traffic was growing about 20% faster than the world’s average rate, and passengers made up 25% of international traffic passing through Singapore. These figures remained resilient in spite of 1958’s trade recession.

We have an excellent natural harbour with the best of man-made institutions to make it into one of the world’s greatest market places. We are building our airport to ensure that every facility is given for traffic in people and goods to come here from all nations. We realise that our services must be both economical and efficient...if we can provide a better and cheaper entrepôt service for others than they can provide for themselves...our neighbours [will] continue to trade with us.

Lim Yew Hock

As Mr Lim described, although Singapore was a reputable seaport then, a world-class airport was essential to further develop the country into an international air and sea junction. This was important for an island trading nation with no hinterland, and whose economic survival depended on its ability to find economic relevance beyond its borders. As a shipping and air transport node and a manufacturing destination with links to major markets and clients, Singapore was well positioned for this next step.

By the 1960s, the world was experiencing a rapid surge in air traffic and significant developments in aviation technology. Having a well-equipped international airport known for safety and efficiency would thus enable Singapore to ride this wave of growth. It would additionally cultivate an investment-friendly climate the government sought to establish. Air traffic and transport therefore became part of the national development strategy, and a pragmatic response to global trends.

Civilian and commercial aviation also grew in significance following

Figure 7: Concorde at Paya Lebar Airport, 1972.
Ministry of Information and the Arts Collection, courtesy of the National Archives of Singapore.

Paya Lebar was free of obstructions, and the airport could be built there following the resettlement of existing squatters and residents. The building cost could therefore be kept low. Consequently, in 1951, land acquisition affecting some 300 families over 1,000 acres (~4.05 km²) of land was carried out. Construction of the airport ensued in 1952, until its official opening in 1955, when it began operations with a single runway and an interim passenger terminal building.

Although there was a clear need for the civilian airport and a projected surge in air traffic, the Colonial government could only afford an interim passenger terminal. There were also other aviation priorities, such as making operational improvements to air traffic control, and physical upgrades to airport infrastructure, such as runway lengthening, enlargement of apron bays, etc.

Nevertheless, building Paya Lebar Airport was a necessary, strategic move to enable Singapore to catch up with international aviation-sector developments.
Singapore’s independence in 1965. Under the previous plan for a common market with Malaysia, road and sea transport would have been the primary means of ferrying goods and people to and from the hinterland. However, as a newly independent state, Singapore sought to cast its economic net far and wide. Beyond just the Southeast Asian region, the Singapore government hoped to attract investments from companies in the United States, Europe and Japan. And having an international airport would make these international connections possible.

Alongside other national priorities such as providing jobs, housing and defence, the government recognised that a good international airport was essential. It would serve not only as an economic lifeline for the country to tap into the global economy, but also reap longer-term benefits commensurate with the high initial costs.

By the late 1960s and early 1970s, Paya Lebar Airport’s physical infrastructure and development had come under strain due to air traffic growth and emerging advancements in aviation technology. These included a new generation of jet planes, the wide-bodied jumbo jets. Two and half times the size of previous commercial planes, they boasted three times the seating capacity and twice the cargo space.

As a result, measures were taken to prepare the airport for these modern aircraft. Works on lengthening and resurfacing the runway began in 1967, but it was clear that a new airport—with larger capacity to accommodate the anticipated increase in air traffic—was required in the medium term. Fundamentally, a decision had to be made between two options: upgrading the existing airport, or building an altogether new and better international airport elsewhere on the island.
Integrating the Planning of Airports and the City: The Singapore Story

Changi Airport is our major investment to exploit our geographic location. Singapore must be prepared and ready to seize every opportunity that comes its way....Can Singapore ever afford not to have such an airport?”

Howe Yoon Chong, Then Minister for Defence

Paya Lebar or Changi? That was the question

In the 1970s, the government realised that Paya Lebar’s single runway would soon reach its maximum capacity and that a second runway was needed to cope with projected air traffic growth. With the expansions, Paya Lebar would be able to handle four million passengers per year. But this was four times that of the one million capacity it was designed for.

Hence, in 1968, the government turned to a team of British airport consultants from Scott Wilson Kirkpatrick and Partners under the Colombo Plan. These consultants were tasked to study the projected growth in air traffic, and draw up plans and guidelines for the development of Paya Lebar Airport.

After an evaluation, the consultants concluded that a second runway was needed by the middle of 1978. Their proposed airport development plan also called for a three-phased $600 million expansion programme over a 20-year period, up to 1990.

But the question remained: was Paya Lebar the best site for Singapore’s main airport in the long term?
Integrating the Planning of Airports and the City: The Singapore Story

...would shift to Changi, and that aircraft would no longer fly over Katong and Kallang, two of Singapore’s prime residential districts. Some even speculated that the spontaneous nature of this announcement was in response to the noise of overhead aircraft drowning out the Prime Minister’s speech.²⁸

Up until then, most people believed that an expanded Paya Lebar, with its second runway, would remain the republic’s major air gateway. Many were also of the view that Changi would serve as a second international airport only in the early 1990s.

The decision between Paya Lebar and Changi was not an easy one, and various experts and officials had competing views. Some British officials supported the use of Changi as Singapore’s main airport. In 1971, British Air Chief Marshal Sir John Grandy announced that the Changi Air Base would be returned to the Republic at the end of the year when the British military withdrawal was complete. He suggested that the authorities prepare to divert the airport expansion programme, ideally to Changi, where most aircraft noise would be over the sea.²⁹

That same year, the Singapore Planning and Urban Research Group (SPUR), a local society consisting of young architects and planners, set out reasons why Changi should be developed instead of expanding Paya Lebar. They pointed out that increasing air traffic and the development of larger, noisier planes like jumbo jets and supersonic aircraft would impose unbearable noise pollution levels on areas along the flight path to Paya Lebar. These included Geylang and Katong,³⁰ which had substantial residential populations.³¹

Despite these comments and debates, the official position at the time remained that Paya Lebar Airport should first be developed to its fullest potential, before Changi was to be developed.³²
Chapter 2

Integrating the Planning of Airports and the City: The Singapore Story

INCLINATION TO KEEP CHANGI FOR MILITARY AIR BASE USE

Subsequently, the air base served as the headquarters and communications centre of Britain’s Far East Air Force until 1971, when it came under the management of the Singapore Air Defence Command.34 Due to the growth in air traffic, Changi Air Base was also used as a diversionary airport for Paya Lebar Airport.

Changi is a military air base and it is likely to continue its present military role for at least the next decade, because it will be very costly to duplicate the military facilities already available at Changi for defence purposes elsewhere—the realistic choice is not to develop Changi now and to abandon Paya Lebar; rather, it is to develop Paya Lebar to its fullest potential and to develop Changi later.35

Ngiam Tong Dow

As described by the Mr Ngiam, then Permanent Secretary of the Ministry of Communications, pragmatic use of existing resources and fiscal prudence were the more immediate concerns.

Figure 10: Changi Military Air Base, one of five military air bases of Singapore, 1965 (not drawn to scale). Aerial photograph by the British Royal Air Force between 1940 and the 1970s, from a collection held by the National Archives of Singapore. Crown copyright.
Soon after, in 1972, the government appointed American airport consultancy Northrop Airport Development Corporation to review the 1969 Airport Plan by the British consultants from Scott Wilson Kirkpatrick and Partners. Since Mr Lee Kuan Yew himself was not convinced that the expanded Paya Lebar Airport was the best course of action, Northrop also studied the feasibility of using Changi as Singapore’s main airport.

The new air traffic forecasts made by Northrop were much higher than those reported in 1969. They claimed that, in order to cope with rapid air traffic growth, expanding Paya Lebar was an urgent matter. Recognising the pressing need for expansion, the government approved the construction of Paya Lebar’s second runway in July 1973. Nevertheless, the question of Paya Lebar’s long-term suitability remained. The following month, Mr Cheong Pak Chow, then Director of Civil Aviation, remarked that Singapore had to consider building a second international airport to keep pace with growing needs.

The global oil price crisis of 1973–74 halted Paya Lebar’s expansion plans. The October 1973 oil crisis led to a five-fold increase in fuel costs by early 1974. As airlines struggled to cope with soaring fuel prices, flights became far more expensive than before. This unexpected development arrested the rapid growth of passenger air traffic worldwide. As a result, annual visitor growth at Paya Lebar Airport plummeted from an average of 25% during the period of 1968–73, to just 9% in 1974.

Despite the impact of the oil crisis, the government remained confident that aircraft and passenger traffic through Singapore would continue to increase in the long term. After all, the country was situated “right in the heart of the Association of Southeast Asian Nations (ASEAN), the fastest growing economic grouping in the world”. The adoption of new wide-bodied jets also meant that there would only be more and heavier aircraft, and more passenger traffic and air cargo were to be expected.

The oil crisis also came with a silver lining. It offered Singapore the chance to rethink its plans for expanding Paya Lebar Airport, since there was less urgency to cope with soaring passenger arrivals in the short term. There was now more time to construct a new passenger airport at Changi, instead of rushing to expand Paya Lebar Airport.

[After the oil crisis erupted in 1973, the] price of oil quadrupled from US$1.20 to over US$5.00 per barrel. Air traffic slowed down and the Boeing 747 jumbos entered service. So fewer planes were using Paya Lebar. This delayed the need for a second runway. I took this opportunity to re-consider the decision.

I appointed Howe Yoon Chong, then Chairman of the Port of Singapore Authority, to head a team to study if we could move to Changi in time before a second runway was necessary. The team concluded that Changi was possible and could be ready by 1981. However, between 1974 and 1981, we would have to invest in more facilities at Paya Lebar to meet the yearly increase in traffic.

Nevertheless, there was no immediate consensus on this complex decision. In 1975, the Ministry of Finance re-submitted the proposal to the government to extend the Paya Lebar Airport by building a second runway. Following this, two opposing groups emerged.

Mr Bernard Chen, then Assistant Secretary at the Finance Ministry, recalled the debate vividly. The first group, led by the Finance Ministry and its Minister Hon Sui Sen, believed that Paya Lebar was the best choice. His reasons were that it was more cost-effective, the airport was already located there, and less new construction was required. Stressing the need for financial prudence, Mr Hon fought “tooth and nail” for Paya Lebar.

The second group included then Minister for Communications Mr Ong Teng Cheong. Mr Ong believed that, despite higher initial costs, Changi was a better choice in the long run because it could cater for future expansion.

Then Prime Minister Lee was inclined towards Changi, largely on environmental grounds. Paya Lebar was located within a densely populated area, and a second runway would have negative implications on the environment and the quality of life for residents nearby. When Mr Lee flew over Logan Airport in Boston in 1974, he was “impressed that the noise footprint of planes landing and taking off was over water”. He subsequently recognised the advantages of building an airport alongside or onto the sea. With Changi, Singapore could retain the flexibility to build additional runways into the sea without having to impose height
restrictions on future building developments. It additionally mitigated the noise pollution burden on residents.46 Years later, Mr Liew Mun Leong, current Chairman of Changi Airport Group (CAG), would reaffirm Mr Lee’s decision. Mr Liew suggested that it would have been impossible for the HDB New Town at Tampines to be built if Paya Lebar Airport had proceeded with its expansion. The height restrictions imposed by flight paths would have prohibited it.47

In 1975, a Special Committee on Airport Development (SCAD) was set up to study the issues and recommend the best course of action.48 This Special Committee comprised the Permanent Secretaries from various government agencies and departments involved in finance, infrastructure, aviation and communications. It included engineers from the electricity, water and gas departments of the Public Utilities Board, Port of Singapore Authority (PSA), Telecommunication Authority of Singapore and the Public Works Department.49

It was chaired by Mr Howe Yoon Chong, then concurrently the Head of Civil Service, Permanent Secretary of the Prime Minister’s Office, Chairman of the Port of Singapore Authority and the Chairman of the Development Bank of Singapore. SCAD’s report writing secretaries were Mr Lim Hock San and Mr Pek Hock Thiam. The former was Mr Howe’s assistant at PSA, and later became the Director General of the CAAS, while the latter was the Principal Assistant Secretary at the Ministry of Communications.

Mr Howe and his team were tasked to come up with a master plan that would define the roles of the Paya Lebar and Changi Airports. The idea was to maximise the potential of both airports while reducing the overlap of functions.50

To this end, four options were considered: to expand Paya Lebar with a second runway to the West; to expand Paya Lebar with a second runway to the East; to have a new airport at Changi with two runways; and to have a new airport at Changi with one runway, and both civil and military operations at Paya Lebar.

One of the SCAD report’s recommendations was for Changi to be “developed into a modern airport worthy of Singapore and that the plans for the second runway at Paya Lebar and for its expansion should be scrapped”.51 It justified the choice of developing Changi, at the projected cost of $1.2 billion—a decision subsequently endorsed by all heads of government ministries and agencies involved.52

Mr Howe recalled then Prime Minister Lee’s discomfort about the earlier proposal to expand and continue using Paya Lebar:

The Prime Minister was not fully comfortable with the earlier decision to build the second runway at Paya Lebar. His concern was wide-ranging. It bothered him that the increased noise and air pollution with an additional runway would irritate more and more people living in the areas surrounding the expanded airport. The traffic congestion, already bad on the approach roads to the airport, would be further aggravated. The resettlement of thousands of families would cause much suffering and hardship. We would be accumulating problems for the future.53

With that, the government decided in May 1975 to form an Executive Committee of Airport Development, headed by Mr Sim Kee Boon. Mr Sim, then Permanent Secretary for the Ministry of Communications and subsequently the Head of Civil Service, would oversee the construction of Changi Airport within six years.

Finally, in June 1975, when announcing the Cabinet reshuffle, the Prime Minister’s Office confirmed that the Changi location would be developed as Singapore’s main international airport.54

ADVANTAGES OF HAVING THE AIRPORT AT CHANGI

Former Chief Defence Scientist Prof Lui Pao Chuen, who was closely involved in the “Paya Lebar vs Changi” debate, championed this decision. He noted that from the technical perspective, the choice of Changi was obviously superior to Paya Lebar.

The Paya Lebar flight path was over populated areas. I lived, at that time, near Katong Park. There was government housing in a place called Arthur Terrace on Arthur Road. It was directly in line with the centre line of the runway. Every evening, the aircraft roared. You can’t hear that from Changi Airport. So the noise at Paya Lebar would have created a lot of problems for residents.
The other thing was the height constraint for buildings affected by flight paths related to Paya Lebar. Changi Airport did not have this problem. Number one, [bound] for Changi aircraft will be flying over water so it doesn’t cause any problem to homes and number two, Changi could still grow and therefore, you would not be constrained as you would be with the Paya Lebar site. So it was so obvious that Changi was the superior solution.\(^{55}\)

An important corollary of the decision to build the international airport at Changi was shifting most of the Changi Air Base operations to Paya Lebar. In other words, Paya Lebar would become a military air base. Prof Lui cited inadequate communication between the leaders and senior officials of the different ministries as a reason for the delay in arriving at a final decision.

So why didn’t we start building the airport earlier in Changi instead of having the military build an air base there? One reason was because MINDEF [the Ministry of Defence] was so powerful that MINCOM [Ministry of Communications] did not dare to try. They thought Goh Keng Swee [then Minister for Defence] would never let Changi go because the Air Force was already building in Changi.

In the mind of MINCOM...Goh Keng Swee would say, ‘What?!’ to moving from Changi. They did not know that Goh Keng Swee did not like the location of Changi for the military air base. Goh Keng Swee’s assessment was that Changi was too close to the coast and therefore vulnerable to attacks by naval commandos. Paya Lebar was superior. So you’ve got a Minister for Defence who actually wanted Paya Lebar for his air base. Had the two ministers only communicated! Finally they did and who was the communicator? Howe Yoon Chong. Sometimes, the decision is so simple. Actually both parties wanted it but they didn’t know that the other side wanted it too.

While the reasons to build the airport at Changi appear compelling today, some of the people involved at the time were sceptical. Aside from the higher cost, they had doubts about the flight and growth forecast which indicated that Changi would eventually handle 30 million passengers per year. Liew Mun Leong, a civil engineer working in the PWD then, summarised such concerns:

To be frank, [then Deputy Prime Minister] Goh Keng Swee was also sceptical about it, and he said that if we were to have 30 million passengers, all our children would have to become waiters, bellboys and porters because there would be so many hotels and restaurants to accommodate them all.\(^{56}\)

Some also wondered if Changi Airport could be built in six years’ time, by 1981. It would be a challenging task to build a modern international airport in such a short period. And finally, “Would the PWD, the oldest department in the colonial government, be able to build the huge new airport? Did the PWD even have the technical competence to do it?”\(^{57}\)

Howe disagreed and had no such doubts. To him, the cost difference was “very much of a bargain” since upgrading Paya Lebar would be expensive, too. He pointed out that the cost for Phases I and II of Changi was an estimated $1.241 billion (~$1.241 billion), while the total projected cost of the second runway and extensions to Paya Lebar was well in excess of $800 million.\(^{58}\) While Changi was indeed more expensive in absolute terms, the extra expenditure provided Singapore with a new, modern, world-class airport with expansion potential. And in terms of meeting the completion schedule, Mr Sim Kee Boon was able to pull together the various branches of the government and civil service to meet the stringent timeline.

Mr Ong Teng Cheong also highlighted the technical challenges of expanding Paya Lebar’s passenger and flight capacity. The second runway, if built there, would be on a site straddling a river and a decade-old public refuse dump. As such, tackling problems such as “drainage, canal diversion, squatter resettlement, removal of rubbish dumps and refilling of the swampy areas” would be time-consuming. He then estimated that the expansion of Paya Lebar would not be completed before 1984.\(^{59}\)

On the other hand, Ong Teng Cheong argued,

The present runway at the Changi airfield could be easily lengthened, widened and strengthened into a runway acceptable for international air traffic operations by the middle of 1980, while the second runway at Changi will be built on land reclaimed from the sea and it could be ready by the middle of 1982. This means two or three years ahead of scheduled completion of the second runway at Paya Lebar. In terms of timing, the Changi option is obviously superior.\(^{60}\)
EXTENSIVE PREPARATIONS FOR THE BIG MOVE TO CHANGI AIRPORT

Very few people appreciate this—we moved from Paya Lebar to Changi in one night without any disruption in [air transport] service. The last flight out of Paya Lebar was an SIA flight around 11.30 [pm]. The first flight into Changi was 6.00 [am] or something like that, [via] Singapore Airlines.

Everything was ready. We didn’t have to bus anybody back [to Paya Lebar]. This is quite an achievement... nobody could have done it without all the planning.65

Bernard Chen Tian Lap, Then Assistant Secretary, Ministry of Finance

Deciding on the Changi location was the first step. Thereafter, thousands of experts and officials set to work at making Changi Airport a reality. Plans were carefully drawn up to optimise land use and ensure adequate space for future airport expansion. These plans also factored in the siting of complementary facilities around the future airport.66

Adjacent land owned by the Housing and Development Board, Changi Republic of Singapore Air Force (RSAF) Airbase and some private parties had to be acquired to assemble the 16.63 km² of land required for the new airport. In comparison, Paya Lebar occupied only 2.85 km² of land—about one-sixth the size of Changi.67

Despite the challenge of land acquisition, one bright spot was that fewer households (about 800) had to be resettled, compared to the Paya Lebar option, which would have required 4,000 households to move.68

Next, additional land had to be reclaimed for the construction of Changi Airport. Fortunately, the Port of Singapore Authority (PSA) had already planned to reclaim 334.4 km² of land in the area for a potential air-sea terminal.69,70 It was deemed possible then to co-locate a container terminal with the upcoming airport to facilitate the possibility of intermodal freight transport.71

Eventually, this idea was shelved by the PSA in 1979 because they needed a faster and less costly solution to manage the rapid growth in container cargo.72 The containerisation of maritime cargo shipping would also have required the use of tall cranes, but the cranes would have posed a safety risk so near to Changi Airport.73 Instead, 7.07 km² of the planned reclamation was carried out by the PSA, and the land was used for part of Changi Airport.

While the seaport did not materialise, a connection to the sea remained important for Changi. Towards the north of the airport, accessibility to the sea was provided in the form of a jetty for the delivery of aviation fuel directly from the fuel tanker to the fuel farm. The extension to the jetty could also serve as a marine base for rescue purposes.74

As a final precaution, Paya Lebar Airport was kept on standby as a contingency option when Changi Airport first opened. The plan was to divert planes to Paya Lebar if any faults or breakdowns occurred at Changi, and to use buses to transport departing passengers to Paya Lebar. But as it turned out, Changi began operations without a hitch, and no passengers had to be diverted to the former airport.
With the decision to move the airport to Changi, the military air base construction at Changi Air Base was halted. Military aircraft operations such as training and patrol ceased, as the Ministry of Defence prepared to use Paya Lebar as an air base instead. At the same time, a parallel taxiway east of the Paya Lebar runway was constructed for future military use. Finally, in 1976, it was decided that after Changi opened, Paya Lebar would become a supplementary airport, handling non-scheduled and charter flights alongside its military functions. Meanwhile, the Netherlands Airport Consultant Group (NACO) was engaged to develop and review existing master plans in preparation for the move to Changi.

In the 26 years since the opening of Paya Lebar Airport in 1955, to the opening of Changi Airport in 1981, annual air passenger traffic through Singapore increased nearly 40-fold from 183,000 to 7,237,000. Cargo movements also grew more than 35-fold from 5,000 to 177,000 tonnes, and aircraft traffic expanded six-fold from 11,500 to 67,600 movements per year.

Based on the above performance, the decision to move to Changi did pay off in economic terms. It also substantiated Mr Ong Teng Cheong’s belief about timing critical developments with economic projections. Ultimately, Singapore’s success as an air link with a modern airport was well thought out, and in no way a coincidence.

The next chapter will examine the judicious urban planning and decisive interventions taken to realise Changi’s success. These include efforts to foster nearby compatible land uses, and strategies to catalyse Singapore’s urban development through its airport and related developments.
An airport requires a lot of infrastructure...both in terms of... land for the industries that are needed to support the airport, as well as the traffic that it generates. Because of the noise and the height constraints...most airports are put far, far away. But as a result, they are not very accessible.”

Lim Eng Hwee, Chief Executive Officer of the Urban Redevelopment Authority of Singapore

LONG-TERM PLANNING TO ACCOMMODATE AIRPORT DEVELOPMENTS

Good city-planning is about ensuring a city develops in a way that achieves optimal economic, social and sustainability outcomes. At the same time, it has to consider physical constraints, conflicting land-use needs and resource scarcity. Almost every city in the world has a physical master plan to coordinate the manner in which it develops. However, not every city is able to ensure that all development takes place according to the plan, and the best laid plans may often not be translated into reality.

In Singapore, there is the national urban policy document known as the Concept Plan. It integrates the policies and programmes of various government agencies to produce a broad blueprint for long-term land use. This plan is reviewed every 10 years.

Singapore’s Concept Plan strategically guides long term land-use planning and development. Additionally, there is the Master Plan which translates the broad and long-term strategies of the Concept Plan into detailed implementation plans over the next 10 to 15 years.

Airport developments feature significantly in Singapore’s Concept Plan and Master Plan for several reasons.

First, air transport infrastructure takes up a large physical footprint and imposes a number of development constraints in its vicinity and along flight paths. These include height limits and noise nuisance, all of which affect land use, and as a result land value.

Second, airports are vital to Singapore’s growth and development. They therefore need to be accessible, have supporting industries located nearby and, where possible, have future room for expansion. On one hand, the airport services generate income and employment directly. On the other hand, the supporting aviation and other industries, foreign exchange earnings of the national air carrier, and tourist spending contribute to Singapore’s economic growth.

Airports also have the potential to catalyse trade and business development. The ease of travel and transport facilitates business networking opportunities and international interactions. All these in turn encourage investment and boost industrial productivity.

In 1967, the announcement of the British withdrawal became an opportunity for the Singapore government to take stock of its landholdings, as well as plan for various land-use needs, including airport expansion and air defence. Thus, the then State and City Planning team drew up the plan—with technical assistance from consultants from the United Nations (UN).

The 1971 Concept Plan was introduced as a result of a four-year survey covering the economic and social aspects of Singapore’s future development. One of the survey findings projected that air transport would become increasingly important as the economy grew, and as international air travel and transportation expanded. In the Concept Plan, Changi was identified as the location for Singapore’s main international airport and aimed to safeguard space for the airport’s future expansion, while minimising the nuisance caused to residents by aircraft noise.75

Since then, both the Concept Plan and the Master Plan have not only been effective in managing the country’s land resources optimally for development. They have also been instrumental in managing the various social, economic and environmental issues faced, and in resolving conflicts among different stakeholders via constructive and innovative means.
CAPITALISING ON THE LEGACY OF BRITISH AIR BASES

When the British announced their plans to withdraw their military from Singapore in 1967, airport planning took on strategic implications beyond air transport and commercial freight. With Singapore achieving independence, the nation’s defence and economic security became a priority. The Singapore Armed Forces was at the time only in its infancy.76

Other ramifications of the British withdrawal were the significant loss of income from the British military bases—responsible for over 20% of Singapore’s gross national product—and the ominous possibility of 25,000 workers being laid off.77

Hence, the Ministry of Defence decided to set aside room within four of the five air bases inherited from the British. They would build up Singapore’s air force from scratch, i.e., Changi, Sembawang, Seletar and Tengah, excluding Paya Lebar.78

The number of airfields in Singapore would have been based on the strategic assessment of scenarios and needs by military planners at that time. Such assessment may vary over time because of changing circumstances. Nevertheless, each airbase imposes significant externalities in the form of noise and height constraints that affect the development of lands and land use near these facilities.79

Tan See Nin, Senior Director, Physical Planning, Urban Redevelopment Authority of Singapore

The next tasks were deciding how to convert the facilities turned over by the British for economic use, and mitigating economic impacts.80 The Bases Economic Conversion Department (BECD) was thus established in February 1968 to expedite the important task of making the most of British legacy infrastructure.

These formerly British assets essentially became a major part of national infrastructure. In order to offset the projected economic losses resulting from the British withdrawal, the government sought to maximise the possible economic spinoffs that the airports could generate through industrialisation and diversification.

Figure 1: Noise zones of three existing British military air bases (not drawn to scale). Adapted from The United Nations Urban Renewal & Development Project Report, Part Three—Planning & Transport (Singapore: Crooks Michell Peacock Stewart Graphics and Printing Division, 1971), Diagram 2, p. 20.

IMPACT OF AIRPORT DEVELOPMENTS ON URBAN LAND USE

We are a very small island, but we have four military air bases—Paya Lebar, Tengah, Sembawang and Changi, and then you have Seletar and Changi serving as civilian airports. Not many cities have got five airports like us. So, as an urban planner, there are a lot of limitations to what you can do [such as not being able to have high-rise skyscrapers everywhere], because the whole island is covered with height constraints. The only exception being, after some bargaining with the Ministry of Defence, the Downtown Area corridor where the controls are not entirely lifted, but higher... If you are at Paya Lebar, from Northeast towards the Southwest and you draw a funnel at the end of the runway, you can see that the Central Business District (CBD) is within the funnel, the most critical part of the whole height template, because anything could happen at the take-off or landing zones.81

Lim Eng Hwee

* The funnel refers to the “airport funnel zone”, an imaginary conical path that extends outwards and upwards from the two ends of an airport runway. This should be kept obstacle-free for the safety of aircraft taking off and landing.
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Being a small city-state, Singapore does not have the luxury of situating large infrastructure like airports in suburban areas, outside the city limits. Siting a major international airport within a bustling city requires innovative planning to overcome challenges and balance trade-offs with land use. The building height and safety restrictions applying to land in the immediate path of both arriving and departing aircraft are one major challenge. As described by Mr Lim, even Singapore’s CBD, despite being a distance from the airports, is still affected by such height constraints.

The urban planners also had to contend with four military airports occupying huge tracts of land (about 5–8 km² each). Located at different parts of the island, they imposed severe building height constraints on surrounding developments. These presented additional challenges for the planning and development of Singapore.

Compatible land uses and the mitigation of noise pollution were other factors considered in airport development. As described by former Deputy Chief Planner Dr John Keung:

> We really paid a lot of attention to airport development, for two reasons. One is that airports take up a huge chunk of land, and at that time we were talking about a third runway, fourth runway, sixth terminal or something like that, at Changi Airport! And this was many years ago...once you do that, the impact on the surrounding development is very severe. So, that means Simei, Tampines and Pasir Ris will forever be 'sentenced' to lower-rise development—you can’t build 40 storeys and so on. Then you have noise problems. You’ve got all kinds of pollution considerations: noise and air. So the restrictions on the surrounding land use are very severe. Of course, you can put industries there, you can put warehousing, you can put golf courses. These uses are suitable given the limitations.

John Keung

In determining land use around airports and air bases, a measure of aircraft noise exposure—known as Noise Exposure Forecast (NEF)** and overseen by the National Environment Agency—was used. Generally, areas subjected to NEF 35 and above were used for industrial developments. On the other hand, residential developments were only permitted in areas experiencing NEF below 35. As a result, Singapore’s airports are largely buffered by a ring of industrial, defence and reserved sites.

Following a review completed in 2012, the NEF measure was replaced with the Day-Evening-Night Level (Lden) noise metric. Similar to the NEF, Lden sums up the corrected noise levels over periods of the day (7 am to 7 pm), evening (7 pm to 11 pm) and night (11 pm to 7 am). It then accounts for increased sensitivity to noise events during the evening and the night. As such, residential developments are only permitted in areas experiencing Lden below 65. The Lden noise metric is currently applied in the upcoming land-use planning for Tengah New Town.

To reduce the impact of military aircraft noise on residents, some flying training is conducted overseas, while military jets are deliberately flown at higher altitudes and lower speeds when over land, except during operational exigencies. Additionally the Air Force takes into consideration any public feedback and adjusts its flying schedules during school examination periods.

** Used in the siting of residential developments from the early 1990s, the Noise Exposure Forecast (NEF) noise metric was a single-number index for predicting cumulative exposure to aircraft noise over 24 hours. It applied a 12-decibel weighting to noise in the night (10 pm to 7 am) period.

Figure 12: 2014 Master Plan depicting industrial land use buffer around the airports (not drawn to scale).
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Given the extent of land affected by height restrictions, noise and other limitations, the planners sought to identify good land uses for areas around the airports. They also wanted to improve the airports’ connectivity to the city, through transport infrastructure and the planning of new residential communities nearer to the airport. All these had to be done while safeguarding enough spare land for future airport expansion.

At present, both the CAAS and RSAF maintain height limit templates to protect their respective flight operations. As such, almost all of Singapore is affected by some kind of obstruction control or building height regulation. For instance, height limits have to be considered whenever a building is being planned. In Tampines, an area near Changi Airport, building heights are capped at 12 to 14 storeys.86

The CAAS, responsible for managing the use of airspace, also has control over the height of buildings, structures and machinery across the island. Figure 13 illustrates some of the CAAS’ requirements: for example, for building development, erection of structures and mobilisation of machinery that fall within the pink-shaded area, the CAAS must be consulted. This rule applies across the board, regardless of the building’s or machinery’s height.

For the other areas of the map, there are stringent RSAF requirements, and CAAS consultation is necessary only if the height of a proposed building or tall construction machinery exceeds 100 metres above mean sea level (AMSL).87 All consultations have to be submitted at least seven working days prior to the mobilisation of tall construction equipment. In the case of buildings, consultations are submitted when developers make a development application through the Urban Redevelopment Authority (URA).

Building developments situated downtown and in central parts of Singapore are the least affected by height constraints because they are further from airport flight paths.88 However, the height limits in these areas are still determined by flight procedure design criteria promulgated by the International Civil Aviation Organization (ICAO). Around the CBD, the tallest buildings are up to 290 metres in height.

Beyond building heights, air traffic affects the permissible activities in surrounding land, as shown in Figure 14. In Singapore’s crowded airspace, recreational activities such as kite-flying, parasailing, the operation of drones and release of sky lanterns may pose safety and flight hazards to aircraft. Therefore, permits must be obtained for such activities within five kilometres of an airport. Permits are also required even beyond the five-kilometre radius, if the airborne objects are flying at a great height or within the Restricted and Protected areas.
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Due to the height control and noise pollution planning considerations, airport fringe areas have limited options for usage, and are costly to maintain. In the 1980s and 1990s, golf courses were considered a sensible use of such land for several reasons.

Golf courses provide aesthetic green belts and open security zones, and the country clubs themselves are responsible for the maintenance of the land. During the 1980s–90s, the clubs also catered to business executives’ rising demand for recreational and leisure facilities. In fact, the 1991 Concept Plan showed plans for 29 golf courses, up from the existing 22 golf courses. The planners had catered for such land use based on their predictions of population growth. At the time, there was less pressure on space for other land uses.

Four golf courses were thus built adjacent to or near Changi Airport: Laguna National Golf & Country Club, Changi Golf Club, National Service Resort and Country Club, and Tanah Merah Country Club. In the past, only land in water catchment areas and open spaces in large British bases were used for golf courses.

Figure 15: Laguna National Golf & Country Club Masters Course.

Photo courtesy of Laguna National Golf & Country Club.

SPORT AND RECREATION
LAND USE
UNDER FLIGHT PATHS

LEVERAGING ACCESSIBILITY TO THE AIRPORT FOR URBAN DEVELOPMENT

(An airport) requires a lot of infrastructure to support it, both in terms of land for the industries that are needed to support the airport, as well as the traffic that it generates. Because of the noise and the height constraints...most airports are put far, far away. But as a result, they are not very accessible. You take an hour, an hour and a half, to get to the city. So, it’s not very attractive as an air hub...For us, actually, we have no choice. We cannot put the airport too far, because this is the furthest it can go already, and it’s still very near—it’s half an hour of travel—very convenient.91

Lim Eng Hwee

As Mr Lim explained, most successful airports are located not too near to, but also not too far from the cities they serve. Airport development requires a successful balance of locating complementary and supporting land uses near to the airport. There also needs to be sufficient transportation links to connect the airport to the rest of the city. Such measures will ensure a good synergy between different activities and alleviate traffic congestion.

The new Changi Airport offered a clean slate of land to comprehensively develop the necessary infrastructure and facilities. It would bolster Singapore’s “operational efficiency as a distribution centre for people and goods that ensured Singapore’s role as the centre of transport and communications”.94

While Changi Airport was further from the city centre than Paya Lebar Airport, construction of good transport links helped to mitigate the additional travel time. The new airport was designed to be linked to the city by two highways, namely the East Coast Parkway (ECP) and the Pan Island Expressway (PIE). In contrast, there was only one access road for the previous airport at Paya Lebar.95

The ECP, built on reclaimed land from the sea along the coast and spanning some 20 kilometres, provides access from Changi to the CBD within 20 minutes.96 It was meticulously landscaped by the then Parks and
Recreation Department and lined with greenery to leave visitors with an eye-catching first impression en route to the city. The ECP offered its travellers a glimpse of Singapore’s dedication and vision to be a Garden City.

Former Prime Minister Mr Lee Kuan Yew highlighted the significance of establishing this positive first impression. He described: “from the moment they [visitors] land at the airport, they should know that this place works. And that’s why we give much attention to the airport. It is a very critical factor because if you can’t get that right, well, there will be many other things you also cannot get right. The airport is their first impression.”97

This transport link further demonstrated to visitors that the government could manage the country, get things right down to the smallest details, and was capable of meeting investors’ requirements.

As part of provisions made to facilitate future expansion plans, a 2.44-metre-wide “hard shoulder” was provided on each side of the expressway. This made it possible for the ECP to become an eight-lane highway, should the need arise.98

A second highway, the PIE, soon followed. Located some two kilometres away from the airport, it connected the airport to the rest of the island other than the CBD. Moreover, roads such as Jalan Eunos were planned to link the PIE to Changi Airport. These would benefit travellers on connecting flights between the two airports until the second runway at Changi was completed in 1984. In the interim, Paya Lebar was also used for non-scheduled and charter aircraft, spillover civil aircraft traffic from Changi Airport, and as a military base under the care of the RSAF.

As air traffic increased in volume, a further challenge was integrating both passenger and cargo transport functions without causing road congestion. Just before the main airport complex, the PIE branches off to a coastal road running along the eastern boundary of the airport. At this point, cargo vehicles and visitors to the Cargo Complex are sieved from the air traffic passengers headed for the passenger terminals. This reduces congestion in the terminal area by separating the heavier and slower-moving cargo vehicles.99

Also, given the short 20-kilometre drive to the city and relative affordability of buses and taxis, Changi Airport operated without a rail link for about two decades. However, in anticipation of future needs, land was safeguarded for a future Mass Rapid Transit (MRT) rail connection from the airport complex to the city.100

From 1987, as the first phase of the MRT system was being built, Changi MP Teo Chong Tee called for an extension of the MRT line to Changi Airport. However, the concerns of the day were about passenger demand, as well as financial and economic feasibility.101

Eventually, with plans to build Changi Airport Terminal 3, the idea of a Changi Airport MRT station was revisited. In November 1996, Prime Minister Lee Hsien Loong announced the decision to have the line. Amounting to $850 million and scheduled for completion in 2001, the line was expected to have an initial daily ridership of 36,000, serving inbound and outbound travellers, airport staff, as well as workers in the planned Changi Business Park.102
When Changi Airport station first opened in 2001, it provided a through train service, end-to-end from Boon Lay to Changi Airport. To enable a speedier journey to the airport, commuters did not have to alight between every few stops. Efforts were also made to support ridership through developments such as Changi Business Park (completed in 1997), the Singapore Expo (completed in 1999) and the Airport Logistics Park of Singapore (ALPS) (completed in 2003). Situated in the vicinity of Changi Airport, the MRT service would cater to air freight, logistics and international trade exhibitions and conventions activities. It would also enhance the utility of surrounding infrastructure.

However, in spite of the best intentions and comprehensive planning efforts, this endeavour was not cost-effective. Ridership to the airport was low as developments along the way had yet to take off. Moreover, residents from the Simei, Tampines and Pasir Ris stations experienced longer waiting times because of the loop to Changi Airport and back.103

As a result, in 2003, a shuttle train service from Tanah Merah to Changi station was operated instead of the initial continuous through train service. This reduced the number of trains from 11 to 3 trains a day to serve the Expo and Changi station, saving SMRT some $2 million a year.104

You can only pull an existing [train] line to serve the [Changi] area, right? Suppose you want to deliberately serve Changi Airport, it’s a very odd configuration. To go to Changi Airport from Tanah Merah, it would take three kilometres. You then need to cut back another three kilometres before you serve Tampines town—[that’s] too long a detour, and you bypass the whole residential catchment.

At that time, probably about 20,000 people worked in Changi...when you do the trade-off, you ask, ‘Should I serve the 20,000 people and X number of tourists?’ Tourists probably don’t mind waiting for 10 or 15 minutes for a train, compared to people who take the train every day in Simei or Tampines.

...But now, with the traffic picking up, with more than 70,000 people working in the Changi area, and the passenger volume in Changi now close to 60 million per year, I think you can justify a direct feed into the Changi Airport without disturbing the residential catchment, because we are now planning a new line. So, you can now pull the new line into Changi Airport, and can still loop back and come back to Tanah Merah. This will serve the best of all worlds, although it came 30 years later.105

Lim Eng Hwee

Once again, it was not an easy task for planners. A direct MRT line was not constructed all the way to Changi Airport at the start because it was not financially feasible and there was a lack of passenger demand. This is important to note because the government bears the infrastructure cost of new rail connections and stations, and must exercise prudence.106 Moreover, new train services affect other existing transport modes, such as buses. In some circumstances, bus services may have to be stopped, or re-routed, so that the train service can operate viably.107

Nonetheless, with the upcoming Terminal 5 at Changi, and Changi East’s future industrial zone set aside for aerospace and other aviation-related businesses, a direct MRT link would eventually be necessary, and it had already been strategically catered for through long-term planning. As circumstances evolve, the MRT service would need to reach the newer developments.108

Besides the various land linkages mentioned, sea linkages to Malaysia and Indonesia were mooted by the Economic Development Board (EDB) and Singapore Tourist Promotion Board (STPB). Tanah Merah Ferry Terminal was built in 1995, at a location relatively close to Changi Airport, to facilitate the convenient transfer of travellers from neighbouring attractions such as Bintan Beach International Resort.
Chapter 3

Integrating the Planning of Airports and the City: The Singapore Story

ECONOMIC STRATEGY FOR LAND USE AROUND AIRPORTS

Airport development has the added advantage of creating new commercial opportunities in its surrounding areas.\textsuperscript{109}

Lim Hock San

In 1969, two years after the announcement of the British withdrawal, the EDB engaged American consulting firm Murphy Mundy and Associates Inc. to conduct a four-month survey. This survey would explore the economic prospects of developing an aviation industry, while bearing in mind the need to support civilian aviation and air defence needs.

Subsequently, in the 1971 Concept Plan, Seletar Airport’s surroundings were earmarked for residential housing and some industrial use. The intention was to have the airport provide employment for nearby residents and support industrial growth. Seletar not only had existing aviation infrastructure, but also housed several aircraft companies that could form the nucleus of a dedicated industrial cluster. All these suggested that Seletar could be developed into an aviation centre.

You have to expand the economic pie and bring in the type of industries that enjoy locational competitive advantages. If industries are dependent on the airport such as certain logistics functions which are time-sensitive, then it makes sense to have them located near the airport. There is also a need to establish whether certain industries are runway-dependant or not. If they are not runway-dependant, they could be sited further away from the airport. Essentially, we need to establish the right mix of industries and other uses around the airport to ensure optimal land use compatibility and not to strain the infrastructure. It was not easy to accommodate a good balance of housing and industry within an area that was subjected to the constraints of an operating airport.\textsuperscript{110}

Tan See Nin

Locating compatible land-use needs is one thing; capitalising on commercial opportunities that made economic sense is another. Mr Tan described how a successfully planned community of land users around an airport needed synergy. A balanced use of land would not create other issues such as traffic jams or a strain on existing infrastructure.

The 1969 Murphy Mundy report proposed that the best way to develop the existing three Royal Air Force facilities at Changi, Seletar and Tengah was to establish a regional air servicing centre, or even an aircraft manufacturing industry. This would create jobs for the trained aircraft technicians and aviation workers, and would also support Singapore’s aspirations to become an aviation hub.\textsuperscript{111,112}

The report made two other recommendations. One was the establishment of an Asian Academy of Aeronautics to train personnel in the various skills required in aviation. This would support the growth of an aerospace sector, and serve Singapore’s need for engineers and technicians in both military and civil aviation capacities. One of these efforts culminated in the Singapore Aviation Academy that would eventually be moved from Seletar to a plot of land nearer to Changi Airport in 1992.

The report also recommended that Seletar be developed as the initial base for the new aerospace industry.\textsuperscript{113} At a minimum, this industry would focus on becoming internationally competitive in air servicing. If possible, the ambitious target was to establish an aircraft manufacturing industry.\textsuperscript{114}

After the study, the government decided that Changi and Seletar air bases would host a range of civilian aviation industries in four promising areas. These were: aircraft engineering, component parts manufacturing, aircraft component assembly and general aviation development.\textsuperscript{115} Aircraft engineering involved the maintenance and overhaul of airborne and ground equipment, while general aviation development focused on regional air charter services for passengers and cargo, as well as pilot training.\textsuperscript{116}

As for Tengah, it would remain an air defence base of operations for the Singapore Air Defence Command, and it subsequently served as the first fighter base of operations for the RSAF.\textsuperscript{117}
The rapid growth of air traffic to and from Singapore facilitated the emergence and success of aircraft servicing and maintenance companies. The business picked up from 1975, and the aviation industry eventually grew to include facilities at Paya Lebar Airport, Changi Airport and Loyang Industrial Estate. By 1979, the total output of the industry reached $170 million, with a value-added per worker twice that of the national manufacturing average.\(^\text{118}\)

In the late 1970s, Singapore sought to attract high-technology manufacturing and service industries to support continued economic growth and create more skilled jobs.\(^\text{119}\) In his 1978 Budget speech, then Finance Minister Hon Sui Sen stressed the importance of higher value-added industries that would be less susceptible to “protectionist tendencies against the cheaper lower-skilled mass consumer products”.\(^\text{120}\)

The EDB sensed a commercial opportunity for Singapore in the area of aircraft servicing and component parts manufacturing. At the time, aircraft equipment was mostly shipped back to the United States and Europe for servicing, involving great expense and long turnaround times. Companies were thus looking for faster, more affordable options.

However, economic planners recognised that Singapore could not manufacture all the required aircraft parts due to a lack of technology and expertise.\(^\text{121}\) The EDB therefore sought to attract foreign companies with the required skills and knowledge, focusing on components required in high volume, and which involved a high degree of manufacturing skill.\(^\text{122}\)

To convince firms with a good track record to locate their plants in Singapore, a 1.93 km\(^2\) industrial site—complete with infrastructure and transport linkages—was developed at Loyang.\(^\text{123}\) Loyang’s location was ideal as it was near both the Johor Strait between Singapore and Malaysia, as well as the future Changi Airport. Phased development of the Loyang Industrial Estate was carried out, and jointly marketed by the EDB and Jurong Town Corporation (JTC) to aerospace engineering and manufacturing plants.\(^\text{124}\)

While Loyang’s proximity to Changi was an advantage for aerospace firms, it was not used solely by that industry. The estate also hosted the Singapore Off-shore Petroleum Service (SOPS) terminal or Loyang base, providing supporting services for the offshore exploration industry.\(^\text{125}\)

By the 1980s, land scarcity was growing apparent. More land was required for economic development, housing and amenities to serve the needs of an increasingly affluent population with rising aspirations. From this time, Singapore underwent a period of restructuring. It was establishing itself as a modern industrial base that leveraged science, technology, skills, and more sophisticated machinery and equipment. To build upon the 1969 Murphy-Mundy report recommendation for best use of former British air bases, officials sought to create a large-scale, competitive aerospace industry. To do so, they had to identify compatible land uses for co-location with the airports and air bases.

Efforts were made to develop Seletar into an aerospace hub as early as 1980. The JTC had come up with a 10-year (1980–90) master plan, mapping out the developments, starting from 1983, to support the aerospace industries.\(^\text{126}\)

...Seletar Airport we tried to turn into an aircraft maintenance centre but that was not easy because the land use commitment was not there. HDB always wanted Seletar Airport to be a new satellite town. But, I think, at that time the arrangement was that we would not need it for another 20 years, so EDB got to use it. But we never managed to promote permanent aerospace facilities there. Many aerospace facilities were in Loyang but Loyang would be off base; they have no runway. A lot of engine repair facilities are there but...the planes would land in Changi, take off the engines, and truck it to Loyang for maintenance. Because that’s not far [away].\(^\text{127}\)

Hwang Peng Yuan

At one point, there were talks of plans to develop Seletar into a public housing estate. However, as described by Mr Hwang, former Chairman of the EDB from 1982 to 1985, these plans did not materialise.\(^\text{128}\) Moreover, the JTC was prepared to develop Changi North as an alternative aviation centre to Seletar. Changi North was a logical site—it was close to Changi Airport, half the planned size of Seletar, largely occupied by farmers (at the time), and had already been set aside as a future industrial estate.
Despite the best intentions to promote the aerospace industry, things did not pick up as hoped, and Seletar remained largely unchanged. It was used mainly by the flying schools located there, while aircraft charters, repair and maintenance made up the remaining flights. Also, there was a public golf course and driving range, a military camp, as well as a few hundred residents living in the area’s colonial-era black-and-white houses.

During the late 1980s, the 1971 Concept Plan was reviewed. Embedded within the subsequent 1991 Concept Plan was a conscious undertaking to better integrate land use and transport with economic planning. The goal was to decentralise economic activity by creating commercial and residential nodes outside the city centre. These would be connected to the city via train and road links. As former Deputy Chief Planner Mr John Keung recalled, airports and aerospace industry considerations were major factors that preceded other developments in this plan.

...in the whole 1991 concept plan, we proposed the decentralisation strategy to create four regional centres, and two of them were designed to help the aerospace industry and the two airports: Seletar and Changi. So that is, to me, quite a major decision because we could have stayed with three [centres]...if you want to sum it up, really, our planning approach is very supportive of airport development—accommodating all the pollution, height restrictions from the airport, [while] at the same time providing this additional regional centre to support the businesses around the Seletar Airport, particularly the aerospace industry. For Changi Airport, much as you can say that there was no aero-city planned with Changi Airport at that time, the intention of [having] Tampines Regional Centre was to provide an off-city business location close enough to serve Changi Airport.

In this new 1991 Concept Plan, Seletar was identified as one of four regional centres (including Tampines, Jurong and Woodlands) to support further decentralisation, alleviate congestion and mitigate over-development in the central area. Technological corridors of business parks, science parks and academic institutions were introduced, alongside an aviation park near to Seletar Airport.

Once again, to keep up with evolving business needs, the government decided in 1989 to redevelop Seletar into the region’s first business airport-cum-aviation business park. Then EDB Chairman Mr Philip Yeo therefore commissioned a special team. He stated: “to further support our efforts in developing the aerospace industry, a study group has been formed to look at the longer-term development of Seletar Airport.”

Well, regarding Seletar, back in 1991–92, when we were first looking at the business park idea, we had...the normal industries. And then we realised that the demand was not just for manufacturing space. Companies had a whole suite of other value-added activities that were part of the manufacturing process—regional HQ functions, central distribution centres, product design, R&D, data centres, etc.
When we found that more and more of this kind of value chain needed to be added to the economy, we decided to expand the definition of ‘industry’ to create a new class [of land use] called Business Park, which permits some of these activities which are very clean and can even be accommodated in office-like premises.

So in 1991, when we created this new land-use class, one of the ideas was actually to have an aviation business park around Seletar Airport, assuming that Seletar Airport would remain at that time. We were prepared then to even design a town to coexist with Seletar.131

Tan See Nin

The new vision of a modern business airport and aviation park—a “business park” land-use classification—emerged at Seletar. Business parks were consistent with the JTC’s action plans to promote Singapore as a global business centre. Operating as total business centres, they would support new industrial and business activities by allowing tenants to conduct the entire chain of business activities within the confines of a single building.134

Hence, “Seletar Aviation Business Park” was envisaged as a hub for non-scheduled flights and smaller aircraft. It would cater to senior business executives arriving on their private jets, and support time-sensitive and runway-dependent service activities.135 In this manner, Seletar Airport could free up capacity for jet aircraft operations at Changi and optimise operation resources within Singapore, enhancing efficiency as air traffic picked up.

However, the servicing of larger aircraft used in commercial aviation required runway access. This had to be done at Changi or Paya Lebar since the existing runway at Seletar was too short. For the servicing of aircraft modules and parts that did not need runway access, a sizeable cluster of aerospace companies carrying out the bulk of MRO (maintenance, repair and overhaul) activities clustered in the Loyang and Changi North industrial areas, which were close to Changi Airport.

Having secured several new projects, we were running short of land for the aerospace industry in the Changi/Loyang area, the cradle of our aerospace industry. If we could not offer options for investors, we would not only lose new investments but also face the danger of the industry hollowing out. Hence, to exploit the opportunities and address the threats, the idea emerged of developing a new integrated aerospace park in Singapore.136

Manohar Khiatani

With the continued growth of the aerospace industry, Loyang and Changi North would eventually run out of space. Thus, as Mr Manohar, former CEO of the JTC said, the EDB considered attracting aerospace manufacturers and related services, such as flight training, as complementary sources of growth.137

In the 2001 Concept Plan, commercial development was refocused in the central area to position Singapore as a global financial hub. Consequently, Seletar Regional Centre was no longer needed, given also that the three other regional centres in development were deemed sufficient to meet the demand for commercial space outside of the central area.138

In 2006, the Cabinet made the decision, announced by the EDB, to commit to the Seletar Aerospace Park development and re-explore its potential as an aerospace hub. Beyond its existing role as a secondary airport that focused on basic flight training and general aviation, its existing runway could be put to further use to support the continued growth of the aerospace industry and complement Changi Airport’s development. The subsequent development of Seletar Aerospace Park will be covered in the next chapter.
POSITIONING SINGAPORE AS AN AIR HUB TO PROMOTE TOURISM AND AIR LOGISTICS

One of the best investments we made was to write off the $800 million sunk into Paya Lebar Airport which we handed over to the RSAF, and to build Changi Airport with two runways for $1.5 billion, which was then big money. The decision was made in 1975. If I had not intervened and we had built the second runway at Paya Lebar Airport as our foreign experts recommended, Singapore’s airport could not have become an air hub.

Lee Kuan Yew

As Mr Lee remarked, Singapore would not have achieved its air hub status without the political will to make tough but necessary long-term decisions.

Upon independence, civil aviation played an important role in Singapore’s economic survival and supported its ambitions to become an air hub. Along with the nation’s efforts to industrialise and build its tourism and logistics industries, the timely development of Changi Airport brought about greater accessibility, and boosted economic growth with trade and investments.

A successful air hub should offer frequent air services and provide extensive airport connections throughout the world. It should ideally also be situated in a strategic location in the international air network. For Singapore to truly succeed as an air hub, airlines, companies and passengers have to be able to fly to and from the country, and use it as a transit point along their journeys. To expand Singapore’s capacity and tap into international markets, the DCA, later CAAS, announced an “open-skies” policy to encourage more airlines to fly to Singapore. As an oil-refining hub, the country also offered easy access to aviation fuel.

Singapore’s liberal “open-skies” policy and many air services agreements with regional countries have made it an attractive air hub. For efficiency, most airlines adopt a “hub-and-spokes” model of operations, where local airports primarily fly passengers to a central regional airport—the hub.

This regional hub then focuses on international long-distance flights, utilising larger and more efficient aircraft to benefit from the economies of scale.

Singapore’s “friendly skies” stance also bolstered its growing reputation as an international business and investment destination. The increased air links supported diplomatic and trade relations with countries in the wider region.

Maintaining an air hub status benefits a country’s economy and brings to bear other related advantages, such as better air travel options for residents. However, hub airports rely on continuous infrastructure planning and investment, and need to have enough land for periodic expansion. This will ensure the air hub has sufficient passenger-handling capacity to cope with the surge of passengers during peak periods.

At the time, the newly established national carrier, Singapore Airlines (SIA), was building its reputation as a world-class airline, in addition to being Changi Airport’s “anchor tenant”. SIA was born out of the 1972 dissolution of the joint Malaysia-Singapore Airlines—Singapore wanted to focus on international routes which were relatively more profitable, while Malaysia’s priority was to improve domestic services to meet its national needs. Today, SIA’s continued growth and success still support Singapore’s airport and civil aviation sector by contributing significantly to passenger and flight volumes.

Throughout the years, the government took bold and decisive steps to leverage Singapore’s air hub growth. It did so by developing economic sectors that were both directly and indirectly related to aviation. In 1966, the EDB was given powers under a new bill passed by Parliament to participate in the economically promising sectors of tourism, aircraft repairs and transportation ventures. At the same time, the STPB was pulling out all the stops to market the nation as a holiday destination in its own right.
To ensure Singapore did not lose potential tourists, according to projections by the Ministry of Trade and Industry (MTI) and STPB, resources were deployed to the development of major tourist infrastructure, such as airports, attractions and hotels. Significant expenses were incurred in expanding Paya Lebar Airport in the interim to manage increased passenger traffic while Changi Airport was being built. More hotels were also constructed around the city centre, incentivised through the Government Sales of Sites programme. For instance, hotels such as Village Hotel Changi, Crowne Plaza and Aerotel were built near the airport, and eventually at the airport, to service in-transit travellers. Today, the tourism sector accounts for about 4–7% of the national GDP.

Furthermore, an integrated planning approach was taken to get the most use out of the airport and supporting industries. For example, purpose-built infrastructure like convention and exhibition facilities were built both in the Central Area (Suntec Singapore Convention and Exhibition Centre) and outside the Central Area (Singapore Expo and Changi Exhibition Centre; the latter accommodates high-profile events like the Singapore Airshow, adding significant commercial and reputational value to Singapore’s economy and attractiveness as a destination). In 2017, the entire Meetings, Incentives, Conferences and Exhibitions (MICE) sector raked in $3.2 billion and accounted for 12% of tourism receipts.\(^{142}\)

The Singapore Airshow debuted at Paya Lebar Airport, moved to a hangar at Changi Air Base, relocated to Changi Exhibition Centre next to Changi Airport, and finally shifted to Changi North. Its present location is still in close proximity to the airport, giving the exhibition the benefits of using existing runways and having an adjacent open area above the sea for aerial displays.

With the opening of the $1.5 billion Changi Airport in 1981 and the rapid growth in air traffic and air services, came the question of how airport development should be managed and regulated.

One initial idea had been for the Port of Singapore Authority (PSA) to manage Changi Airport. This would allow a seamless air and sea administrative and logistics system that would facilitate air-sea cargo and passenger transport.\(^{143}\) However, this idea was dropped when plans for the co-located air-sea terminal were shelved in the late 1970s.

Finally, it was decided that Changi Airport would be managed by the CAAS, a statutory board established in 1984 under the Ministry of Communications. Its other duties included management of civil aviation and related facilities, air traffic control services, enforcing air safety regulations, managing airline flight schedules, airport tariffs, and issuing aviation licences and permits.

Prior to the formation of the CAAS, most of these functions came under the DCA in the Ministry of Communications. However, research indicated that many successful international airports of the time—including Amsterdam’s Schiphol Airport, Tokyo’s Narita Airport and London’s Heathrow Airport—were managed by statutory bodies or commercial organisations, rather than Ministry departments. A statutory board had more flexibility to respond to rapid changes and technological improvements in the aviation industry, and oversee the competitiveness of Singapore’s civil aviation industry.\(^{144}\)
To maintain continuity, veterans who had invested time and effort in understanding the needs of aviation and airports were appointed to the first CAAS Board. These included Mr Sim Kee Boon and Mr Lim Hock San. The former was the Chairman of Keppel Shipyard and previously Chairman of the Executive Committee of Airport Development and Head of the Civil Service. The latter was Director General of Civil Aviation; Mr Lim had prepared strong policy arguments in favour of moving the airport to Changi in the 1970s.

In the several years following its opening, Changi Airport’s Terminal 1 reached full capacity. It had originally been designed for 10 million passengers per year, but served 14.1 million passengers in 1989, and expected 15 million visitors the following year. When Terminal 2 was completed in 1990, the airport was able to handle 20 million international passengers annually—the largest capacity in the Asia-Pacific region. These figures were much higher than the initial projection of 10 million passengers for each of the three terminals.

Besides setting a high bar for service standards, sweeping efforts were taken to measure operations and ensure utmost efficiency. In that regard, the Immigration and Checkpoints Authority deserves due credit. The airport operators helped to ensure that arriving passengers’ bags were on the luggage claims belts between 12 and 30 minutes upon passenger disembarkation. They also processed departing passengers at the rate of around one passenger every two minutes at the check-in counters.

Cargo handling adhered to stringent standards as well. Air cargo leaving or arriving was cleared within two to four hours, while cargo transfers from one plane to another took 45 minutes. For transhipment, a permit application for the transfer of cargo from the seaport to the airport, and vice versa, took about 20 minutes with the computerised TradeNet system. Meanwhile, transhipment courier parcels were unloaded from a plane, trucked to a courier centre, delivered to a courier company and despatched to another plane within an hour.

In fact, the air logistics industry and the closely associated air cargo industry benefitted from Singapore’s industrialisation from as early as the 1970s, even before Changi Airport was ready. This was when a number of electronic components and precision instrument industries were set up in response to the government’s bid to attract foreign investment.

In 1970, to cope with the projected introduction of wide-bodied aircraft and knock-on need for air services and logistics, newer and bigger air freight terminal buildings were constructed at Paya Lebar. Following that, the Singapore Airport Terminal Services (SATS) was set up in 1973, and the Changi International Airport Services (CIAS) was established in 1978 to improve the speed and efficiency of air cargo handling.

In the 1980s and 1990s, Singapore strived to become a competitive transhipment and international logistics hub to complement its success as an air hub. It did so with comprehensive offerings, including: excellent infrastructure, services, support, development of electronic
data interchange (EDI) systems such as TradeNet, and sufficient air freight capacity. There were also various government incentive schemes, including the Operational Headquarters (OHQ) incentive, to encourage manufacturing companies and specialised distribution companies to develop Singapore’s logistics base.

As a result, Singapore is today an international logistics hub that is known for its reliability, quick turnaround times and comprehensive air cargo services. It is replete with modern, capital-intensive infrastructure, such as the Changi Airfreight Centre (CAC), the Airport Logistics Park of Singapore (ALPS), the SATS Coolport, dnata coolchain and the Singapore Freeport. Its other offerings include climate-controlled storage for perishables and pharmaceuticals, 24-hour Free Trade Zone operations with expedited customs procedures, and warehousing facilities for ultra-high secure storage and international trading of high-value collectibles like fine art and jewellery.

Despite rising costs of land and labour, Singapore’s airport facilities are regularly upgraded to meet the needs of passengers and to uphold various aspects of airport operations. These improvement works extend to its runways and taxiways, passenger terminals, parking bays, landside road and parking systems, and other ground services. Its logistics facilities and services also undergo continual upgrading to meet productivity, efficiency and service standards.

Maintaining spare capacity ahead of demand through regular expansion and development has contributed to the success of Changi Airport. However, to secure its status as an air hub, the airport needs to uphold its high service standards. The next chapter will explore the upcoming challenges the country faces in maintaining its status as a successful air hub and ensuring continued economic growth. It will additionally examine how Singapore’s already limited land is being used more intensively as the trade-offs become increasingly complicated.
While our land is limited, we must plan on the basis that there must always be room for growth....We will continue to augment our land capacity through reclamation, by building higher and by going underground. We will also pursue efforts to recycle and optimise our land to make the best use of this limited resource.”

Khaw Boon Wan, Coordinating Minister for Infrastructure and Minister for Transport

BUILDING ON PAST ACHIEVEMENTS AND NAVIGATING MORE COMPLEX LAND-USE TRADE-OFFS

In 1980, seven million passengers passed through Paya Lebar Airport. Decades later, in 2018, the number of passengers increased to some 65.6 million people across Changi Airport’s four terminals. During this same period, cargo traffic grew over ten times, from 180,000 tonnes per annum in 1980 to 2.15 million tonnes in 2018.

As of 2018, there were about 100 airlines operating at Changi, connecting Singapore to over 400 cities in some 100 countries and territories. Changi Airport handles more than 7,000 flights every week, with an aircraft taking off or landing every 90 seconds.143

The civil aviation industry is one of the key drivers of economic growth. As described by then Deputy Prime Minister Tharman Shanmugaratnam, aviation contributed a sizeable 6% of GDP in 2016. Almost every other sector of Singapore’s economy depends on an efficient and advanced aviation sector, which also provides quality jobs and sees relatively high productivity.149 Along with globalisation, aviation has contributed towards Singapore becoming “a global economic hub” and “cosmopolitan city”.150

Today, the country has one of the largest and most comprehensive aerospace operations in the region, providing competitive one-stop aircraft maintenance, repair and overhaul (MRO) services. Singapore has additionally become a major advanced aerospace manufacturing location. It houses the Asia Pacific’s only large commercial engine assembly and test facility, and two major fan blade manufacturing facilities.151

The successes of Changi Airport, the national carriers (SIA Group, including Silk Air and Scoot), the MRO and air cargo sectors, and the spin-offs in trade, tourism and investments, have all contributed significantly to Singapore’s economic growth.

We have about 710 km² of land. Of this, about one-third is used for industry, commerce and housing. The remaining two-thirds are used for roads, sea port, airport, reservoirs, utilities, military training grounds and also social and community facilities like parks, hospitals and schools. These land use allocations will likely remain the same over the next decade.152

Khaw Boon Wan

What are the next steps and anticipated challenges? As Mr Khaw explained, land-use plans need to be dynamic and relevant to Singapore’s future needs. While land reclamation has in the past offered Singapore a good way to mitigate the constraints of land scarcity, extensive land reclamation is less feasible in the long term. There are limits to reclamation, such as the rising costs and availability of imported sand, possible detrimental impact on the ecosystem and environment, and the physical limits imposed by shipping lanes and territorial boundaries of neighbouring countries.

The Ministry of National Development and planners at the URA have taken various measures to free up land for new purposes. These include the development of reserve land, intensifying land use, and reusing and rezoning old industrial areas and golf courses for more productive purposes.
The government further recognised that relocating an airport or air base could have very significant benefits, especially in terms of freeing up large areas of valuable land for development. One earlier example of this was the relocation of the international airport from Paya Lebar to Changi, which changed the fortunes of the Tanjong Rhu area. Although Tanjong Rhu was situated at an attractive location next to the Kallang Basin and near to the city, planners could not approve the development of high-rise waterfront condominiums there. This was because it could be directly under the flight path leading to Paya Lebar Airport if it were to be expanded. However, once low-flying commercial aircraft shifted to Changi, it became possible to develop Tanjong Rhu into a prime waterfront housing area, thereby optimising the use of the land and increasing its value.

...if you look back now, most of our airports were inherited from the past, so we leverage on them, we try to build around them in the right way….Moving forward, the big question is, can we rationalise the number of airports we have in Singapore? Can we consolidate in a way that doesn’t sacrifice our strategic interests? To what extent can we consolidate? Do we need all five of them? That’s the main thing.

...it makes sense to make better use of land on the island and move all the constraining uses to the fringes or even off-shore and that is how it is done today and as we move forward into the future.751

Tan See Nin

SELETAR AEROSPACE PARK FOR INDUSTRIAL GROWTH

There’s a strategic advantage...[in having] the business aircraft, smaller aircraft, and the aerospace industry all form a hub around Seletar without affecting the operations at Changi.754

Lim Eng Hwee

The early 2000s saw the global aerospace industry go into a tailspin. This was in the aftermath of the 9/11 attacks against the United States and the outbreak of Severe Acute Respiratory Syndrome (SARS) in Asia shortly after. Yet in spite of these challenges, Singapore did not lose sight of longer-term plans to grow the aerospace industry.

With the aerospace industry’s development, the EDB sought to attract aerospace manufacturers and related services as complementary sources of growth.155 However, the planners anticipated that industrial sites at Loyang and Changi North would soon run out of space, and that new industrial parks were needed in the longer term.

Why, then, was Changi not further developed as Singapore’s main aerospace industry hub? According to Ko Kheng Hwa, the EDB’s then managing director, "the primary consideration is that there is not enough land to meet the needs of the various competing users at Changi for us to fully capitalise on the growth that we expect in this industry in the next 10 to 15 years".156

Furthermore, accommodating the types of aircraft and unscheduled nature of MRO services and business aviation flights at Changi Airport could compromise its efficiency for scheduled flights.
During this period, around 2006, there were calls from private aerospace companies to upgrade Seletar Airport and its surroundings. Regional competition was also heating up. For instance, Senai Airport in Johor was reportedly offering free land to some companies based in Seletar, if they relocated there for the long term.157

Since earlier plans to develop Seletar had not materialised, the area remained relatively untouched. Companies there mostly occupied colonial-era buildings, and had to supplement the limited power supply with their own diesel generators. Heavy rains also brought frequent flooding, and the roads, built for a different era, were narrow and full of potholes.158 Furthermore, the airport runway had to be extended to accommodate larger aircraft for MRO services.

In the early 2000s, Seletar consisted of offshore supplies specialists and multinational MRO players, all performing a secondary role to the Loyang/Changi North cluster. It then hosted a smaller cluster of about 30 companies serving the aviation sector. These included private jet charterers, aviation component suppliers and air logistics, such as Fokker Services Asia, Hawker Pacific, Executive Jets Asia, Jet Aviation and ST Aerospace Engineering.159

To meet the demand from aerospace companies and new investors for industrial space, the Seletar Aerospace Park (SAP) was created. Clearly, the infrastructure dating from the 1960s was inadequate for the EDB’s ambitious plans for Seletar. Extensive redevelopment was needed, and this called for negotiations between several agencies. The Ministry of Defence (MINDEF) owned Seletar Airport, while the CAAS then served as the operator, manager and regulator, while JTC Corporation was the master planner and developer for the SAP. Consequently, the EDB partnered the JTC in marketing the SAP to potential users.160

The EDB’s plans for Seletar received strong support from the Minister for Trade and Industry, and was bolstered by an earlier Cabinet decision to retain Seletar Airport. However, there were still several rounds of negotiations by the EDB and JTC with various agencies—each with a different stake and interest in Seletar—before a consensus was reached.161 For instance, one of MINDEF’s interests in the redevelopment of Seletar was to retain its youth flying club, which served to train and identify potential talent for the RSAF.162

Besides these stakeholders, the Singapore Land Authority (SLA) owned much of the land around the airport which had been leased to aviation companies. It also managed the residential leases of the black-and-white houses.

In May 2006, it was officially announced that Seletar Airport would be redeveloped into an aerospace park. Scheduled for 2018 completion, the project spanned three phases. It involved the development of 1.4 km² of land adjacent to Seletar Airport.

We are prepared to put in the resources and the infrastructure [at Seletar]. Now we need to send this signal far and wide because companies all over the world are looking at where to put their next facility.163

Ko Kheng Hwa

For this project, the JTC took the lead in the master-planning and infrastructure development, in consultation with the URA.164 Compared to the existing Changi North-Loyang aerospace hub, some land parcels in the SAP have direct access to the airport’s runway. According to the EDB’s and JTC’s joint estimates, the development of the SAP would result in the employment of 10,000 people and add $3.3 billion to Singapore’s GDP.165 Seletar Airport was also upgraded to match the new aerospace hub. This included extending the runway from 1,592 to 1,863 metres in length.

The planners also recognised that as Singapore’s population grew, the SAP land could be required in the future for housing or other needs. As a compromise, land leases were allocated to tenants for a period of 30 years instead of the previous 30+30 years. This allowed for future planning flexibility.166 But to balance the well-being of existing residents with the goal of economic development, studies were conducted to assess and control the impact of the noise from increased airport operations on nearby residential areas, such as Yishun and Sengkang.167

To address noise concerns of residents, only newer and quieter aircraft were allowed in both Seletar and Changi Airports. They had to meet stringent noise certification standards under Chapter 4, Annex 16 of the Convention on International Civil Aviation. These aircraft included the Boeing 747-300, 747-400, 777, 767; and Airbus 300, 310, 320, 330, 340
and 380. Those whose noise levels failed to meet the standards (the Boeing 707, 727, 737-100, 737-200, 747-200; DC8 and DC9) would no longer be allowed into Singapore.

Moreover, as part of the noise abatement measures for Seletar Airport, training and cargo flights are prohibited from operating between 10 pm and 7 am daily. Engine run ups at Seletar Airport are also not allowed during this period. Since January 2019, to minimise noise during resting and sleeping hours, the CAAS has also implemented an expanded night flight restriction between 10 pm and 7 am daily, excluding emergency and medical evacuation flights.

When the plans for the aerospace park were announced, efforts were made to create ready-built infrastructure for the industry players, and to foster the conservation of nature and lifestyle areas. Much of the unique colonial-built heritage and natural greenery from the former Seletar camp were preserved.

As a dedicated industrial park for the aerospace industry, the SAP would anchor the four key activities of aerospace: MRO services, design and manufacturing, training, and business and general aviation. The clustering concept allowed tenants and users to access a diverse suite of aviation services. In addition, Seletar would support further diversification into newer areas for Singapore, such as MRO services for the narrow-body and smaller aircraft segment, and a regional aviation campus for aeronautical training institutions.

Subsequently, in 2016, it was announced that a new Passenger Terminal Building (PTB) was to be constructed at the eastern side of Seletar Airport. The new terminal would allow Seletar Airport to improve its passenger experience, with enhanced facilities such as check-in counters and a hall for those waiting to receive flights. This would also facilitate the shifting of scheduled turboprop aircraft operations from Changi Airport to Seletar Airport, to free up capacity for bigger planes at Changi.

In addition, the new terminal would also allow Seletar Airport to serve business aviation and private aircraft needs, by offering privacy for arrival and departure, private drop-offs and more comfortable waiting lounges.

According to the EDB, the aerospace industry has grown at a compounded annual growth rate of 7% in value-add over the past 20 years, up to 2017. In 2016, accounting for 10% of global output, Singapore’s aerospace industry generated $8.9 billion worth of total output, achieved a value-add of $3.35 billion, and employed 21,000 people, 80% of whom were locals.

Recognising the importance of the sector, the Aerospace Industry Transformation Map (ITM), developed with industry stakeholders, was launched on January 2018 by the Ministry of Trade and Industry (MTI). The aim is to create 1,000 new jobs in the sector by 2020 and generate a total of $4 billion in value-add for the industry. It also anticipates ways to address future challenges and requirements so that Singapore can sustain its competitive advantage.
RELOCATION OF PAYA LEBAR AIR BASE

Paya Lebar Air Base (PLAB) is the largest among the four air bases (Changi Air Base, Paya Lebar Air Base, Sembawang Air Base and Tengah Air Base) run by the RSAF. Of the three military air bases that handle fighter jets, Tengah and Paya Lebar are closer to residential areas, while Changi Air Base is separated from residential areas by Changi Airport.

Former Chief Defence Scientist of MINDEF, Prof Lui Pao Chuen, noted the difficult trade-offs involved in maintaining operational readiness, while maximising the benefit of valuable development potential.

Ask yourself why the highest buildings in the CBD are all the same height of 280 metres? It is a height constraint because of Paya Lebar. We cannot build a Manhattan in the CBD. But once we move the air base out, suddenly the CBD can be built high.

...I think we should have moved from Paya Lebar earlier. We could have. Having built Paya Lebar, we ought to have been building Changi [Air Base] so that we would have the option of moving out earlier as opposed to waiting until all the buildings around Paya Lebar were already built up. So we missed out on an opportunity by not taking a longer-term view about Changi.

The relocation of Paya Lebar Air Base was finally announced by Prime Minister Lee Hsien Loong in 2013. Because of its size and proximity to homes, the relocation of PLAB is particularly significant in terms of its impact on land use and planning possibilities, and reduction in noise levels for nearby residents.

[The relocation] frees us to develop new, exciting plans for the big chunk of eastern Singapore, going all the way down to Marina Bay,...If we can carry off these plans, we don't have to worry about running out of space or possibilities for Singapore.173

Lee Hsien Loong

Relocating PLAB will free up 8 km² of prime land in the northeast region—an area larger than the current Bishan or Ang Mo Kio towns. The land will allow construction of new residential homes, offices, factories and parks. Without the height restrictions around Paya Lebar and its surroundings, stretching all the way down to Marina Bay, this permits the construction of taller buildings in all of those areas.174

According to private developers, the freed-up land alone can accommodate 60,000 to 80,000 public and private homes. The lifting of building height restrictions will moreover provide increased opportunities for redevelopment. Currently, the height restrictions for private residential blocks range from 8 storeys in Geylang, to 24 storeys in Marine Parade.175

The decision to relocate PLAB demonstrates the complex nature of the land-use trade-offs that Singapore has made since the 2000s. The relocation is a long-term undertaking, which will be realised from 2030. Various assets from PLAB are expected to be relocated to Changi Air Base East (CAB) and Tengah Air Base (TAB).176
BUILDING TENGAH NEW TOWN

In July 2017, the government announced that Tengah Air Base would be expanded to accommodate some military assets, following the future relocation of Paya Lebar Air Base. This will be a major undertaking: 1.06 km² of land will be acquired, and over 80,000 graves from Chinese and Muslim cemeteries will be exhumed. Some major road realignments will also take place, for instance, at Lim Chu Kang Road.177

Despite the building height restrictions near military air bases, it will be possible to integrate residential and industrial land uses around Tengah Air Base with careful planning, advances in noise reduction solutions and some compromises. For example, industrial and other uses that are less sensitive to noise can be located to areas where the noise levels are higher and away from residents. Adequate buffers will also be provided between residential areas and other uses of land that may cause noise and other nuisances.

Meanwhile, plans have been made to develop areas near Tengah. On April 2016, Finance Minister Mr Heng Swee Keat announced the development of the Jurong Innovation District, a new “industrial park of the future”.178 The first phase of this 6 km² site will be ready around 2022, bringing together researchers, students, innovators and businesses to develop new products and services. Jurong Lake District, hailed as Singapore’s second central business district, lies just south of Tengah. Together with new developments in a Northern Growth Corridor linking Woodlands and Sembawang, the broader Jurong Lake District area is expected to become a dynamic, vibrant commercial and industrial environment, generating quality job opportunities for residents.

Tengah’s planned residential communities are just as eagerly anticipated. The master plan for Tengah town was unveiled in September 2016 by National Development Minister Lawrence Wong. Dubbed the “Forest Town”, it will be about the size of Bishan. Situated to the west of Singapore, Tengah will be the first HDB town to be developed since Punggol New Town some 20 years ago.179

The Forest Town will be fully developed over two decades and has since launched its first sale of flats in 2018. With public housing making up over 70% of the total area, it will provide up to 42,000 new homes upon its completion.

FURTHER EXPANSION OF CHANGI AIRPORT

Changi Airport was launched back in 1981 with just one terminal building, but visionary leaders like Sim Kee Boon had the foresight to allocate sufficient space for future terminal buildings.183 Nearly four decades later, air traffic and tourism have truly taken off, and Changi has undergone a spate of redevelopment, with the completion of three additional terminals, and an upcoming fifth terminal (T5).

In 2009, the government decided to corporatise Changi Airport. This was necessary for it to stay competitive, given the emergence of other modern mega airports, the introduction of long-haul aircraft which reduces the need for intermediate hubs, global airport companies, the consolidation of airlines into mega-carriers, and competition from neighbouring world-class airports.184
On one hand, the reconstituted CAAS focuses on being an aviation industry regulator, promoter and developer. On the other hand, the Changi Airport Group (CAG) is responsible for the corporatised business functions, namely the operational aspects of managing Changi Airport, emergency services and overseas investment.

With the corporatisation, the CAG is run like a business entity. It can pursue business ventures and opportunities with greater flexibility, in response to industry changes and global market movements. It is also poised to attract and retain top talent to compete with global airport operators.185

All these measures illustrate how Singapore takes the long view in airport planning and development, and will invest and take bold measures to stay ahead in the competitive aviation business. In March 2012, a high-level multi-agency Changi 2036 Steering Committee was set up to review the airport’s future needs. Comprising numerous government agencies and the CAG, the Steering Committee provides strategic directions for the future development of Changi Airport.

With the opening of the experiential Terminal 4, which can handle 16 million passengers a year and utilise “smart airport” technologies like self-service check-ins, Changi Airport now has the capacity to welcome 82 million passengers annually. Also, the recently completed mixed-use Jewel Changi Airport development in front of Terminal 1, a partial expansion of the terminal itself, will contribute an additional capacity of three million passengers per year. Terminal 2 will also be expanded to handle an additional five million passengers a year. These works will commence at the end of 2019 and take around five years to complete.

At present, Changi is the world’s seventh busiest airport, managing some 1,000 aircraft movements a day on its two runways and a record 65.6 million passengers in 2018. It is, however, approaching full capacity with 68 aircraft movements per hour during the daily peak period. There is therefore a need for a third runway. The proposed four-kilometre-long runway, to be ready by the early 2020s, is being built on the same reclaimed land in Changi East as T5, and needs 40 kilometres of taxiways to connect it to the existing terminals.

Terminal 5 (T5) will be the largest airport terminal in Singapore, with a capacity to handle around 50 million passengers per annum in its first phase. Space has also been set aside for future satellite terminals, should additional capacity be required. Once completed, T5 will occupy some 10.8 km² of land—the size of Tampines New Town or 2.5 Marina Bays.

Figure 24: Satellite image of the Changi Region taken from Draft Master Plan 2019.
Image courtesy of the Urban Redevelopment Authority.
It will consist of the airfield, three-runway system (which will be ready in the early 2020s), and other related facilities, such as the Changi East Industrial Zone and other aviation support areas south of the terminal.

According to the Report of the Committee on the Future Economy, set up in January 2016 to review Singapore's economic strategies, the T5 development is a necessary investment that will reinforce the country’s status as a premier air hub. This move to strategically expand passenger handling capacity ahead of significant projected aviation traffic growth will also help Changi Airport retain its market share and foster more air links and connectivity to other cities. These will in turn support the growth in tourism, financial services, trade and investment, logistics and manufacturing.

Beyond new airport terminals, Jewel Changi Airport—a joint venture between the corporatised CAG and local developer CapitaMalls Asia—is a tourist attraction in its own right. Opened in April 2019, it has allowed for further expansion of Terminal 1's arrival hall and substantially boosted connectivity between Terminals 1, 2 and 3. Jewel Changi Airport also boasts a 40-metre-tall indoor waterfall, one of the largest indoor parks and plant collections in Singapore, in addition to its many retail, F&B, and hotel offerings.

As illustrated in the Draft Master Plan 2019 (shown in Figure 24), Changi Region is set to be a vibrant and thriving economic hub, hosting industries that maximise synergies with Changi Airport. Changi Aviation Park, the existing air cargo cluster, can be expanded with the development of Changi East Industrial Zone. A waterfront district offering recreational and tourism possibilities and catering to seamless inter-modal “fly-ferry” linkages from Terminal 5, could also be created. An innovative lifestyle business district leveraging the Singapore University of Technology and Design (SUTD) and Changi Business Park, supporting aviation-related research and development, could result. There could even be a Changi East Urban District lifestyle business centre where new offices, MICE facilities, hotels or even lush landscaped public spaces are located at the doorstep of the future Terminal 5.

These plans are intended to keep pace with growing air travel and freight demands, as Changi Airport is increasing its capacity and enhancing its offerings progressively. Going forward, the future Terminal 5, Changi East Industrial Zone and Changi East Urban District will provide additional capacity for Changi Airport’s future growth.
In spite of being land-strapped, Singapore has managed, with judicious urban planning, to accommodate all five airports for the past 50 years or so.

Since the 1960s, the airports have been a critical lifeline for national growth and development. Along with its port, they have enabled Singapore to reach out to a broader economic hinterland, and to thrive as a small island city-state connected to the region and the wider world.

In the 1970s, Paya Lebar Airport served as an economic driver, supporting industrial diversification and facilitating foreign investment. However, it soon became evident that Paya Lebar was no longer suitable for long-term aviation operations, so Changi Airport was built at the eastern fringes of Singapore.

According to Mr Ho Beng Huat, former Deputy Director-General for Airport Management at the CAAS, Singapore had not initially set out to make Changi the best airport in the world. What instead worked in the nation’s favour were the readily available spare capacity and the commitment of public service leaders such as Mr Sim Kee Boon. The latter recognised that a huge amount of taxpayers’ money was being spent on the public infrastructure, and considered it an important responsibility to run Changi Airport well.

In 1984, Singapore won its first Best Airport award from the Business Traveller magazine. Soon after, to meet the needs of discerning travellers and higher expectations of Singaporeans, Changi stepped up efforts to provide better customer service. Over the years, it has constantly upgraded its facilities, and provided efficient service and more leisure options. These pioneering standards of service excellence placed Singapore on the international map and brought about more vibrancy and travel options to local residents. More than being Singapore’s gateway to the world, the airport was also the world’s gateway to Singapore—an efficient, business-friendly and modern Garden City.

Concurrent with these airport operation efforts, Singapore’s aerospace industry grew in tandem with the development of Seletar and Changi. Aerospace companies like Rolls-Royce provided jobs and value add, while MRO services and advanced aerospace manufacturing supported air hub development.

Since the 2000s, more complex land-use trade-offs have stretched the imagination and expertise of Singapore’s urban planners, challenging them to develop creative concepts and to find new ways of integrating land uses. While in the past the airport needed to be situated close to the city centre due to limited accessibility, today the rest of the island has been developed. As a result, land use has to be optimised so as to provide room for future expansion. Urban planners have to continuously review Singapore’s land-use needs while taking into account security, economic and social needs.

In view of the various interests, to truly contribute to a city’s liveability, airports cannot remain separate and disconnected from the broader urban environment. They must be closely linked through physical transportation and logistics connections to meet local transportation needs. Moreover, they must feature public spaces and amenities for residents of the city, as well as travellers and visitors.

Changi is built on reclaimed land...and there is a foreshore, a coast around...we must be aware that we are on an island and we cannot miss the opportunity to make sure those are also great areas for recreation and if possible, for residential use as well.\textsuperscript{187}

Tan See Nin

As a sovereign country that is responsible for its own defence and security, Singapore requires a strong air force and the continued existence of military air bases. This is in spite of the high cost in terms of noise and constraints on development resulting from height restrictions and compatible surrounding land use.

Airports are here to stay, despite having to relinquish one of them (PLAB) in future to free up valuable land. Neglecting the role of air bases would be to trade “our continued peace and security for comfort and economic gains” in the short term.\textsuperscript{188}

Why does the Air Force still want to have its own air bases? The answer is that the air base is there not only for wartime when the airport stops. The most difficult part of operating an air force is during the period of uncertainty. They call it the period of tension, when you don’t know whether a war will start or not. So you need a high state of operational readiness, but at the same time, you want life to be as normal as possible. At that point in time, you would have your civil aviation and military aviation both operating at a high and intensive level. Therefore you would rather have the air bases separate, as opposed to having to mix the two.\textsuperscript{189}

Lui Pao Chuen
The cases of PLAB and Tengah demonstrate that airports and air bases can be creatively integrated and redeveloped. Long-term planning that is sensitive to the needs of different stakeholders, and that leverages the airport as much as possible, can overcome the challenges imposed by airports on Singapore’s land use. As URA Chief Executive Mr Lim Eng Hwee foresees, this will create new canvases for the transformation of Singapore’s urban landscape in the decades to come.

The consolidation of the military air bases allows us to free up not just the land at Paya Lebar, which is close to a thousand hectares, but all the height constraints around it. From a planning perspective, it’s very strategic.

If you look at the way we do long-term planning, we take a very major step almost every 10 or 20 years, that can help us to transform Singapore. The decision to move the port out from the city area was made more than 20 years ago, and it’s very significant. We are about to reap the benefits. PSA [Port of Singapore Authority] is already moving out, and next year, half of the port [at Tanjong Pagar] will be empty. This gives us a whole new canvas to do things.

20 years later, we took another big step, which gave us the ability to use the Paya Lebar [Air Base] land, which is bigger than a town. The entire height constraint will also be lifted, which is very significant.

Over the next 40 years, this will provide us with the opportunities to redevelop some of the land and rejuvenate all older towns around the Paya Lebar area, from Tampines to Bedok, Hougang, Serangoon, even Sengkang and Punggol. Those are younger towns, but as they age, they will have the ability to redevelop.

To redevelop is very costly; if there’s no benefit or gain, it’s very hard to proceed. But with the lifting of height constraints, we can continue to rejuvenate and redevelop the older towns and reap the benefits over the next 40 to 50 years.192

Lim Eng Hwee

Airports are not something that Singapore takes for granted. Air connectivity is vital in maintaining our operations as a trading hub, and a financial and business centre. More than just a major infrastructure for the aviation business, the airport anchors Singapore as a hub city, greatly contributing to its economic dynamism.

With the aviation market projected to grow rapidly in Asia and the Pacific in the upcoming decade post-2030, Changi’s challenge is to maintain its leading position among other world-class airports and also be future-relevant.

As such, exceptional efforts are now being channelled into improving Changi Airport’s lifestyle offerings. Jewel Changi Airport, which opened in 2019, is envisaged to be a game-changer that will transform the airport into a “lifestyle destination with world-class attractions all in one space.”191

There is also the upcoming mega T5, Changi’s biggest and, arguably, most ambitious project to-date. T5 offers a clean slate upon which to build an integrated airport development from scratch and incorporate smart-airport concepts to reap economies of scale and consolidate operations. Even more opportunities will be created when the remaining land at Changi East is developed for supporting industries.

As Chief Executive Officer of Changi Airport Group Mr Lee Seow Hiang described, “There is so much more we can do. We have to constantly strive to get better”.192 What will continue to distinguish Singapore’s airport developments are the cross-agency integrated planning system approach to resolving constraints and trade-offs, sensitivity to stakeholders, and planning way ahead for the best outcomes. These measures will take civil aviation and urban development to even greater heights.

Figure 25: Rain Vortex at Jewel Changi Airport, 2019.
Photo courtesy of Changi Airport Group.
POST-SCRIPT

For a small country like Singapore, which needs to be connected to the world, having an excellent airport is an existential issue. Right from the start, we were clear that we wanted to make it very convenient for people to fly to and from Singapore.

In the earliest master plan drawn up for Changi Airport, the intent was to have three passenger terminals to cater for a maximum handling capacity of 30 million passengers a year. But soon after Terminal 1 commenced operations in 1981, the government had the foresight to approve more land to be reclaimed for future airport expansion, where Terminal 5 is slated for construction.

Changi Airport’s overall attractiveness to travellers is undisputed—passenger movements have nearly doubled to some 65 million in the past eight years, while city links have increased from 190 to over 400. Passenger traffic is also expected to continue growing.

To cope with the growth in passenger traffic, existing terminals are revamped and expanded from time to time. Whenever such undertakings are carried out, the airport management would leverage the latest technologies and more innovative designs to improve upon existing facilities.

Changi Airport’s continual and extensive expansion and upgrading programmes over the years include Terminal 4, designed to achieve maximum capacity with a smaller footprint. There is also Jewel, a mixed-use development: positioned as a lifestyle destination with world-class attractions, it boosts the airport’s appeal as a stopover. Finally, there is Terminal 5, the largest terminal so far.

These game-changing moves to boost Singapore’s competitiveness as a leading air hub complement other efforts to enhance Seletar Airport and expand the nearby industrial estates such as Changi Business Park. They will also catalyse the growth of related aviation and aerospace industries, bring about new business opportunities to the industrial estates, and support successful decentralisation of economic activities away from the city centre.

Aviation infrastructure development has far-reaching consequences on a country’s urban development. To strike a good balance in meeting aviation needs and optimising overall land use for a land-limited city-state, comprehensive long-term planning is necessary to have such infrastructure built ahead of time.

Lee Seow Hiang  
Chief Executive Officer,  
Changi Airport Group
1911
- The first flight in Singapore took off at the old Race Course (now Farrer Park), as part of a flight demonstration.

1919
- The first overseas aircraft landed at Race Course in Singapore en route from England to Australia.

1929
- Singapore's first airport, Seletar Air Base, a military installation, was completed.

1930
- First commercial flight landed in Singapore.
- The then colonial government decided to build a new airport at Kallang Basin.

1935
- Kallang Airport received its first aircraft.

1937
- Kallang Airport was officially opened and operated for the next 15 years (1937–42, 1945–55). Weare’s Air Service started Malaya’s first internal air service, linking Singapore to towns in Peninsula Malaysia. Malayan Airway Ltd (MAL) was registered.

1942
- The development of civil aviation was interrupted by the Second World War.

1947
- Malayan Airway Ltd (MAL) inaugurated its first scheduled flight from Kallang to Kuala Lumpur, Ipoh and Penang.

Timeline: Airport Development Milestones

Before 1950
Integrating the Planning of Airports and the City: The Singapore Story

Timeline: Airport Development Milestones

1951
- A decision was made to build a new airport at Paya Lebar.

1952
- Resettlement of residents and reclamation of marshy ground at Paya Lebar commenced.

1955
- Paya Lebar Airport was officially opened.

1967
- Announcement of British withdrawal from Singapore.

1969
- Murphy-Mundy report on the economic prospects of developing an aviation industry was commissioned.

1971
- Singapore’s first concept plan was formulated to guide upcoming physical developments.

1972
- Singapore Airlines was formed out of the “reconstruction” of Malaysia-Singapore Airlines (MSA).

1975
- A decision was made to build Changi Airport. Site preparations at Changi, including massive earthworks and reclamation from the sea, began.

1976
- Final Master Plan for Changi Airport, based on a preliminary plan drawn up by then Airport Branch of the Public Works Department, was endorsed by the Airport Consultative Committee of the International Air Transport Association.

1977
- Reclamation and earthworks at Changi was completed. Start of basement construction for Changi Airport Phase I.
## Integrating the Planning of Airports and the City: The Singapore Story

### Timeline: Airport Development Milestones

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1981</td>
<td>Start of Phase II development, which included work on the second runway.</td>
</tr>
<tr>
<td></td>
<td>Changi Airport was officially opened.</td>
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<tr>
<td>1984</td>
<td>Ministry of Finance approved the government grant for construction of Terminal 2.</td>
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<tr>
<td></td>
<td>Civil Aviation Authority of Singapore (CAAS), formerly known as the Department of Civil Aviation, was formed.</td>
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<tr>
<td>1986</td>
<td>Construction of Passenger Terminal 2, which included associated roadwork, two multi-storey carparks, a people mover system [Changi Skytrain], and a baggage transfer system between the two terminals.</td>
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<tr>
<td></td>
<td>Changi Airport surpassed the 10 million passenger milestone.</td>
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<tr>
<td>1990</td>
<td>Terminal 2 was completed and opened for operations, doubling Changi’s passenger capacity to 44 million a year.</td>
</tr>
<tr>
<td>1991</td>
<td>Terminal 2 was officially opened.</td>
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<td></td>
<td>1991 Concept Plan was unveiled, introducing the idea of creating technological corridors made up of business parks, science parks and academic institutions, while also promoting a policy of decentralisation through the development of regional and sub-regional commercial centres served by expressways and a mass rapid transit (MRT) system.</td>
</tr>
<tr>
<td>1992</td>
<td>Singapore Aviation Academy (SAA) was officially opened.</td>
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<tr>
<td>1994</td>
<td>Changi Airport surpassed the 20 million passenger milestone.</td>
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<tr>
<td>1995–96</td>
<td>Improvement works were carried out at both terminals, with Terminal 1 receiving a $170 million refurbishment, and Terminal 2 adding two new finger piers and 22 new aerobridges.</td>
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<tr>
<td></td>
<td>Go-ahead was given for a third passenger terminal at Changi Airport.</td>
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<tr>
<td>1998</td>
<td>Commencement of works to extend Terminal 1.</td>
</tr>
<tr>
<td>1999</td>
<td>Changi Airport won its first “Best Airport in the World” title from Business Traveller magazine.</td>
</tr>
</tbody>
</table>

1980s

- Start of work on the second runway.
- Terminal 2 completed and opened for operations.
- Construction of Terminal 2.

1990s

- Completion of Terminal 2.
- Introduction of the Concept Plan.
- Opening of Singapore Aviation Academy.
- Expansion works at both terminals.
- Commencement of works to extend Terminal 1.
2000
- A groundbreaking ceremony was held for the construction of the new Terminal 3.
- Completion of Terminal 1’s $420 million extension, adding two new finger piers consisting of 14 aerobridges.

2002
- Official opening of the Changi Airport MRT station: the $850 million project involved a 6 km MRT line extension from the Tanah Merah MRT station.
- Official opening of the Changi Business Aviation Centre (now replaced by the JetQuay CIP Terminal), catering to senior business executives flying into Changi Airport on private jets.
- CAAS announced a three-year $210 million Air Hub Development Fund to help airlines and the aviation sector tide over uncertainty in the global aviation industry.

2003
- The Airport Logistics Park of Singapore (ALPS) was officially opened. The $35 million ALPS, located next to the Changi Airfreight Centre, was gazetted as a Free Trade Zone.
- Commencement of works to give Terminal 2 a $240 million facelift.
- Changi Airport surpassed its 30 million passenger milestone.
- CAAS announced a new $45 million terminal dedicated for use by low-cost carriers, with commitment from Tiger Airways to operate there.

2005
- Changi Airport became the first airport outside Europe to welcome the Airbus 380 when the super jumbo double-decker aircraft arrived for airport compatibility verification tests. It also became the first airport in the world to have a third Passenger Loading Bridge ready for simulation tests with the A380 aircraft.
- CAAS awarded a site at Changi Airport for lease for the development and management of a nine-storey airport hotel.
### Integrating the Planning of Airports and the City:
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#### Timeline: Airport Development Milestones

<table>
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<th>Year</th>
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| **2006** | - The Budget Terminal was officially opened for scheduled flight operations, making it the first dedicated terminal in Asia for low-cost carriers.  
  - The Terminal 3 Topping-out Ceremony was conducted in May.  
  - The $240 million Terminal 2 upgrading project was officially completed. |
| **2007** | - Master plan for Seletar Aerospace Park was announced by the JTC Corporation. |
| **2008** | - Terminal 3 commenced scheduled flight operations. The three main terminals could now handle 66 million passengers a year, 20 million more than the previous handling capacity.  
  - CAAS awarded a $500 million tender to upgrade Terminal 1.  
  - CAAS embarked on a $10 million expansion project for Singapore’s Budget Terminal to increase the terminal’s handling capacity from 2.7 million passengers per annum to 7 million. |
| **2009** | - Two entities—the new CAAS and Changi Airport Group (CAG)—were formed from the corporatisation of Changi Airport’s operations and restructuring of the CAAS. |
| **2011** | - Seletar Airport completed its runway extension. |
| **2012** | - The Budget Terminal was closed to make way for the construction of Terminal 4—a larger building to accommodate the continued growth of air traffic.  
  - Changi Airport surpassed the 50 million passenger movements per year milestone. |
| **2013** | - CAG announced that it had awarded a $985-million contract for the construction of Terminal 4.  
  - Relocation plans for Paya Lebar Air Base were announced.  
  - Details on the expansion of Changi Airport were announced: Terminal 5; the three-runway system; land earmarked for industrial facilities; and enhancement of ground connectivity. |
| **2016** | - Masterplan for Tengah New Town was unveiled.  
  - Construction of Terminal 4 was completed. |
| **2019** | - Official opening of Jewel Changi Airport. |
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APPENDIX: EXECUTIVE POLICIES AND INSTITUTIONS

(I) Executive Policies

<table>
<thead>
<tr>
<th>Tool</th>
<th>Description</th>
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<tr>
<td>Special Committee on Airport Development (SCAD)</td>
<td>Set up in early 1975 to define the roles of Paya Lebar and Changi Airports, so as to decide future airport developments and recommend the best course of action within three months. SCAD was chaired by the Head of Civil Service, and its members comprised the Permanent Secretaries from various government agencies and departments involved in finance, infrastructure, aviation and communications. These would provide greater choice and convenience for Singaporeans and visitors alike.</td>
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<tr>
<td>Liberal Aviation “Open Skies” Policy</td>
<td>Policy to provide extensive and liberal framework for more air services and city links to Singapore, thus facilitating growth rate in trade, investment and tourism flow between Singapore and other countries, and allowing airlines to mount services in response to market demand without restrictions.</td>
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<tr>
<td>1971 Concept Plan</td>
<td>The first Concept Plan which set out the development needs for a projected population of four million by 1992. It laid the foundation for future urban growth by safeguarding land for future developments, including land buffers around airports, the international airport sited at the periphery of the island, and the transportation networks from the airport to the rest of the city.</td>
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<tr>
<td>1991 Concept Plan</td>
<td>The next Concept Plan that proposed a decentralisation strategy—a series of regional, sub-regional and fringe commercial centres to be developed in different parts of the island. The intention was to bring jobs closer to homes, alleviate congestion in the city centre, and have regional centres support developments such as the airport and those around it.</td>
</tr>
<tr>
<td>Maintaining capacity ahead of demand</td>
<td>To develop airport infrastructure ahead of demand so as to have the ready capacity to attract airlines to operate to Singapore, as well as to serve passengers comfortably and efficiently.</td>
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(II) Institutions

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<tr>
<td>Bases Economic Conversion Department (BECBD)</td>
<td>Set up in February 1968, it was tasked to convert camps and defence facilities left behind by the British for economic use.</td>
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<td>Public Works Department (PWD)</td>
<td>Formerly under the Ministry of National Development, the PWD had three main divisions: the Administrative Division, the Architectural Division and the Engineering Division. It was in charge of building many roads, buildings, canals and other important public works/structures. It was corporatised in 1999.</td>
</tr>
<tr>
<td>Ministry of Communications</td>
<td>Predecessor of the Ministry of Transport, the Ministry of Communications was first set up on 16 April 1968. Since then, it has undergone three name changes corresponding to updates in its roles and responsibilities. These have had to do with policies relating to the provision of land, sea and air transport, as well as postal, telecommunications and information technology.</td>
</tr>
<tr>
<td>Civil Aviation Authority of Singapore (CAAS)</td>
<td>The mission of the CAAS is to grow a safe and vibrant air hub and civil aviation system, which would make a key contribution to Singapore’s success. Its roles are to oversee and promote safety in the aviation industry, develop the air hub and aviation industry, provide air navigation services, provide aviation training for human resource development, and contribute to the development of international civil aviation.</td>
</tr>
<tr>
<td>Changi Airport Group (CAG)</td>
<td>The CAAS had previously been performing two distinct roles: a regulator of civil aviation matters and an airport operator. After careful consideration, Changi Airport was corporatised in 2009. The restructured CAAS has a focused role as an industry regulator, while the corporatised CAG sees to the promotion of Singapore as an air hub, and the planning for future expansion and development of Changi Airport’s infrastructure.</td>
</tr>
<tr>
<td>Economic Development Board (EDB)</td>
<td>A government agency under the Ministry of Trade and Industry, the EDB is responsible for strategies that enhance Singapore’s position as a global centre for business, innovation and talent. Facilitating investments and undertaking industrial development in the manufacturing and internationally tradeable services sector, it works with Singapore-based companies to transform their operations and boost productivity, and to generate growth by growing new businesses overseas. The EDB’s mission is to create sustainable economic growth with vibrant businesses and good job opportunities.</td>
</tr>
<tr>
<td>JTC Corporation (JTC)</td>
<td>Starting out as the Jurong Town Corporation in 1968, it was renamed JTC Corporation in 2000. It is the lead agency in Singapore that spearheads the planning, promotion and development of a dynamic industrial landscape. The JTC’s mission is to develop industrial infrastructure to catalyse the growth of new industries and transform existing enterprises.</td>
</tr>
<tr>
<td>Port of Singapore Authority (PSA)</td>
<td>The PSA was formed in 1964 to take over the functions, assets and liabilities of the Singapore Harbour Board, and was corporatised in 1997. It ensures that Singapore’s port remains responsive to industry developments and marketplace demand.</td>
</tr>
<tr>
<td>Singapore Tourism Board (STB)</td>
<td>A statutory board under the Ministry of Trade and Industry, the STB is responsible for developing Singapore’s tourism sector as well as promoting and marketing the country as a tourist destination.</td>
</tr>
<tr>
<td>Ministry of Defence (MINDEF)</td>
<td>First established in 1965 as the Ministry of the Interior and Defence (MID) with Dr Goh Keng Swee as its first Minister, its key priority then was to build up the army into a credible force as soon as possible. MID initially oversaw both internal and external defence, but later split into two ministries: the Ministry of Defence (MINDEF) and the Ministry of Home Affairs (MHA).</td>
</tr>
<tr>
<td>Singapore Airlines (SIA)</td>
<td>SIA is the national carrier of Singapore and one of the most successful airlines in the world. It was restructured from the joint Malaysia-Singapore Airlines in 1972. As Changi Airport’s anchor tenant, SIA’s growth and success has supported the advancement of Singapore’s airport development. This continues to be a mutually beneficial relationship today.</td>
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Integrating the Planning of Airports and the City: The Singapore Story

As a former British colony, Singapore had flourished as a trading port-of-call due to its strategic location along the shipping route between Asia and Europe. However, neither its past colonial links nor geography could guarantee its continued success in the oncoming jet age.

For the newly independent government formed in 1965, there were several fundamental national priorities, such as housing, job creation, education and infrastructure. However, a strategic decision was taken to build a new commercial international airport at Changi—a hefty mega-infrastructure that carried both substantial costs and risks for a land-strapped island which already had four airports. Such a decision bore far-reaching consequences in terms of land use, transport, industrial planning, defence, residential and social spaces.

In this Urban Systems Study, readers will learn about the comprehensive planning that went into the development of Changi Airport, and the integrated manner in which it was carried out. It additionally explores Singapore’s experience in navigating the unique urban-planning constraints and trade-offs brought about by both civilian and military airports, and examines the systematic approach taken to capitalise on airport developments to catalyse urban and economic development.

“Changi Airport is our major investment to exploit our geographic location. Singapore must be prepared and ready to seize every opportunity that comes its way. Whether we have been extravagant in investing in an airport of this size and level of sophistication is a question worthy of a rhetorical rejoinder. Can Singapore ever afford not to have such an airport?”

Howe Yoon Chong, Former Minister for Defence