Singapore, Unlimited

SINGAPORE, UNLIMITED

First published in 2020

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Set up in 2008 by the Ministry of National Development and the then Ministry of the Environment and Water Resources, the Centre for Liveable Cities (CLC) has as its mission 'to distil, create and share knowledge on liveable and sustainable cities'. CLC's work spans four main areas – research, capability development, knowledge platforms, and advisory. Through these activities, CLC hopes to provide urban leaders and practitioners with the knowledge and support needed to make our cities better. For more information, visit www.clc.gov.sg.

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Foreword

Desmond Lee
Minister for National Development
Singapore

Singapore as we know it today is a modern city, with well-planned districts and good infrastructure amidst a quality living environment. Most of our resident population stay in affordable, well-designed public housing, where they have easy access to green spaces. This is a far cry from what Singapore used to be, when it was a challenge to meet even basic needs such as clean water, electricity and sanitation.

The transformation of Singapore from a third-world country into a liveable and sustainable city-state came about through the concerted effort of many, including long-term planning by officers from various government agencies and strong support from Singaporeans. From the development of Changi Airport to the cleaning up of the Singapore River, our pioneering leaders and public officers displayed resilience, creativity, and sheer grit in overcoming complex problems with daring and innovative urban solutions.

The issues that Singapore faces today are very different from what we faced more than five decades ago. These include urban renewal, climate change, and most recently, ensuring that we can be a resilient city which can weather the storm of a pandemic. Though these issues may seem less tangible in nature, they are no less complex, and are just as important. We must hence find scalable and sustainable solutions to address our new set of challenges, to ensure that Singapore can continue to transform and progress with time.

Singapore, Unlimited pays tribute to the vision and hard work of those who planned, shaped and built modern Singapore, in spite of the difficult historical, political and social constraints of the era. I hope that Singaporeans will be able to draw on the lessons from our past experiences, and values of our early planners, to continue to build and develop Singapore into an endearing home and a distinctive global city for future generations.

Introduction

Khoo Teng Chye
Executive Director*
Centre for Liveable Cities

* Mr Khoo served as Executive Director of the Centre for Liveable Cities from July 2010 to December 2020.

In 2017, the Centre for Liveable Cities published *Xiao hongdian*, *da geju* (小红点，大格局), a Chinese language book that documented the planning and development of modern Singapore. The book was the brainchild of the Centre's then Chairman Dr Liu Thai Ker, and was authored by Singaporean writer Han Xin Yu. Assisting Ms Han were two researchers from the Centre, Wong Chock Fang and Lin Guangming.

In putting together the book, the project team interviewed thirteen individuals who had made significant contributions to the country's transformation into a leading global city. Among them were Singapore's first chief planner, an expert who advised the government on the development of the Mass Rapid Transit System, and the country's first Commissioner of Parks. The team also conducted rigorous research on Singapore's development, poring over countless primary documents, books and other materials.

With Dr Liu's guidance, Ms Han, Ms Wong and Dr Lin put together an excellently researched and written publication that accurately documented Singapore's development experience. The book was enriched by a strong personal angle that drew on the recollections and anecdotes of the interviewees, and the narrative skill of the author.

Since its publication, we have given copies of *Xiao hongdian* to many visiting officials, experts and academics from Mainland China and other Chinese-speaking countries who visited the Centre, as well as others whom my colleagues and I met at meetings and conferences abroad. Many of them, after reading the book, contacted us to request additional copies for their superiors, colleagues and subordinates so that they, too, could acquire a better understanding and appreciation of Singapore.

By this measure, the book has been a big success. The positive response prompted us to decide on publishing an English translation, so that it could reach a wider audience both in Singapore and overseas.

The result of this is *Singapore, Unlimited*, an adapted translation of *Xiao hongdian*. It retains much of the original's content, but is updated with new research that yielded additional information and details on Singapore's urban changes, especially in recent years. Appropriate adjustments have also been made to the narrative style and structure, so that the book would be clearer and more engaging to the English reader.

Otherwise, both books share a common objective: to document Singapore's development not only through intensive research but first-person accounts of thirteen pioneers who devoted so much of their professional lives to Singapore. I had the honour and pleasure of working with some of them, including as their subordinates in the public service. They were dedicated, resourceful and hard-working, capably translating the ambitious policy directions and instructions of Singapore's founding leaders such as Mr Lee Kuan Yew, Dr Goh Keng Swee and Mr Lim Kim San, into concrete plans and outcomes that have improved the lives of generations of Singaporeans.

There are countless publications on Singapore's modern development. But there are very few that transport the reader to the meeting rooms and corridors where many of the key policies that shaped our country were debated and decided on, and to the mudflats, tunnels and development sites where this group of extraordinary individuals translated them into action.

More importantly, this book takes the reader into the minds of these pioneers. It explores the sense of mission, duty and responsibility that fuelled their work, whether it be to rejuvenate a decaying city centre, clean up a fetid river, build up sustainable sources of potable water, develop a world-class public transport network or create hundreds of beautiful parks and gardens. Together, they helped Singapore to overcome its limited land, financial and natural resources, and grow into an economically vibrant, stable and attractive country.

Their vision of Singapore's possibilities and their belief in its limitless potential are what inspired the title of this book.

Singapore, Unlimited is intended to inform and inspire leaders, officials and all others seeking to improve their cities. Today, this task is more pertinent than ever before, as we face the incredible challenge of rehabilitating cities, economies and societies in a world ravaged by the COVID-19 pandemic.

At the Centre, we are continuing our efforts to come up with new insights on how cities should develop and evolve. These efforts build on the longstanding research we have conducted into the key systems that contribute to the liveability of a city.

In particular, we have distilled the process behind Singapore's urban development into a framework that outlines how the country achieved its liveability outcomes, which are: a high quality of life, a competitive economy and a sustainable environment. The systems underlying these outcomes are key, emphasising the importance of integrated master planning and development, and dynamic urban governance.

Since its founding, the Centre has built up a valuable body of research centred on this liveability framework and how it relates to Singapore's past and future development. *Singapore, Unlimited*, like many of our other publications, is a product of the work we have been doing over the past 12 years.

I would like to express my thanks to Minister Desmond Lee for contributing the foreword to this book. I also wish to acknowledge Ms Heng Tien Tien and Ms Tan Wan Lin for their excellent effort in translating *Xiao hongdian*, and Mr Ken Lee for conducting additional research, and adapting and editing the translated manuscript.

A view of the Singapore River and Boat Quay, in Singapore's city centre, 1950s. (Arthur B Reich Collection, courtesy of National Archives of Singapore)

1 The 1971 Concept Plan

The government of newly independent Singapore formed a group of planners and experts to establish a comprehensive plan for the long-term physical development of the country.

Chua Peng Chye was one of Singapore's pioneering urban planners, and served as the country's Chief Planner from 1973 to 1976.

Chua joined the public service in 1959 as a town planner with the Singapore Improvement Trust. In 1967, he was appointed to a project team established by the Singapore government with the support of the United Nations, to develop the country's first island-wide land-use plan—the Concept Plan of 1971. This plan served as a blueprint for the physical development of Singapore, guiding the creation of infrastructure such as housing estates and transport networks across the country.

Chua led many of the country's early planning initiatives and measures. He received several accolades for his contributions to Singapore. In 2015, the DesignSingapore Council recognised him as a distinguished designer in the field of urban development with the Singapore Design Golden Jubilee Award.

He passed away on 16 April 2019 at the age of 87.

PLANNING THE CROWN COLONY

In the early 1950s, the British authorities in Singapore commissioned Sir George Lionel Pepler—a well-known town planner—to craft a series of land-use plans to guide the development of the colony. Pepler led a team of planning experts to conduct a survey of Singapore's infrastructural conditions and prepare a comprehensive master plan.

His plans were adopted by the colonial government as Singapore's first official Master Plan in 1958, intended to guide the island's development up to 1972. Modelled after the Greater London Plan of 1944, the 1958 Master Plan envisaged the development of residential, commercial, industrial and community functions in various parts of the colony. It also considered the need to safeguard land for uses such as open spaces, recreational areas, nature reserves and water catchments.

The architects of the 1958 Master Plan assumed that Singapore's development would proceed at a slow but steady pace, and mostly retained the pre-existing spatial structure of the colony. The plan was designed on the basis that Singapore's population would increase to about two million by 1972. However, Singapore's population grew more rapidly than projected, exceeding two million as early as the late 1960s. The growing population created problems such as uncontrolled urbanisation, rising unemployment, poverty, housing shortages and poor public hygiene.

As Singapore made further strides towards full self-governance in the latter half of the 1950s, it became clear to its early leaders that new development plans had to be established urgently.

SEEKING ASSISTANCE FROM THE UNITED NATIONS

Lacking the technical expertise and financial resources to do this on its own, the Singapore government turned to the United Nations (UN) for assistance. In 1962, the UN dispatched a Norwegian town planner, Erik Lorange, to study the possibilities of urban renewal in Singapore. Lorange conducted a six-month preliminary planning study and proposed a staged approach to the redevelopment of the Central Area. He further recommended urgent revisions to the 1958 Master Plan, and the establishment of another team of UN experts to conduct further planning studies on Singapore.

In 1963, the UN sent a three-man team comprising urban planner Otto Königsberger, land expert Charles Abrams and economist Susumu Kobe to Singapore. They embarked on consultations with the government and crafted specific action plans for the country's urban renewal. The team also proposed a new spatial concept for the country, which came to be known as the Königsberger Plan.

THE STATE AND CITY PLANNING DEPARTMENT

The Singapore government subsequently established the State and City Planning Department (SCPD) to further study the Königsberger Plan and prepare a comprehensive plan for Singapore's spatial development.

The SCPD quickly put together a project team comprising 12 experts from the UN and an equal number of local officers from government agencies such as the Ministry of National Development (MND), the Housing

and Development Board (HDB) and the Public Works Department (PWD). Chua Peng Chye remembered the team as being inter-disciplinary, with experts drawn from a variety of planning, technical and policy fields.

One of the team's first tasks was to conduct detailed projections of indicators such as population growth, housing demand, motor vehicle stock, household income, employment rate and gross domestic product (GDP). Chua recalled that the project team accorded particular importance to population growth. This was a crucial indicator in the land-use plan, because it would determine not only the number of new houses that had to be built, but also the types and locations of these developments.

Equally important was to consider how the economic and industrial structure of the country would evolve in the coming years, because these changes would have an impact on matters such as the composition of Singapore's workforce and the location of employment centres. In addition, the changes would comprise more granular issues such as the type and scale of factories, offices, commercial centres and other developments needed to support Singapore's growth.

Many of the methods employed by the team to collect data, statistics and other forms of information were innovative for the time. These included in-depth surveys with the local population, devising economic growth models and conducting sociological studies. The team prepared multiple iterations of plans, testing each of them against different sets of assumptions, before deciding on the best outcome.

Chua recalled the difficulties the project team encountered, particularly in conducting site surveys of undeveloped areas around Singapore. This was because many parts of the country were covered with impenetrable foliage, rendering them impossible to map and study accurately. There was also the problem of squatter settlements and slums in and around the city centre. The redevelopment of these locations could not take place until the inhabitants were successfully resettled and the areas cleared.

The project team conducted door-to-door surveys and interviews with Singaporeans as a means to better understand their needs. Chua conceded that the team, particularly the UN experts from other countries, did not always design these interviews effectively because they did not fully understand the lifestyles and societal conditions in Singapore. Some of the questions posed by the team members—how many parks they wanted in their neighbourhoods, for example—revealed blind spots in their understanding of ordinary Singaporeans at the time, who were more often concerned about bread-and-butter issues affecting their livelihoods.

THE CONCEPT PLAN IS FINALISED

The project team completed its work in four years, finalising a Concept Plan for Singapore's development in 1971. This plan mapped out various land-uses for Singapore over a 20-year timeline, on the assumption that the population would increase to four million by 1991.

According to Chua, the 1971 Concept Plan is notable for its integrated approach to land-use planning. The most tangible expression of this approach is the Ring Plan, a spatial strategy to link residential, industrial, commercial, environmental and other developments across the country through a comprehensive transport network.

The East Coast Parkway (ECP) and Benjamin Sheares Bridge, 1986. The ECP was completed in 1981. (Ministry of Information and the Arts Collection, courtesy of National Archives of Singapore)

The 1971 Concept Plan. The plan was the first strategic land-use blueprint for Singapore's development. (Urban Redevelopment Authority)

Under the Ring Plan, the development of the country would be concentrated in a southern swathe of Singapore between Jurong and Changi. High-density satellite towns would be located around the three sides of the Central Catchment Reserve, and an extensive transportation network of expressways and an urban rail system would connect these towns to commercial and industrial centres in various parts of the island.

Chua recalled that the project team considered at least six planning options before deciding on the Ring Plan. There were several advantages to this plan. For one, it meant the Central Catchment Reserve could be retained as a green space and reservoir network. The Ring Plan also allowed for the country to be developed in stages, providing flexibility to the government to adjust each phase of development in accordance with prevailing economic, social and other conditions.

Another key advantage of the Ring Plan was that it enabled the creation of a comprehensive round-island transportation system.

A TRANSPORTATION-FOCUSED PLAN

In the 1960s, the government was deeply concerned with traffic congestion and the impact it could have on the country's growth. In Singapore, the amount of land then allocated to transport infrastructure was 12%, much lower than the 20% average in other major cities. New and extensive transport infrastructure was urgently needed; simply widening the existing road network would not suffice.

Housing and Development Board (HDB) flats under construction at Marine Parade in 1973. (Marine Parade Community Centre Collection, courtesy of National Archives of Singapore)

The project team conducted several transport surveys and studies to develop a deeper understanding of the complex psychology of commuters as they moved from one point to another. Beyond merely connecting spaces, it was important to consider qualitative features of planned roads and expressways: whether, for example, they would be convenient, reasonable or even logical routes for people to take.

The project team proposed the integration of a public bus and urban rail system with an extensive network of expressways to promote cross-island connectivity and accessibility, minimising commuting times for residents between their homes and workplaces.

The plan marked out the location of key traffic arteries such as the Central Expressway (CTE) and Pan-Island Expressway (PIE); and established the contours of what were to become the Mass Rapid Transit (MRT) system's North-South and East-West Lines. There was also a transportation network to serve satellite towns.

AN IMPORTANT PLANNING MILESTONE

To Chua, the Concept Plan of 1971 was an important milestone in Singapore's development. From an urban planning perspective, it was the first blueprint to effectively integrate land-use planning for a variety of major land-uses, providing guidance on the allocation and development of land parcels for each use. It was thus an effective tool for the government to conduct long-term planning at both the macro and micro levels.

The plan provided space for nature reserves and commercial centres; industrial parks and public parks; housing estates and

Industrial estate at Eunos Crescent, 1981. (Quek Tiong Swee Collection, courtesy of National Archives of Singapore)

military camps, all comprehensively linked by a transport network. In the industrial sector alone, for example, the Concept Plan safeguarded land parcels for the development of industrial corridors and business parks, such as at Jurong, Pulau Ayer Merbau (to support the petrochemical sector), Sungei Kadut and Kranji (for carpentry and construction), and Changi (for the aviation industry).

Beyond safeguarding the Central Catchment Reserve as a green lung and key water resource, the Concept Plan envisioned the construction of reservoirs and drainage reserves across the country. Separately, areas for parks, green spaces and nature reserves were also safeguarded, reflecting the government's focus on managing air, water and other forms of pollution in the 1970s.

More broadly, the Concept Plan made space for the provision of strategic infrastructure such as power stations, water supply lines and waste incineration plants—developments that generally take substantial time and capital. It thus provided a long-term guide for the construction of these facilities without interfering with other plans for national development.

Another distinctive feature of the plan was its introduction of the concept of reserved land parcels: tracts of land which have no specified use in the immediate term. The reserve land concept thus provided a buffer stock of land for future development. Dr Liu Thai Ker, the former Chief Executive Officer of the Urban Redevelopment Authority (URA), once remarked that if not for the concept of reserve land, Singapore would have quickly exhausted its land resources, with no land to spare for further development.

Over time, the Concept Plan would not only prove to be the government's key instrument for conducting long-term spatial planning, but an important guide to planners in formulating detailed spatial plans at the local level.

According to Chua, the Singapore government had always placed high priority on urban planning. In fact, the Planning Department was established in 1959 as part of

the Prime Minister's Office (PMO). It was only moved to the MND in 1962, as the ministry took on a larger role in formulating policies on housing and employment.

"But Mr Lee Kuan Yew was still very concerned about national planning, often asking us to report to him on the planning situation. If he had any questions on this matter, he would call us up directly for replies. He was very serious about it," recalled Chua.

LESSONS FOR SINGAPORE

To Chua, the success of the 1971 Concept Plan offers many lessons for policymakers and planners. Urban planning is a complex feat of engineering that requires an assessment of objective indicators as much as a consideration of subjective ones. And national planning is a monumental effort that demands substantial time and energy. How can one properly answer the question of what to plan for a country of several million people without careful study and precise calculation?

For example, a central consideration in any successful planning effort is the projected rate of population growth. To accurately determine the land-use needs of a country, planners must work closely with statisticians who accurately project trends in births, mortality, migration and other indicators. This is no easy task, especially over a long planning horizon.

Chua added that for planning to be effective, it is necessary to carry out sociological surveys, public consultation and research to better understand the needs and preferences of the population. In designing the 1971 Concept Plan, the project team conducted extensive research, including through surveys, samples, investigations and social experiments.

One of the key areas of inquiry was transport—specifically, to determine the location of roads and expressways. The project team considered the location of housing estates and their respective resident profiles, and studied commuting routes to and from employment centres. Apart from this, the team also had to develop an understanding of social patterns and habits—for example, where people travelled to for recreational and entertainment purposes. All this would influence transport needs at the local, regional and national levels, and had to be carefully considered when designing an island-wide transport network.

Chua emphasised that governments must enact robust institutions such as planning committees to hold planners accountable in matters of implementation and execution, along with serving as platforms for communication, coordination and conflict resolution. Related to this is the need to establish clear legislation and rule of law: collectively, these provide a solid foundation for the implementation of approved plans.

There is also a need to inject planning flexibility, so that unanticipated problems that could place limits on implementation timelines and spatial allocations can be more easily tackled. Flexibility also provides room for innovation, enabling planners to capitalise on advancements in expertise and technology, yielding better development outcomes.

Finally, to execute planning effectively, governments must build a corps of planners with expertise and technical knowledge. The Singapore government understood this and made it a point to cultivate talent from the very start. For example, it assigned one

A view of Marina Bay and skyscrapers in Singapore's Central Business District. (Stijn Dijkstra)

Singapore official to partner each of the UN technical experts on the SCPD's project team. The government wanted to capitalise on a vital learning opportunity and ensure that even after the UN experts left Singapore, their professional skills and expertise would be retained in the Public Service.

A VALUABLE EXPERIENCE

Chua's experience in the SCPD project team taught him several lessons about mediating between different parties and navigating bureaucracy. Apart from working with other members of the team, he also had to engage with consultants from the UN and Singapore government agencies, ensuring there were smooth channels of communication and coordination among all parties. This could be challenging, given that different individuals have different personalities, experiences, cultures and expectations.

Ultimately, Chua remembered his experience in the project team as a positive one, describing it as a good opportunity for learning and practice. "These were all real lessons from practical experience and extremely valuable."


區全民熱烈慶祝國

2 Urban Renewal in the City Centre

A team of pioneering urban planners helped transform Singapore's deteriorating city centre into a modern, flourishing mixed-use district.

Mr Alan Choe joined the Housing and Development Board (HDB) in 1962 as an architect and town planner. He worked on the planning and development of Singapore's earliest public housing estates. Choe also led the Urban Renewal Department, which was tasked with planning and redeveloping Singapore's city centre.

In 1974, the Urban Renewal Department separated from the HDB and was established as a new statutory board, the Urban Redevelopment Authority (URA), under the Ministry of National Development (MND). Choe headed the URA as its first General Manager until 1978.

In his distinguished public service career, Choe has also served as Chairman of the Sentosa Development Corporation (1985–2001) and a member of the Singapore Tourist Promotion Board (1968–1998).

Hock Lam Street, prior to urban renewal works in the city centre, 1969. The street was subsequently expunged. (George W. Porter Collection, courtesy of National Archives of Singapore)

A CITY OF SLUMS

By the early 20th century, Singapore had developed into a flourishing port city with an established city centre located at the mouth of the Singapore River in the southern part of the island. Immigrants from China, India, the Malay archipelago and elsewhere streamed into Singapore, many of them settling into the existing buildings and tenements in the city centre.

At that time, Singapore's city centre extended for about a mile along both banks of the Singapore River, spanning an area of about 7 km^2. At only about 1% of Singapore's total land area, the city centre was densely populated. The area suffered from over-crowding, homelessness, poverty, pollution, disease and other urban woes.

The British authorities that governed Singapore established the Singapore Improvement Trust (SIT) in 1927 to clear urban slums and do proper town planning across the island. The SIT built a number of housing projects in areas around the city centre, including at Tiong Bahru, but their efforts were disrupted by the outbreak of the Second World War and the Japanese occupation of Singapore (1942–1945).

The city centre survived much of the aerial bombings during the war and was largely intact. But many of Singapore's residents had fled the country for rural areas in Malaya and elsewhere to escape the conflict. When the war ended, many that returned once again crammed into the city centre, seeking jobs in a war-ravaged economy that had only started to recover.

The city centre came to house thousands of the urban poor, homeless, destitute and unemployed. Many of the shophouses and buildings that served as their accommodations were dilapidated, poorly maintained slum dwellings.

One of the main reasons for the state of the city centre was the enactment of rent control by the British authorities in the 1940s. Their aim was to reduce homelessness by preventing landlords from indiscriminately raising housing rents, so that the masses could afford housing. Ironically, the controls depressed rental revenues and discouraged landlords from maintaining their properties.

As the demand for housing soared in the post-war years, many tenants divided their already narrow living quarters into even smaller spaces, in order to earn some money by subletting them to others. In many cases, dozens of overworked labourers were squeezed into a single room, triggering outbreaks of diseases like tuberculosis and dysentery.

The situation was serious enough for the authorities to establish a Housing Committee in 1947 to strengthen the SIT's efforts at slum clearance and building new houses. However, their efforts were inadequate to tackle the problems faced by the urban poor in the city centre, especially as Singapore's population grew rapidly after the Second World War.

The 1959 General Election gave Singapore a fully elected parliament and a cabinet that held powers of full self-government for the first time. The People's Action Party (PAP), which won the elections by a landslide, quickly put in place various measures to resolve the problems faced by many working class Singaporeans. One of these was the establishment of the HDB in 1960 to build affordable housing.

The HDB's founding chairman Lim Kim San witnessed the problems faced by the urban poor, as he described in an interview conducted in May 1985:

> **Some of the labourers were so poor they shared trousers between them… Some people will work at night and others will work during the daytime. So, when the one who works in the daytime is out, the one who works at night sleeps in the bunk. And I came across one with a blanket right up to his neck. Of course it's very dark. You don't see light. It's very dark and it takes time to get your eyes accustomed, adjusted. I came across one and I told him, 'Are you sick? You are covered up with a blanket.' He says, 'No. I've got no pants on…my other brother has just taken my pants out. I'm wearing briefs.' …The smell and conditions were terrible, really terrible.**

HOUSING THE PEOPLE

Alan Choe, who joined the HDB in 1962, recalled that then Prime Minister Lee Kuan Yew set an ambitious target for the government to build 10,000 flat units each year between 1960 and 1965. In comparison, the SIT had only built 32,000 flats in its roughly 30-year period of operations between 1927 and 1959.

In its first year, the HDB built about 11,000 flats, all of them one-room units that shared toilets and kitchens. It was only in the second year that it started building larger two- and three-room flats equipped with their own bathrooms and kitchens. By 1965, the year Singapore gained full independence, the government had built 54,430 flats. By the late 1960s, almost 40% of the population lived in HDB flats.

A NEW PLAN FOR THE CITY

In 1958, the colonial authorities had issued a Master Plan to guide Singapore's development up to 1972. The plan assumed that Singapore's development would proceed at a conservative pace, with most of the country's pre-existing spatial structure kept intact. However, these assumptions did not anticipate the rapid pace of Singapore's economic and population growth, especially in the early 1960s.

The PAP government realised that the 1958 Master Plan was inadequate in providing sufficient room for the country's growth. A new master plan was needed to guide the country's spatial development over the long term. Lacking technical expertise and resources, the government sought the assistance of the United Nations Development Programme (UNDP) to review the 1958 Master Plan and propose a new blueprint to guide Singapore's development.

The UN sent a Norwegian planning expert, Erik Lorange, to study the urban conditions in Singapore. Choe spent a considerable amount of time with Lorange: "I literally walked every street in Singapore's city centre with the expert. It took us a few months to investigate the whole of Singapore. In the end, we prepared a report, recommending that Singapore needed to undergo urban renewal."

The UN approved Lorange's report, sending a three-man team of experts to help Singapore develop a plan for urban renewal. Choe was put in charge of assisting the team, which

Children playing in the "five-foot way" of a shophouse, 1960s. (Urban Redevelopment Authority Collection, courtesy of National Archives of Singapore)

comprised urban planner Otto Königsberger, housing expert Charles Abrams and economist Susumu Kobe, in their study of Singapore. The HDB assigned two other officers to assist Choe in this effort.

"At that time, all three of us had no experience. I was the architect and planner, the other two were assistant planners. We had no idea about urban renewal when we started the work," recalled Choe.

By the time the UN experts completed their work in Singapore, the HDB's three-man team had gained considerable expertise and experience. The HDB established an Urban Renewal Department (URD) comprising Choe and his two colleagues.

Choe said the government sent him on many overseas missions to learn how countries such as Great Britain, Germany, the United States and Japan implemented urban development and renewal. Choe's visits to the United States, where he met several mayors, senators and urban planners, were the most instructive, albeit in an unexpected way. "Knowing what we should not do, was the most valuable lesson," Choe recalled.

His exposure to methods of urban planning and renewal in America convinced him of the need to devise "a Singaporean way".

URBAN RENEWAL COMMENCES

In the early 1960s, Singapore's city centre, which comprised slightly more than 1% of the country's total land mass, housed about 18% of the country's resident population. Most of the area's buildings were one to three storeys in height, and many were at least a century old. The majority were poorly maintained and lacked basic amenities such as proper plumbing, sanitation and electricity.

Shophouses being demolished as part of urban renewal works, 1980s. By this time, intensive urban renewal was taking place across the city centre, enabling the development of modern skyscrapers such as the Furama Hotel, pictured in the background. (Ronni Pinsler Collection, courtesy of National Archives of Singapore)

It was not uncommon for seven to eight families to share a house with only one lavatory and kitchen. The streets and back-lanes of shophouse blocks—where human excrement and household rubbish were collected—had become multi-functional spaces where children played, families ate their meals and the itinerant congregated.

In 1966, the UNDP allocated funds to Singapore for the implementation of urban renewal efforts. The process was led by the MND, which began work on preparing a comprehensive urban renewal plan for the country, starting with the city centre.

In 1971, the publication of Singapore's first Concept Plan, a strategic land-use plan intended to replace the 1958 Master Plan, gave a strong boost to the urban renewal project. The 1971 plan clearly outlined Singapore's spatial needs over the next 20 years and provided guidance to planners on how land across the island would be allocated and developed. The plan also gave the URD officers a greater sense of mission, showing them that their efforts to rebuild the city centre were closely linked to the broader needs of the country.

For Choe, this was a realisation that urban renewal should not solely be about building roads and public areas. There was a need to think about how to build a comfortable and attractive environment, and to inject life in the city.

In the years that followed, the urban renewal project would be conducted on a large scale, with the government having to acquire privately held land, resettle individuals and families in newly constructed public housing, demolish old buildings and build new developments.

A CHALLENGING, COMPLEX AND SENSITIVE PROJECT

The government first divided the city centre into 19 precincts, each covering an area of between 60,000 m^2 and 800,000 m^2. Urban renewal commenced from the northern-most and southern-most precincts, proceeding in phases

into the heart of the city centre. One of the reasons for this was that the proportion of land under private ownership tended to be lower in the outer precincts, with more land parcels owned by the state. This made it much easier and faster for the government to undertake redevelopment efforts there. In turn, the redevelopment of these outer precincts generated momentum for subsequent phases of the urban renewal project.

Once the government approved a plan for the redevelopment of a precinct, urban renewal officers would conduct site surveys to obtain information on the number and composition of households there. They also collected information on matters such as the employment and income profiles of residents. This data was intended to help the authorities determine plans for resettling each household. For example, individuals whose jobs were located in the city centre would be resettled in new housing developments nearby.

There was also the need to plan and implement the construction of essential infrastructure, including electricity cables and substations, drainage channels, roads, lamp posts and vehicle parking facilities; as well as parks, green spaces and landscaping. These efforts required substantial capital investments and detailed coordination with a range of government agencies.

Moreover, the renewal of the city centre was a politically sensitive project. For one, there was a fragmented system of land ownership in the city centre, with individual landlords owning shophouses and other buildings on very small plots. But if renewal was to be carried out in a meaningful way, entire street blocks and districts—including those containing privately owned property—needed to be redeveloped.

To do this, the government had to use a colonial-era law, the Land Acquisition Act, to expropriate privately held land for

A view of Clarke Street (now part of the Clarke Quay entertainment complex), with People's Park Centre in the background, 1985. People's Park Centre, completed in 1973, was built on one of the first land parcels sold through the Sale of Sites programme. (Ronni Pinsler Collection, courtesy of National Archives of Singapore)

comprehensive redevelopment. The Act was amended in 1966 to strengthen the government's power to acquire land for public purposes. The government compensated land owners at market value, as was required under the Act; but many land owners were nonetheless unhappy with the acquisition effort.

The effort to resettle families and individuals displaced by the redevelopment plans was also a prickly one. It required URD officers to have courage and sensitivity, especially since many were reluctant to leave their existing premises. The URD officers had to assure them that provisions would be made to resettle them in other locations.

In cases of large-scale resettlement, where the clearance area was of a significant size, the government would re-house residents and shop-owners in new public housing complexes close to the clearance site, thus reducing disruption and inconvenience to them. A new HDB estate at Outram Park, for example, was developed to house many former residents of nearby Chinatown.

On average, six new flats were needed to house those who had been displaced following the demolition of a single old shophouse building. Between 1960 and 1972, the government had to resettle about 50,000 households affected by urban renewal and related public works. The rapid development of public housing in HDB new towns such as Toa Payoh just outside the city centre greatly aided this effort. Ultimately, the government successfully resettled all individuals and families displaced by the city centre's urban renewal.

During this period, the government also made efforts to explain the necessity and goals of urban renewal. In 1967, Choe contributed an essay to the Nanyang Siang Pau, Singapore's main Chinese language newspaper. He explained that the urban renewal project was aimed at rebuilding the city centre, clearing slums, improving the physical environment, enhancing the quality of public services and creating new employment opportunities for the people. Spaces would also be created for different commercial uses such as offices, banks, hotels and shops to spur the country's economic growth.

Leaders like then Prime Minister Lee personally chaired several meetings with residents who would be affected by resettlement. He wanted to give them a proper and complete account of the government's plans, so as to gain the trust and support of the public for the urban renewal effort.

THE SALE OF SITES PROGRAMME

Following land acquisition, resettlement and demolition, the government had to implement plans for the construction of new commercial and residential developments. One of the key features of the urban renewal project was the government's partnership with real estate developers from the private sector to do so.

In 1967, the URD launched the Sale of Sites programme to sell land parcels in the city centre to private developers for the development of new buildings. In the run-up to the first Sale of Sites programme, the URD conducted in-depth market studies to understand issues such as the business considerations of developers and the market demand for housing and shop space.

At Choe's suggestion, a committee of cabinet ministers—the Ministers for Law, National Development and Finance—was formed to

A view of high-rise office blocks along Shenton Way, 1973. The Sale of Sites programme provided land for the development of many commercial buildings in the city centre. (Ministry of Information and the Arts Collection, courtesy of National Archives of Singapore)

oversee the programme, determine conditions of tender and approve the sale of each site.

The URD designed the Sale of Sites programme such that it was transparent and fair. The sites were offered for sale through an open tender process, with available sites advertised in local newspapers. Those who wanted to purchase a site had to submit their bids to the URD at a prescribed time, depositing them in a tender box. After all bids were received, URD officers would review each submission and post the tendered prices on a notice board.

In the case of the first sites offered for sale through the programme, bidders were also required to submit design proposals for the developments they wished to build on each site. A group of officials, chaired by Choe, would assess each of these design proposals. To eliminate any form of personal prejudice or bias in the evaluation process, the design proposals could not be labelled with the names of the designers who had prepared them; if so, they would be rejected.

Choe explained that it was important to ensure the best designs were chosen for the redevelopment of the city centre. It was therefore not necessary for a site to be sold to the highest bidder. However, if the working group wanted to recommend the sale of a site to a tenderer with a strong design proposal but lower bid, it would have to submit robust justifications to the ministerial committee. This approach ensured that the URD remained fiscally prudent, responsible and accountable to the government.

Today, the Sale of Sites programme is known as the Government Land Sales (GLS) programme, and the approach pioneered by Choe to evaluate tender proposals on the basis of both design and price continues. Choe said this approach encouraged enterprises to give opportunities to young architects and designers.

“For one project, we get a few designs, giving different architects the chance to show their talent. From there, we pick one. Every time

we do this, more and more good architects are given a chance to realise their plans. In this way, we helped promote design and architectural knowledge in the industry."

From 1967 to 1989, the Sale of Sites and GLS programme released about 1.8 km^2 of land for 155 development projects, facilitating the city centre's redevelopment and expansion. Over a 20-year period, the city centre transformed into a modern financial and business centre. Perhaps the largest physical changes occurred in the areas of Shenton Way and around the former Golden Shoe Complex, where developers erected a series of landmark skyscrapers that have come to define Singapore's modern skyline.

PRESERVING BUILT HERITAGE

Despite the significant physical changes in the city centre, several streets and entire districts were retained and conserved. Today, places like the Tanjong Pagar conservation district and Boat Quay still feature original buildings and structures built over a century ago. The retention of Singapore's urban built heritage is the result of efforts undertaken by Choe and other pioneering planners.

On 3 June 1967, Choe received a letter from Lee asking if he had thought about preserving built heritage in the city centre precincts selected for urban renewal. In fact, Choe had already drafted a report with a detailed preservation plan for old buildings and structures. Choe submitted this report to Lee, who promptly endorsed it.

To Choe, old buildings are a visual record of the history of a place, and the unique style and architecture of these structures can express the cultural distinctiveness of a city or country in a tangible way. Urban renewal should not simply be a process of demolition but also include plans for preservation and rejuvenation. To execute preservation effectively, governments must have proper plans to retain and enhance old structures. There must also be institutions to conduct research on the historical and aesthetic value of these structures; and legislation to provide for their retention, upgrading and maintenance as historic sites, buildings or even memorials.

In 1971, the government established the Preservation of Monuments Board and enacted legislation for these purposes. Conservation was also adopted as an important feature of the URD's work, and remains a core focus for its successor agency, the URA.

Under Choe's leadership, the URD and the URA successfully conserved several streets and entire districts of old shophouses and historic buildings in the city centre. Choe recalled that this was a difficult task: "At that time, these buildings were very old and dilapidated, and occupied by many labourers and unemployed people. We not only had to resettle them, but also help renovate the buildings ... one by one."

There were also substantial economic trade-offs, since many of these well-located districts could otherwise have been redeveloped for high-density complexes such as apartments or commercial skyscrapers. Indeed, many of these areas were ultimately passed over for conservation. Choe lamented the demolition of historic buildings in areas such as Raffles Place. In his view, the loss of these structures makes it even more important for planners to exercise greater sensitivity in planning and implementing the country's future urban development.

ESTABLISHING THE URBAN REDEVELOPMENT AUTHORITY

The URD was first established as a department under the HDB. As the urban renewal project continued into the 1970s, Choe began to feel strongly that the URD should exist as an independent unit, separate from the HDB.

The main reason for this was that the HDB's focus was on building more public housing to meet the population's needs. This task was closely related to the urban renewal of the city centre in the early years of independence. However, in subsequent decades, it became clear to Choe that the URD's approach to urban renewal was significantly different to the one undertaken by HDB in developing public housing. For example, urban renewal called for the re-planning and sale of land within the city centre to cater to national, social and business needs, oftentimes in partnership with the private sector. For Choe, the URD's separation from the HDB would enable each entity to better focus on its respective responsibilities.

After discussing his views with superiors at the HDB, Choe met the then Minister for National Development E. W. Barker to explain his proposal for establishing the URD as a standalone agency. Barker considered Choe's views and quickly approved the proposal.

On 1 April 1974, the Urban Renewal Department (URD) was reorganised as the Urban Redevelopment Authority (URA), an independent statutory board under the MND. For Choe, the creation of the URA illustrated the open-mindedness of Singapore's early leaders and their willingness to experiment with organisational changes that would benefit policy implementation.

The creation of the URA as an independent entity energised the urban renewal officers, who went on to plan and implement a series of bold, ambitious developments in the 1970s and 1980s.

THE DEVELOPMENT OF RAFFLES CITY

One of these was Raffles City, a large-scale commercial development located just north of the historic Civic District, in the heart of the city centre. The site housed Raffles Institution, a prominent school for boys founded in 1823. Choe felt the school sat on prime land and should be relocated to free up the site for other purposes.

At a 1968 meeting with Hon Sui Sen, who was then the head of the Development Bank of Singapore (DBS), Choe described the urban renewal project and discussed the possibility of redeveloping the Raffles Institution site as a landmark commercial centre. Hon expressed a strong interest in the project. Sometime later, he called Choe to convey DBS' interest in developing the site. Over the telephone, Choe shared his plans for the commercial centre to be developed in partnership with the private sector, and his vision for this development to be designed by an internationally renowned firm. Hon expressed enthusiasm for Choe's plans, readily confirming DBS' participation in the project.

Plans for the development of Raffles City were announced in 1969. It was conceptualised as Singapore's largest standalone commercial development, with a range of facilities constructed to world class standards. The project, comprising some 400,000 m^2 of office space, would also include hotel and retail uses. The entire complex would be designed by a team led by the famous Chinese-American architect I.M. Pei.

A row of newly conserved shophouses along Tanjong Pagar Road, 1989. (Courtesy of National Archives of Singapore)

The ground-breaking ceremony for Raffles City took place on 14 August 1980. Hon, who was by then Singapore's finance minister, delivered a speech that described the commercial centre as a "unique development for Singapore, perhaps for this part of the world, and will no doubt serve as an example for high quality developments on prime sites here and elsewhere". Connecting the Orchard Road prime shopping belt and the Shenton Way Central Business District, it would be served by a major interchange station on the future Mass Rapid Transit (MRT) system.

The design and construction of Raffles City involved the use of innovative planning and architectural techniques, construction methods and materials. The complex officially opened in 1986 and quickly became a new commercial landmark in Singapore. Today, it remains one of the country's busiest and most famous developments. For a while, one of its towers was the tallest hotel in the world.

For Choe, Raffles City also marked an important turning point in Singapore's development. It showcased the business opportunities for foreign developers and architectural firms in Singapore, and inspired confidence in its real estate market. In subsequent decades, foreign investments in this sector helped drive Singapore's further development.

LEARNING FROM EXPERIENCE

In the 1980s, Singapore's urban skyline started to take shape. The commercial areas at the mouth and along the banks of the Singapore River featured an attractive mix of modern skyscrapers and restored shophouses that extended north towards Raffles City. The seamless commercial corridor stretched towards Orchard Road, which by that time had established itself as the country's key shopping district. In the southern part of the city centre, the renewal of the Golden Shoe district and Shenton Way facilitated the development of an important financial centre.

A view of the city centre today, with the Chinatown and Tanjong Pagar conservation areas in the foreground, and Raffles Place and Marina Bay in the background. (Chuttersnap)

Reflecting on the urban renewal project, Choe described several factors for its success.

The first was the strong political will of government leaders such as Lee, who paid personal attention to the detailed plans of the renewal efforts. The government was also prepared to bear the political costs of implementing land acquisition and resettlement, both of which were sensitive issues at the time.

Another defining feature of the project was the establishment of clear goals and timelines. Choe himself articulated many of the project's core objectives from the very start, setting clear directions for the work of the URD. Perhaps the best illustration of the URD's care in setting implementation timelines was its effort to coordinate clearance plans for the city centre with the construction of new public housing by the HDB. This made it possible to quickly resettle many of the city centre's residents in new housing units.

Choe also stressed that the government took a long-term view in planning the urban renewal project. For example, despite the urgency with which redevelopment efforts took place, the government believed in the need to selectively conserve and retain parts of the city centre as Singapore's built heritage. Laws and regulations were also introduced in the early 1970s to protect these structures. Today, conservation districts such as Chinatown, Little India and Kampong Glam are important repositories of local culture and character.

The project would have failed if not for the clear and transparent laws and regulations in place to support its implementation. The Land Acquisition Act enabled the government to acquire large tracts of land for development, even as it provided protection and certainty to private landowners that they would be fairly compensated. The Urban Redevelopment Authority Act gave legal certainty and powers to the newly formed URA, which greatly aided in the discharge of its mandate. In addition, the Sale of Sites programme (now called the Government Land Sales programme), with its numerous tender conditions and rules, provided for the well-regulated and timely development of new buildings in the city centre.

Finally, Choe gave credit to the spirit of cooperation and team work that existed among officers in infrastructure agencies such as the URD, the Public Utilities Board (PUB) and the Public Works Department (PWD). At the time, many of the agencies involved in the project reported directly to the law ministry and the MND; coincidentally, both these ministries were headed by E. W. Barker. This greatly facilitated the success of URD's efforts to rebuild the city centre.

A VAST OUTLOOK

For Choe, "Singapore is a small country with a bold vision and vast outlook. Its successful development has been a source of pride to its people."

The pioneering urban planner added that the country's drive to keep improving is not less strong today than it was in the years following independence. "Singapore has even loftier goals, and these will continue to shape Singapore's skyline over time."

A young boy at a Housing and Development Board (HDB) estate, 1980s. (Singapore Tourist Promotion Board Collection, courtesy of National Archives of Singapore)

3 Public Housing

In the years following independence, the Housing and Development Board constructed thousands of affordable flats to house the people, resolving the problems of homelessness and poor living conditions that had affected many in Singapore.

Dr Liu Thai Ker joined the Housing and Development Board (HDB) in 1969 as an architect and planner, eventually assuming the role of Chief Executive Officer (CEO). During his time at the HDB, Liu oversaw the development of 23 new towns, comprising more than 500,000 flats.

In 1989, Liu moved to the Urban Redevelopment Authority (URA), where he served as CEO and Chief Planner until 1992. During his time at the URA, Liu led the effort to draw up the 1991 Concept Plan, a strategic land-use blueprint that would guide Singapore's spatial development over the long term.

Liu has served as chairman of several institutions in the arts and academic sectors, including the National Arts Council, and the School of Design and Environment at the National University of Singapore. Liu was also Advisory Board Chairman of the Centre for Liveable Cities between 2008 and 2020.

Reflecting on his career at the HDB, Dr Liu Thai Ker described public housing as one of the building blocks of modern Singapore. "The success of public housing not only enabled people to live and work in peace, but built a stable society and allowed for economic growth."

When Singapore gained self-government from the British in 1959, it was an economically depressed country facing massive income inequality and social cleavages arising from the multi-ethnic composition of its population. The government grappled not only with the challenge of developing Singapore's economy, but also existential threats to its sovereignty. There was an urgent need to unite the people and foster a sense of nationhood.

Then Prime Minister Lee Kuan Yew believed that promoting home-ownership was one of the best ways to nurture a common identity among the people of Singapore. Liu recalled that this was a bold and unconventional idea at the time, and went against the prevailing trend in many developed countries where governments developed social housing for rent to lower income citizens. Lee's decision to build and sell houses to the people was founded on his belief that home-ownership gave people a larger stake in the country and a stronger will to protect its independence.

HOUSING PROBLEMS IN EARLY SINGAPORE

Up to the mid-1920s, the colonial authorities made little attempt to manage the housing situation in Singapore. As the population grew rapidly at the turn of the century, housing conditions deteriorated, especially in the over-populated city centre.

In 1927, the British colonial authorities established the Singapore Improvement Trust (SIT) to resolve widespread housing shortages by building flats in and around the city centre. Over the next 30 years, the SIT built about 32,000 new flats, but this did little to resolve the housing problem.

In 1959, Singapore's population had grown to 1.6 million, but there were only about 40,000 housing units in the whole country—one house for every 40 people. Thousands lived in overcrowded shophouses and tenements, on the street, and in temporary shelters and slums.

ESTABLISHING THE HOUSING AND DEVELOPMENT BOARD

When the People's Action Party (PAP) assumed power in 1959, it dissolved the SIT and replaced it with a new organisation to oversee the construction and management of public housing. The HDB, formed on 2 January 1960, reported directly to the Ministry of National Development (MND).

Lim Kim San, a former banker who had been invited by Lee and other PAP leaders to join the government in the late 1950, was named the HDB's first chairman. Lim appointed senior civil servant Howe Yoon Chong as Chief Executive Officer and architect Teh Cheang Wan as Chief Planner. The three men steered the HDB through its formative years.

One of the HDB's first tasks was to determine the extent of the housing shortage in Singapore and calculate the number of new houses that had to be built. The studies showed that Singapore required 150,000 new houses over the next 10 years. Of this, housing developers in the private sector could probably construct 40,000 houses, mainly for upper and

middle income families. The HDB would have to provide the remaining 110,000 houses.

The HDB introduced two consecutive 5-year flat building programmes. It planned to build 50,000 new flats in the first 5-year phase and 60,000 in the second. These were ambitious targets, but the HDB managed to achieve them. By end 1970, it had built almost 121,000 new flats and shophouses.

HOME-OWNERSHIP FOR THE PEOPLE

In 1964, Lim, who had by then been appointed the Minister for National Development, announced a "Home Ownership for the People" programme, articulating a set of goals that have continued to shape HDB's policies in the decades since.

In the early years of independence, the HDB offered flats as rental accommodations to lower income Singaporeans who did not have enough money to purchase them. With the government's new focus on promoting home-ownership, it allowed rental tenants to purchase their existing accommodations without having to foot a deposit or satisfy monthly income requirements. For these buyers, the HDB introduced monthly instalment plans stretching over 20 years at an annual interest rate of 6%.

For prospective buyers who were not existing rental tenants, the HDB extended housing loans at similar interest rates with 15-year repayment periods. However, this did not result in a large number of flat purchases because many Singaporeans were still unable to raise the down-payment—set at 20% of the purchase price of the flat—required for a loan.

To address this problem, then Prime Minister Lee decided to allow Singaporeans to use their Central Provident Fund (CPF) savings to pay for their flats. The CPF system is a compulsory savings scheme introduced in 1955 to provide a source of income to working Singaporeans in their retirement years. In 1968, the government passed an amendment to the CPF Act to raise the rate of contribution. Thereafter, the HDB launched a revised home ownership scheme that enabled prospective flat-buyers to tap on their CPF savings to pay the 20% down-payment and finance the housing loan through monthly instalments over 20 years. These changes triggered a dramatic increase in the demand for new flats and consequently, the national home-ownership rate.

THE HDB'S FIRST THREE DECADES

In the 1960s, the HDB focused on resolving the critical housing shortage, which included resettling many former residents of the city centre. The 1970s ushered in a period of political stability and rapid economic growth, with the government devoting substantial funds to the development of more public housing estates across the island.

As household incomes grew rapidly in the late 1960s and early 1970s, the HDB raised the income ceiling on prospective flat buyers to enable more Singaporeans to purchase flats, resulting in the number of flat applications reaching a peak in February 1974. To cater to the changing tastes and preferences of a more affluent population, the HDB also implemented plans to build higher quality flats and improve the provision of amenities in new towns.

During the 1980s, the HDB focused on adopting new methods of planning and

Home-buyers viewing newly completed flats at Toa Payoh, 1967. Toa Payoh was the first housing estate built by the HDB. A banner in the background reads, "Homeownership for the People". (Ministry of Information and the Arts Collection, courtesy of National Archives of Singapore)

construction, as well as innovative technologies to improve building standards. This period saw a vast improvement in the quality of flats built by the HDB. In the latter part of the decade, some 30 years after the construction of the first HDB flats, the government introduced the Main Upgrading Programme (MUP) to refurbish older public housing estates such as Toa Payoh.

By 1989, the HDB had built more than 530,000 flats, averaging 18,000 a year since 1960. Almost 90% of Singapore's citizen population lived in HDB flats.

PLANNING HDB TOWNS

The planning and design of HDB towns evolved substantially over time.

In the 1960s, the HDB built public housing estates within a 10 km radius of the city centre, in places like Queenstown and Toa Payoh. As the city centre was still the commercial heart and main employment centre of the country, this made it easier for residents to travel to and from their work places.

In 1971, the government published Singapore's first Concept Plan, which outlined a model of spatial development where new housing estates would be located to the north, east and northwest of the city centre. Accordingly, during the 1970s and 1980s, the HDB built new towns in areas like Bedok, Marine Parade, Ang Mo Kio, Bukit Batok and Hillview.

Liu recalled that when he first joined the HDB in 1969, the focus of his work was on design and research. At the time, the HDB had no concrete plans for the design of new towns. Liu and his team assumed the task of preparing design blueprints for these towns. They planned for each town to house up to 300,000 people and contain a range of recreational, commercial and other amenities.

Initially, the team planned each town as a connected series of neighbourhoods. Each neighbourhood would comprise up to 6,000

Newly constructed blocks of flats at Eunos, 1981. Landscaping and greenery are ubiquitous in all HDB estates. (Housing and Development Board Collection, courtesy of National Archives of Singapore)

flats and accommodate about 15,000 residents. But Liu had some reservations about the size of each neighbourhood, which he felt was too large to foster a sense of community and belonging.

After consulting the Singaporean sociologist Dr Chua Beng Huat, Liu devised a plan for each new town to be made up of smaller communities, to be termed "precincts". Each precinct would comprise up to 1,000 flats, with a single point of entry and exit. It would incorporate playgrounds and other common activity areas for residents. The precincts would be linked by a network of walkways and other connecting passages. The intention was to create opportunities for residents to meet and interact, thus encouraging a sense of familiarity and neighbourliness.

FLAT DESIGNS THROUGH THE DECADES

The earliest HDB flats were designed as basic one-room dwelling units with shared bathrooms and kitchens. This enabled new blocks of flats to be constructed quickly, and reflected the urgent need at the time to provide basic shelter to those who had to be resettled from the city centre's decaying tenements and slums. Each flat measured about 200 ft^2, but there were also more spacious units measuring about twice that size to house larger families.

From the mid-1960s, the HDB started to build larger flats, including four- and five-room flat types with multiple bedrooms, a kitchen and bathroom. Some were as large as 1,000 ft^2. In 1979, the HDB even introduced "executive flats" measuring more than 1,500 ft^2 for those with higher incomes. Many HDB flats served as multi-generational homes, housing families of up to 10 members.

In the subsequent decades, the HDB built a greater variety of flat types to meet the changing needs and preferences of Singaporean households.

ENSURING AFFORDABILITY

A key imperative of the HDB's building programme has been to ensure that flats remain affordable for the vast majority of Singaporeans. To do so, the HDB has had to carefully control construction costs while ensuring reasonable building standards.

During his leadership of the HDB, Liu undertook measures to improve the efficiency and productivity of flat construction. These measures helped to minimise costs and safeguard the affordability of flats for Singaporeans.

One of his first initiatives was to commission the Japanese construction firm Shimizu to conduct a detailed study of the HDB's contractors, and recommend productivity improvements. The study identified areas for improvement and provided guidelines to contractors on how they could enhance their work processes and boost efficiency, as well as minimise the wastage of building materials and other resources.

Liu also introduced modular construction in the HDB's building programme as a means to improve construction productivity. For one, less concrete was required in the construction process. He also encouraged contractors to carry out the pre-casting of building components themselves to reduce their reliance on sub-contractors and better manage costs.

The HDB also deliberately kept the design and finishing of HDB flats simple. Liu recalled that this elicited some criticism from the public, who observed that HDB flats were overly basic, with untreated walls, rough floors, and simple windows and doors. Liu recalled that HDB's first chief planner Teh Cheang Wan had the best response to such criticism:

> **We use the least amount of money to create the maximum amount of living space for the people. The living space in each house doesn't increase regardless of how much work you put into decorating it.**

For Teh, the HDB's priority was to provide adequate living space in each flat; it would be imprudent to spend unnecessarily on aesthetic features.

ESTATE MANAGEMENT

The HDB also introduced policies to ensure that new housing estates were properly managed and maintained. These efforts were intended to prevent them from degenerating into slum-like colonies, a situation that was common in many subsidised housing projects in the developed world. The HDB took measures to maintain high levels of public hygiene and cleanliness, and provided landscaping to create a green and attractive environment in each estate. In the

1980s, the HDB adopted computer technology to enhance its responsiveness to mechanical problems such as faulty lifts and other forms of malfunctioning equipment.

It also introduced communication channels to allow residents to provide feedback to HDB on local issues. Liu said that the HDB's estate managers carried out regular inspections around housing estates, enabling them to identify problems and quickly resolve them. Another innovation was the government's establishment of neighbourhood committees. These committees, comprising residents, served as an important source of information on the physical condition of each estate and also provided constructive suggestions for improvement.

PUBLIC HOUSING AND NATION-BUILDING

The goals of Singapore's public housing programme are perhaps best summed up in three simple words: accessibility, affordability and security. The HDB was established to deliver low-cost housing to all Singaporeans, and to give them an asset to enjoy over their lifetimes.

These goals have fundamentally shaped the HDB's policies through the years. There have been priority schemes and subsidies for selected groups of buyers, home improvement programmes to upgrade older flats and a lease buyback scheme that has allowed retired Singaporeans to monetise their flats for additional income while continuing to live in them.

The public housing programme also set out to foster a sense of community and nationhood among Singaporeans. The HDB ensured that each estate included a spectrum of flat sizes, from cheaper two-room flats to more expensive executive apartments. This arrangement created more opportunities for people of different income levels and social backgrounds to meet and interact.

A playground in a HDB estate at Bedok Reservoir, 1984. Public spaces and recreational amenities provide opportunities for social mixing and interaction, encouraging a sense of community and familiarity among residents. (Ministry of Information and the Arts Collection, courtesy of National Archives of Singapore)

In addition, there were policies to encourage interaction between Singaporeans from different ethnic backgrounds. In the 1970s and 1980s, as the resale market for HDB flats expanded, Singaporeans had greater choice in where they wanted to live. The HDB observed that some ethnic groups tended to prefer certain locations, which led to the growth of enclaves. To arrest this trend, the HDB introduced the Ethnic Integration Policy (EIP) in 1989 to impose ethnicity-based quotas on flat ownership in HDB estates. The EIP has ensured that the ethnic mix in HDB estates reflects the overall ethnic composition of Singapore.

PUBLIC HOUSING AND NATIONAL LAND-USE PLANNING

Following his tenure at the HDB, Liu joined the URA as its CEO, where he formulated national land-use plans. During his time at the URA (1989 to 1992), Liu led a review of Singapore's Concept Plan, a national land-use blueprint that was first developed in 1971 with the assistance of experts from the United Nations (UN). The review resulted in the creation of the 1991 Concept Plan, which envisioned Singapore transforming into a distinctive "Tropical City of Excellence".

THE 1991 CONCEPT PLAN

When the government decided to embark on a review of the Concept Plan in the mid-1980s, the social, economic and physical conditions of the country were vastly different from those faced by the team of planners and UN experts that designed the 1971 Concept Plan.

The urban renewal project was mostly complete, with the removal of the last slums and squatter settlements in the city centre. Much of the physical infrastructure in the 1971 plan had also been implemented: the HDB had built over half a million new homes, the Mass Rapid Transit (MRT) system would soon open in 1987, and the government had developed a network of new expressways connecting the city centre with other parts of the island.

The challenge, then, was to design a new Concept Plan that would enable Singapore to reach First World status, and provide a higher quality living environment to its people.

In the run-up to the review of the Concept Plan, the government restructured the MND by moving two of its departments—the Planning Department, and the Research and Statistics Department—to the URA. This move, in 1989, greatly enhanced the professional capacity and resources of the URA and enabled it to conduct urban planning in a more integrated way. Additionally, the move created administrative efficiencies, enabling the URA to be a more focused and effective organisation.

The government assembled a committee to oversee the Concept Plan review, with seven sub-committees convened to look into different areas of planning. As CEO of the URA, Liu played an important leadership role in the review committee. Among his responsibilities was to lead several working groups to review the designs of HDB flats and estates, and other key public developments.

At the start of the review process, the government conducted a series of studies to determine key parameters such as the long-term population of Singapore and the residential, social, recreational and other preferences of its people. It also had to project the country's future economic conditions and structure,

and calculate the amount of land needed to support its further growth and development. Additionally, there was a need to consider the future size of Singapore's land mass, which had been increasing since the 1960s through reclamation. This was a key planning parameter that would have an impact on the distribution of development intensities across the country.

The review process also included an extensive series of consultations with representatives from the private sector and academia. Such public consultations, which were unprecedented at the time, allowed people from different areas of expertise to discuss and give their views on the future planning and development of Singapore.

Liu stressed that those involved in the review process approached their work in a scientific, rational and statistical way. Important questions had to be answered about how the city would be developed and structured. These could not be approached in a callous or flippant fashion, such as by blindly applying theoretical concepts or ideological beliefs.

THE DECENTRALISATION STRATEGY

One of the key features of the 1991 Concept Plan was the decentralisation of commercial functions and activities from the city centre to other parts of Singapore. Among the reasons for this planning strategy was the need to reduce population

Interior of a HDB flat in Toa Payoh, 1980. Many early HDB flats were designed to accommodate large multi-generational families. (Ronni Pinsler Collection, courtesy of National Archives of Singapore)

Prospective flat-owners tour a newly completed block of flats at Bras Basah, 1980. Many HDB flats in the city centre were occupied by those relocated from old shophouses and tenement buildings. (Ministry of Information and the Arts Collection, courtesy of National Archives of Singapore)

density and traffic flows at the city centre, and optimise the use of the island-wide transportation network. The decentralisation strategy led to the creation of several regional centres and satellite towns such as Woodlands, Jurong and Tampines.

Visually, the 1991 Concept Plan revised the ring pattern of the 1971 plan with a "Constellation Plan". This took shape as a hub-and-spoke model of development, in which the Central Area would serve as the commercial heart of the country, with development taking place in a series of outward radiating rings. Singapore was split into five regions outside the city centre. In turn, each region was divided into an average of five satellite towns each, creating 25 such towns across the island.

Dr John Keung, Singapore's Deputy Chief Planner from 1997 to 2001, described this as the heart of the 1991 Concept Plan, and one that has continued to influence Singapore's spatial development even today.

Liu explained that his experience in planning HDB towns significantly influenced the decentralisation model of the Concept Plan. Many of the ideas and insights he gained at the HDB were adapted in designing the national land-use blueprint.

The concept of satellite towns, which was based on what has been termed the "polycentric" model of urban planning, was not novel at the time. Many European cities, including in England, had developed satellite towns in order to reduce over-population and traffic congestion. On average, European satellite towns had populations of about 30,000 to 50,000 people. In Singapore, where land was scarce and HDB estates were built to accommodate large numbers of residents, satellite towns would have to be planned differently.

To determine the optimal size and layout of each satellite town, Liu and his team conducted a series of planning studies, and consulted sociologists and anthropologists.

Liu explained that studies had shown that a critical mass of about 5,000 to 10,000 households would be necessary to support a reasonable provision of commercial, recreational and other amenities in a given community. Other studies suggested that the longest distance an average person would be willing to walk to access various daily essentials was 600 m. Adjusting this figure to account for Singapore's tropical climate, the team decided to work with a distance of 500 m. Liu also relied on a series of studies suggesting that it tended to be difficult for people to develop a sense of belonging in communities that exceeded a geographical area of about 30,000 m^2.

Taking these findings into consideration, Liu and his team worked out the general physical parameters of satellite towns in Singapore. Each town would comprise a series of up to five neighbourhoods, cover an area of up to 25 km^2, and house a population of up to 300,000 residents. Each town would be planned as a self-sufficient community with a town centre that incorporated commercial, recreational and other social functions. There would also be light industrial estates to provide some employment for residents, and other social uses such as schools. The towns would be connected to other parts of the island by expressways and the MRT.

For Liu, satellite towns make up the basic building blocks of Singapore. Elaborating on the decentralisation strategy he helped introduce, Liu said: "From the start, the southern part of the city centre formed the heart of Singapore's busiest commercial area.

A view of HDB flats at Bishan, overlooking Bishan-Ang Mo Kio Park. (Jason Goh)

It was crowded with commercial activities and residential developments, making it a densely populated place suffering from various traffic, environmental and other problems. In my view, we could capitalise on the MRT and bus network to extend Singapore's spatial development to the rest of the island, thus reducing the pressures on the city centre. We built the largest satellite towns at the final stops of each MRT line, developing commercial and retail centres there. The intention was to attract large numbers of people to travel in the opposite direction, away from the city centre. This would spare the city centre from excessive development."

EXPERIENCE AND EXPERTISE, NOT THEORIES AND IDEALS

Reflecting on his experiences in public service, Liu said much of the work he had done in developing Singapore was based on the application of practical experience, rather than "planning ideals". Singapore, he said, had given him "the opportunity to personally participate in the country's planning and development, to study and consider solutions and best practices."

"For my team and I, this was the highest honour."

Worker erecting scaffolding at Clarke Quay, 1982. (Ronni Pinsler Collection, courtesy of National Archives of Singapore)

4 Economic Transformation

Singapore's leaders transformed the economy through establishing a robust industrial base and pursuing a strategy of economic diversification.

Dr Philip Yeo has played a leading role in the development of Singapore's economy, including in the life sciences, petroleum and chemical processing sectors. He has also contributed to Singapore's economic diversification and internationalisation, as well as developed and strengthened Singapore's economic relations with other countries.

Yeo joined the public service as an officer in the Ministry of Defence in 1970, rising to the position of Permanent Secretary for logistics, technology research and development, and defence industries.

In 1986, Yeo was appointed Chairman of the Economic Development Board (EDB), where he remained until 2001. Thereafter, he led the Agency for Science, Technology and Research (A*STAR) as Chairman from 2001 to 2007. From 2007 to 2011, Yeo served as Special Advisor for Economic Development in the Prime Minister's Office (PMO).

For Dr Philip Yeo, pragmatism is what underlies Singapore's economic policies. Rational planning and an ability to change with the times are the reasons why the government could steer Singapore's economy through global crises and other challenges, and safeguard its vitality and relevance.

SINGAPORE'S ECONOMY: 1959–1984

The British founded a trading post on Singapore island in 1819 and developed it into a port city over the subsequent 150 years. In 1959, Singapore gained self-governance from the British. Full independence followed in 1965 after the country split from Malaysia. The newly elected government, led by the People's Action Party (PAP), faced several challenges in its effort to develop the national economy.

One of these was the low literacy and skill levels among the working population, due in part to the disruptions caused by the Second World War. During the war, Singapore was occupied by the Japanese from 1942 to 1945. Japanese colonisers shut down many of the territory's schools, disrupting formal education for thousands of Singaporean children. Families that fled to rural Malaya and other parts of the region were also unable to provide proper education to their children. As these children came of age in the 1950s and 1960s, their employment prospects were limited to manual labour and other low-skilled jobs. The more enterprising ones started businesses, but most of these were modest operations.

In the early years of self-government, one of the government's priorities was to create jobs for the people. During this period, the government decided to develop labour-intensive industries as the main driver for economic growth.

In 1961, it established the EDB to plan and develop Singapore's industrial infrastructure. One of the EDB's first and most important projects was the development of the Jurong Industrial Estate, which commenced operations in 1962 with the opening of a factory by the firm National Iron & Steel Mills.

Jurong Industrial Estate's growth was slow in the initial years, with very few companies setting up factories there. This was primarily due to the lack of houses nearby and the area's inaccessibility from other parts of the island. But the fledgling estate received a boost from the Housing and Development Board's (HDB) construction of Jurong New Town, which commenced in the mid-1960s; as well as the creation of new public road and urban rail networks in and leading to the area. These developments greatly promoted the success of the estate and its growth into the country's main industrial hub.

The late 1960s and early 1970s was a period of fast-paced industrialisation that created many jobs for Singaporeans and fostered the growth of sectors that generated rapid economic development for the country. There are several notable features of this period in Singapore's economic history.

First, the government focused on developing export-oriented industries. This stemmed from the realisation that the country's small and limited domestic market would not be sufficient to sustain meaningful economic growth over the long term.

Second, the government undertook many efforts to raise the workforce's skill levels, such as by encouraging the development of higher value-added sectors in the

economy and introducing technical training programmes for workers.

Third, the government introduced incentives to attract foreign companies to set up operations in Singapore. It believed the inflow of foreign capital would not only aid in the development of export-oriented industries but create more and higher quality jobs for Singaporeans.

During this period, the government undertook efforts to shift the focus of the manufacturing sector away from low-skilled industries such as apparel, textile and toy production, towards industries such as electronics, component and precision engineering, semi-conductors and petrochemicals. During the 1970s and early 1980s, these industries contributed significantly to Singapore's economic growth.

To equip workers with the necessary skills and expertise to gain employment in these higher value sectors, the EDB set up technical institutes to provide professional training to Singaporean workers. Many of these institutes were established in collaboration with countries that had invested in Singapore at the time, including Germany, France and Japan.

The government's efforts to attract foreign investors in developing export-oriented industries met with success as early as the late 1960s. In 1969, the American semi-conductor company Texas Instruments became one of the first multi-national corporations (MNC) to open a factory in Singapore. The subsequent years saw the entry of several major foreign companies, including the American computer firm Hewlett-Packard and the Japanese electronics giant NEC. In the energy sector, companies like Shell and Esso built petrochemical refineries and other processing and production facilities in Singapore. These early foreign investors played an important role in the development and internationalisation of the country's electronics and energy sectors.

The benefits from foreign investment were not limited to these two sectors. During the 1970s and 1980s, MNCs also invested heavily in other parts of Singapore's economy, including aviation and pharmaceuticals.

The entry of these firms helped create high quality jobs just as Singapore's literacy and educational levels were on the rise. As a result, many Singaporeans took on administrative, managerial and other professional roles in these firms. Foreign investors introduced higher standards of management and organisation to Singapore, creating positive knock-on effects for local enterprise development.

MNCs and other major foreign companies also developed industrial and other forms of infrastructure in Singapore, relieving the need for government to allocate funding for such developments. This enabled the state to allocate its funds to public infrastructure and social programmes, including public housing and transport.

Yeo described the 1970s as a period when the government set the framework and laid the groundwork for Singapore's long-term economic development. It established the broad direction for the economy and the main avenues for the growth of key industrial sectors. The focus was on developing Singapore's export-oriented manufacturing capacity. The idea was to do so in an upward direction along the value chain, creating higher value products.

As a result, the contribution of the manufacturing sector to the overall economy exceeded that of the trade sector by the 1980s.

Workers at Jurong Industrial Estate, 1967. The estate's first factory started operating in 1962. (Ministry of Information and the Arts Collection, courtesy of National Archives of Singapore)

This was a stunning accomplishment for a country that had been a colonial trading post for much of its recent history.

Singapore's economy continued to register positive growth through the late 1970s and early 1980s despite turbulence in the macroeconomic environment stemming from a series of global oil crises. The country also experienced many positive social and physical changes: the HDB had built thousands of new houses for Singaporeans, solving the housing crises of earlier decades; urban redevelopment and renewal policies led to the rejuvenation of the city centre, and rising levels of education and literacy created a more sophisticated populace. These rapid changes created new possibilities for economic development, many of which were realised in subsequent decades.

THE 1985 RECESSION

In 1985, Singapore experienced its first post-independence recession. Economic growth slowed considerably and productivity rates plummeted across many industrial sectors. Many companies laid off employees while less resilient ones were forced to shut down, leading to an increase in unemployment.

During this period, the Ministry of Trade and Industry (MTI) appointed Yeo to chair the EDB, tasking him with tackling the economic malaise. When he assumed this role in 1986, Yeo focused on implementing growth promotion policies, including efforts to diversify Singapore's economic base and strengthen economic fundamentals so that it could better ride out future storms. Through the efforts of Yeo and other officers in the economic

agencies, the government established new plans for the economy, including identifying and nurturing the growth of sectors with strong development potential in Singapore.

One of the strategies formulated by the government at this time was to capitalise on Singapore's manufacturing and production capacity, and its technical expertise in these areas. This would position the country as a global business hub that would attract foreign companies in the emerging sectors of education, lifestyle, medical technology, telecommunications and software. This strategy has greatly shaped the development of new industrial infrastructure in the 1990s and beyond.

BATAM INDUSTRIAL PARK

During Yeo's chairmanship of the EDB, he helped establish plans to develop an industrial park on Batam island, in Indonesia's Riau archipelago.

As Singapore emerged from the recession of the mid-1980s and resumed positive economic grow, employment numbers started to rise again. By the late 1980s, Singapore was enjoying near full employment, with workforce shortages experienced in several industries, especially labour-intensive ones.

At a meeting with Dr Goh Keng Swee, who was then Vice-Chairman of the Monetary Authority of Singapore (MAS) and a former Minister for Finance, Goh remarked that more land in Singapore would have to be allocated for the development of capital-intensive and knowledge-based industries as economic priorities continued to evolve. In turn, labour-intensive industries would have to be relocated to other areas such as the more remote parts of the island. But land in Singapore was limited and it would be difficult to find appropriate space for these industries. Yeo, reflecting on Goh's remarks, knew that a lack of workforce and land could severely hinder the continued growth of labour-intensive industries that were still a significant contributor to Singapore's economic development.

In 1989, Yeo held a meeting with the Indonesian Ambassador to Singapore, where the issue of Singapore's industrial development was discussed. The ambassador had observed that Singapore and Batam were located close to each other, divided only by the Singapore Strait. Given this physical proximity, there was an opportunity for Singapore to locate its labour-intensive industries at Batam.

At the ambassador's invitation, Yeo visited Batam for the first time in March 1989. He observed that the island was relatively backward, but that it had a number of favourable features. First, there were large tracts of undeveloped land available for the construction of factories and other industrial facilities. Also, the island had a large potential labour force. Finally, Batam had a reservoir that could generate hydro-electric energy and serve as a source of water for industries.

In May 1989, Yeo called on Goh to share his observations and recommend the development of an industrial park for labour-intensive enterprises at Batam. He also arranged for Goh to visit the island. During this visit, Goh agreed with Yeo on the island's potential and instructed that he send a note to then Prime Minister Lee Kuan Yew to propose collaborating with the Indonesian government to develop an industrial park at Batam. Lee reviewed and approved the proposal.

A garment factory, 1970. The labour-intensive manufacturing sector was a key driver of economic growth in newly independent Singapore. (Ministry of Culture Collection, courtesy of National Archives of Singapore)

In August 1989, Lee met Indonesian President Suharto in Brunei, where they agreed to jointly develop Batam Industrial Park. In working out the details of the project, Yeo, representing the EDB, insisted on two conditions. First, each industrialist would have full ownership of the land on which it built its facilities; second, the park would be a tax-free zone. Singapore and Indonesia also conducted negotiations to decide on the respective ownership and management arrangements for the joint venture. The two countries reached an official agreement on the development in January 1990, less than a year after Yeo's maiden visit to Batam.

During the signing of the agreement, members of the Singapore delegation were dressed in Indonesian batik shirts, while those in the Indonesian delegation were dressed in business suits. To Yeo, this illustrated the respect that each side accorded to this bilateral endeavour, and marked a promising and positive start to the partnership.

The ground-breaking ceremony for Batam Industrial Park took place on 28 February 1990. Over the years, the government has adopted the park as a model for the development of other collaborative industrial and business parks overseas, providing useful lessons and best practices for the implementation of projects such as the Suzhou Industrial Park in eastern China.

THE TECHNOLOGY-DRIVEN 1990s

A central feature of Singapore's economic policies in the 1990s was the government's focus on furthering the development of technology-intensive industries in a more qualitative way. The government would continue to nurture the growth of the high-value chemical, electronics and engineering sectors which had taken off in the 1970s and 1980s, but there would now be a stronger focus on nurturing innovation and promoting research and development (R&D).

In 1991, the government established the National Science and Technology Board (NSTB) to promote R&D, facilitate the establishment of laboratories, coordinate research activities and programmes across the country, determine the allocation of research funds, evaluate the workforce needs of technology-intensive sectors, and organise partnerships with foreign research institutions. The government established a 5-year plan to invest some S$2 billion in the NSTB's work.

The government took efforts to enhance the R&D capabilities of MNCs and local companies, as well as to attract more technology-based businesses to establish a presence in Singapore. In 1992, it developed the International Business Park in Jurong East to incubate knowledge-based enterprises and provide supporting facilities and services to them. In 1997, it established Changi Business Park in the eastern part of Singapore to accommodate technology companies, R&D facilities, and data and software firms.

These and other business parks formed much of the infrastructure in Singapore for promoting industry-based research and catalysing the growth of high technology industrial sectors in Singapore. The growth of these sectors, in turn, created positive outcomes such as providing more skilled jobs for Singaporeans, and improving the professional capabilities and expertise of the labour force.

MOVING TOWARDS AN INNOVATIVE, KNOWLEDGE-BASED ECONOMY

Yeo describes the first decade of the 21st century as a crucial transition period for Singapore as it sought to position itself as an innovative, knowledge-based economy.

In 2001, Yeo was appointed Chairman of the NSTB, which was subsequently restructured into A*STAR. The agency's primary role was to develop Singapore's research capabilities across multiple sectors, and nurture scientific talent in those areas. The objective was to elevate R&D levels and reap economic dividends from the presence of highly skilled human capital in Singapore.

Singapore's efforts to remain competitive in an increasingly sophisticated, technology-driven global economy paid off. By 2013, Singapore's manufacturing industry, which was dominated by the research-focused chemical, electronics, precision engineering, transport engineering and biomedical sectors, accounted for almost 20% of the country's gross domestic product (GDP). The biomedical manufacturing sector, which included the medicine and medical technology sub-clusters, itself contributed more than 8% of GDP, with an annual growth rate of over 20%.

In recent years, the biomedical manufacturing sector has been a particularly bright spot for Singapore. To facilitate the sector's continued expansion, the government initiated the construction of the Tuas Biomedical Park on reclaimed land at the western tip of Singapore in 2013. The park has provided substantial space to major pharmaceutical companies for their manufacturing facilities, including production of medicines, medical equipment and other related products.

THE IMPORTANCE OF INFRASTRUCTURE

Yeo said that it is of vital importance for any country to have extensive physical infrastructure to support its economic development. Over the decades, the government has invested heavily in physical infrastructure, as a means to foster the growth of new industries and expand the country's economic base.

From a planning perspective, the development of physical infrastructure has enabled the clustering of related industry sectors, allowing for a more efficient and optimal use of land. Yeo described how the development of two industrial parks, Jurong Island and One-North, played a major role in the evolution and growth of Singapore's economy since the 2000s.

JURONG ISLAND

Jurong Island was formed through the merging of seven small outlying islands in the waters off the south-western coast of Singapore through land reclamation. In the 1960s, petroleum companies Esso and Mobil had separately built oil refineries on a number of these islands.

In the 1970s, Yeo had visited Indonesia's Karimun island, located to the south of Singapore in the Riau archipelago. While returning to Singapore by helicopter, Yeo observed the seven islands that today form Jurong Island and considered the possibility of combining them into a single island to house Singapore's petrochemical industry. Yeo felt that with proper planning and implementation, it could even become a major petrochemical centre.

Workers in a Texas Instruments factory, 1969. The American semiconductor company was one of Singapore's first major foreign investors. (Ministry of Information and the Arts Collection, courtesy of National Archives of Singapore)

The idea to create Jurong Island took shape in 1991, when the government allocated S$7 billion to the Jurong Town Corporation (JTC) to implement this project. The project was started—as Yeo had envisioned more than 10 years before—with the creation of a large artificial island to house a 30 km^2 industrial park. The planning approach was for Jurong Island to be a base where companies could consolidate all levels of their industrial activities. There would be adequate space to accommodate production, manufacturing and processing facilities. It would even accommodate back-end logistics needs such as warehousing and utilities.

While master-planning for the project proceeded, Singapore's economic agencies were faced with the challenge of convincing global petroleum companies of the viability and success of this project, and attracting them to invest in it. Yeo recalled that there were doubts and concerns at the start of the planning process.

Fortunately, these concerns proved unfounded. Many companies bought into the vision for Jurong Island, and signed on to build their facilities there. It was almost as if the ambition and boldness of Singapore's plans imbued the plans with credibility, assuring foreign investors that the government would definitely see the project through to completion. For Yeo, the success of Jurong Island is, in part, an illustration of the trust that many foreign investors placed in Singapore's ability to deliver on its plans.

By the time Jurong Island opened in 2000,

there were 60 companies that had committed to establishing a facility there, representing a combined investment value of more than S$20 billion. This was almost three times the government's initial investment in the project. In 2016, just 25 years after the plans for the island were first finalised, the investments on Jurong Island totalled almost S$50 billion.

In the years since, the government has implemented plans to expand and develop Jurong Island even further. In 2010, it announced the Jurong Island Version 2.0 initiative as the next phase of development. A focus of this initiative is to develop R&D facilities that will promote the development of the petrochemical industry in a more sustainable way.

ONE-NORTH

One-North is a 2 km^2 business park located about 7 km west of Singapore's Central Business District (CBD). The government developed One-North to house Singapore's knowledge and innovation-driven industries, providing space for technology companies in sectors such as biomedical sciences, information and communications technology (ICT), and new media.

The development comprises three interconnected hubs: Biopolis, Fusionopolis and Mediapolis, to house companies in the biomedical, ICT and media sectors, respectively. One-North was planned to be located in close proximity to renowned educational institutions such as the National University of Singapore, to create opportunities for companies to partner with stakeholders in research and academia.

Beyond providing infrastructure to support industrial and business uses, it would also provide facilities for research and education, as well as recreational and retail spaces to meet the needs of those working there.

Plans for the development of One-North were finalised in 2001. According to Yeo, One-North will only be fully developed in 2040, although much of it is already operational today. Once completed, the business park will provide over 2 million m^2 of floor space to meet the needs of a diverse group of tenants.

A COUNTRY NEEDS ITS SCIENTISTS

Yeo himself has led many efforts to promote the nurturing of human talent and capital in the various organisations he has led. He recognises that in a country with limited natural resources, it is crucial to continuously build on and improve the skills of its labour force, turning it into a competitive advantage for economic development.

As Chairman of A*STAR, Yeo established the National Science Scholarships in 2001 to provide funding for young research scientists. The scholarships are awarded to those conducting research at all levels, from undergraduate students to PhD candidates. After leaving school, scholarship recipients would be required to work in A*STAR for up to six years, contributing to the development of science and technology-related industry clusters in Singapore.

The scholarship programme has funded the education of thousands of scientists at the PhD level, many of whom now hold key positions in industry, academia and other fields.

Reclamation works at Jurong Island, 1999. (Ministry of Information, Communications and the Arts Collection, courtesy of National Archives of Singapore)

Beyond nurturing local scientists, the government has also undertaken efforts to attract talented scientists from overseas to conduct research in Singapore. There are several benefits to this. For one, many of these scientists are able to build and manage research institutions and laboratories in Singapore, passing on their knowledge, expertise and methods of inquiry to other scientists and researchers in the country.

For Yeo, the development of scientific knowledge and research capabilities in Singapore also creates a fertile environment for the fostering of entrepreneurship. This is what will enable the economy to adapt quickly to economic and technological changes, and develop in a nimble and sustainable way.

BUILDING ON A STABLE BASE

Yeo explained how Singapore's economy had managed to develop so successfully over a relatively brief period of time.

The government first focused on building a stable and sustainable economic base. It then built on that base by developing high-potential industries and providing world-class infrastructure to support their growth. The government also provided a clear and transparent regulatory environment, and invested in developing the skills and capabilities of the labour force.

He added that Singapore's growth did not come about through the application of

A cluster of buildings in the Fusionopolis section of One-North business park. (Chuttersnap)

any template or model. Every policy decision and initiative was arrived at through careful observation and consideration, and the application of learning and experience.

For Yeo, the key to Singapore's successful economic development has been an attitude of "pragmatism". This was by way of considering the circumstances and needs of the time, finding the best approach to assume at each juncture, maintaining a practical mindset and being bold enough to adopt innovative solutions.

The Marine Parade Community Centre organised its first computer camp for children in 1983. (Marine Parade Community Centre Collection, courtesy of National Archives of Singapore)

5 A Wired Nation

Since the late 1970s, the government has embarked on a series of initiatives to drive the adoption of computers and information technology (IT) in the public service and across economic sectors to boost IT literacy amoung Singaporeans.

Dr Tan Chin Nam joined the Singapore Armed Forces as a systems engineer in 1974. In 1982, Tan was appointed the first General Manager of the newly established National Computer Board (NCB). From 1986 to 1994, he also served as the Managing Director of the Economic Development Board (EDB). While concurrently leading the NCB and EDB, Tan introduced several policies that fostered the growth of Singapore's IT sector.

From 1995 to 2002, Tan served as the first Chairman of the National Library Board (NLB), where he helped improve Singapore's public library system. From 2002 to 2008, Tan was the Permanent Secretary of the Ministry of Information, Communications and the Arts (MICA). He also served as the Chief Executive Officer of the Infocomm Development Authority (IDA) from 2003 to 2010.

Singapore Airlines staff operating the KRISCOM system at the company's offices in Robinson Road, 1973. KRISCOM was a computer-based system introduced in 1972 to manage flight reservations and check-ins. (Ministry of Information and the Arts Collection, courtesy of National Archives of Singapore)

RESTRUCTURING SINGAPORE'S ECONOMY

When Dr Tan Chin Nam began his civil service career in the early 1970s as a systems engineer, the use of computers was still a novelty in Singapore and much of the world. But even in those days, the government had started considering the use of computers and computer-based technology to promote economic growth.

After Singapore's independence in 1965, the government focused on developing labour-intensive industries such as manufacturing and processing, including through extending incentives to foreign investors. These export-oriented industries created jobs and enabled the country to experience high economic growth rates for several years.

By the late 1970s, Singapore had become an industrialised, stable economy. The unemployment rate had declined since the immediate post-independence years, educational levels and literacy rates had increased, and Singaporeans enjoyed a high quality of life.

At the start of the 1980s, the government implemented plans to turn the labour-intensive economy into one that was more capital-intensive, with a focus on developing the services sector and higher value-added industries such as electronics, petrochemicals and precision engineering.

As part of this structural shift, the government also prioritised the development of computing and computer-based industries.

COMPUTERISING SINGAPORE

In March 1980, the government formed a Committee on National Computerisation (CNC) to study how Singapore could develop into a regional centre for the development of computer software and computing-based services. The government appointed Dr Tony Tan, then the Senior Minister of State for Education, to chair the committee.

Following discussions with senior officials in the public sector, as well as representatives from the computer industry, the CNC proposed the establishment of two sub-committees to (i) offer recommendations and provide support for all technical issues concerning the use of computers and handling of data, and (ii) promote the use of computers in the Civil Service as a means to improve productivity and administrative efficiency.

Tan, who was then Director of Systems and Computer Organisation at the Ministry of Defence (MINDEF), was appointed to lead the second sub-committee, named the Civil Service Computerisation Sub-Committee. Tan recalled the sub-committee conducted an eight-month survey of various government departments to determine the extent of their computer use and identify opportunities for further computerisation of administrative processes.

ESTABLISHING THE NATIONAL COMPUTER BOARD

The sub-committee's study and recommendations resulted in the 1981 establishment of the NCB, and the Civil Service Computerisation Programme (CSCP). The NCB was tasked with implementing the CSCP.

The CSCP's main objective was to promote the use of computers across the civil service. In the first five years of the programme, the government allocated S$100 million to the NCB to implement projects such as formulating standards for software use, establishing computer security protocols, developing network-based technology to integrate the flow of information across agencies, and training public servants in the use of information technology (IT)—which was not a widely known concept at the time.

By 1989, the CSCP had installed almost 200 computer systems across government agencies. The computerisation of many government processes improved administrative efficiency and productivity. It also improved the ways in which public-facing agencies such as the Central Provident Fund Board (CPFB), Registry of Vehicles (ROV) and Housing and Development Board (HDB) delivered public services to citizens.

Beyond these benefits, the CSCP raised public awareness and understanding of computer use, and created new opportunities for IT firms to participate in government contracts for the provision of computer-based products and services. The NCB also established a professional accreditation scheme for computer-based training and education. The NCB was at the forefront of the government's efforts to develop the IT sector and nudge Singapore's economy towards a more knowledge-based, capital-intensive course.

A DECADE OF CHANGE

The 1980s were formative years for the IT industry and the spread of computing in Singapore. During this decade, the government focused on efforts to further computerise civil service processes, develop computing and IT capabilities among students and workers, promote the widespread use of computers among the public, and enhance private companies' computing capabilities.

In 1983, the government formed a committee to promote the teaching of computer-aided design and manufacturing in tertiary educational

institutions. Tan said this greatly improved the ways in which budding engineers, architects and IT personnel were trained. When they entered the workforce, the economy benefitted from greater automation and productivity in fields such as construction, planning and technology. As a result of the government's efforts, the number of IT professionals in Singapore grew rapidly during the early 1980s. At the start of the decade, there were only about 800 IT professionals in the country. By 1984, the number had increased to over 3,000.

In 1987, the NCB established a Knowledge Engineering Resource Centre to provide technical training and support to software engineers in the use of IT systems. Tan said there were only three such centres worldwide at the time, including one in Spain and another in Scotland. Singapore's centre was the only such institution that had been established by the state.

In December 1986, the Ministry of Trade and Industry (MTI) introduced a National Information Technology Plan to boost Singapore's economic competitiveness through the use of IT. Under this plan, the NCB would lead public sector efforts in three key areas: develop the software export sector, promote greater public use of IT, and build nation-wide IT infrastructure.

Tan was General Manager of the EDB in 1987 when the government also appointed him to chair the NCB. In announcing the appointment, the government explained that Tan—with one foot in the technology space and another in the area of economic development—would be well-placed to steer the growth of Singapore's IT industry. In many ways, Tan's concurrent leadership of the NCB and EDB—which was a statutory board formed under the MTI—facilitated the successful implementation of the MTI's National IT Plan. Tan attributed this success to the close

Trade Development Board officers using a computer, 1986. The government mounted an ambitious effort to promote the use of computers across government agencies. (Ministry of Information and the Arts Collection, courtesy of National Archives of Singapore)

coordination and collaboration between the government and IT firms, including in areas such as research and development (R&D), skills training and public education.

The government also made efforts to boost the use of IT in the private sector, especially among small enterprises. In 1986, the EDB introduced the Small Enterprise Computerisation Programme (SECP) to help small businesses adopt computer-based systems. Among other forms of assistance, the SECP provided advisory services to companies in the designing of computer systems to meet their business needs, and also extended loans for the installation of these systems.

More and more companies signed up for the SECP, realising that IT gave them an edge over their competitors, not least by enabling them to cut business costs through improvements in productivity and efficiency. For Tan, the SECP helped promote the widespread adoption of IT in the private sector, especially during the late 1980s. By the early 1990s, there was a 70% IT adoption rate in companies that employed more than 10 people.

Singapore's banking and financial services industry also experienced many benefits through the use of computer-based technologies. For one, IT enabled these companies to better tap into a global network of clients, such that transactions could be conducted from anywhere in the world. Management teams could also more effectively oversee and administer global business operations.

By 1989, Singapore's computer services industry recorded revenues of more than S$1 billion for the first time. This represented a 14-fold increase from the S$69 million generated by the sector in 1980.

1990s: AN INTELLIGENT ISLAND

During the 1990s, the government sought to develop Singapore into a global city, and embraced IT as an important conduit through which to achieve this.

In 1991, the government announced plans to transform Singapore into an "intelligent island" through the development of comprehensive IT infrastructure. This announcement marked an important change in the government's approach to harnessing the benefits of IT. Most notably, IT would not only be leveraged to develop the economy, but also to contribute to other important national goals.

The government's objectives included the building of connections between communities at the local and international levels, and improving Singaporeans' quality of life. The NCB set up 11 teams to develop an IT Master Plan that included some 60 initiatives to promote the use of IT at all levels of society over the following 10 years.

Tan did not anticipate the speed and readiness with which Singaporeans embraced IT during the 1990s. Indeed, innovations in this sector profoundly changed the ways in which Singaporeans lived and interacted, moulding the country into a veritable "intelligent island" and setting the stage for the country's subsequent evolution into a "Smart City".

THE 2000s AND BEYOND: FOCUSING ON THE COMMUNITY

In the 2000s, following the rapid adoption of computer technology in earlier decades, the government's IT policies focused on leveraging IT to improve Singaporeans' quality of life.

The government merged the NCB and the Telecommunication Authority of Singapore (TAS) to form a new statutory board, the Infocomm Development Authority (IDA). Among the new agency's key functions was to work closely with other agencies and community groups to promote and enhance the adoption of IT at all levels of society.

In 2004, the government updated the 1991 IT Master Plan with a new thematic emphasis—"Intelligent Nation 2015: iN2015"—that envisioned Singapore's development into a "Smart Nation" over the next decade. In many ways, the iN2015 plan marked an important shift in the government's view on how IT could be applied. Beyond just economic outcomes, the plans focused on social imperatives.

The Minister for Information, Communications and the Arts (MICA) at the time, Dr Lee Boon Yang, said:

> **We must emphasise that the iN2015 Master Plan is not only about economic competitiveness. We will also be exploring ways to ensure that the elderly, less privileged and disabled can also enjoy connected and enriched lives for self-improvement and life-long learning. This is to bridge the digital divide and create opportunities for all.**

Tan, who was then the Permanent Secretary of MICA, also felt strongly about the need to develop IT infrastructure and smart technological systems in a way that would improve people's lives.

As part of the iN2015 plan, the government committed S$4 billion in funds to boost the growth of Singapore's IT and communications sector. This helped create many tangible improvements to Singaporeans' lives. For example, the IDA launched a 2010 initiative to offer high-speed broadband internet at affordable rates to individuals, businesses, schools and other organisations, enhancing Singaporeans' access to and use of the internet.

Singapore's Smart Nation project continues to be defined by a people-centric focus. In April 2014, Prime Minister Lee Hsien Loong described various priorities for the government's Smart Nation initiatives. Among them was to enable older Singaporeans to live meaningful and fulfilling lives, and develop a more efficient transportation system through the use of data analytics and other smart technologies.

Tan described Singapore's IT journey over the years with three 'C's: compute, conduit and content. In the early 1980s, the government focused on promoting the use of computers. Thereafter, the focus shifted to the use of technology as a conduit for communication and sharing information. Finally, recent years have seen an emphasis on the development and dissemination of content to enrich and benefit the lives of citizens.

TECHNOLOGY AND KNOWLEDGE: ENHANCING OUR PUBLIC LIBRARIES

In a three-decade long public service career, Tan has worked in several agencies, accumulating a range of diverse professional experiences. Although many of these experiences were not directly related to the area of computing, it is clear that Tan's expertise in formulating and implementing IT-related policies contributed substantially to his work in these sectors.

Students using computers at a secondary school, 1986. Computers started to become widely used in public schools during the 1980s. (Ministry of Information and the Arts Collection, courtesy of National Archives of Singapore)

A good example of this is Tan's role in improving Singapore's public library system.

In 1992, the then Minister for Information and the Arts George Yeo established a committee to review the provision of public library services in Singapore and recommend areas for improvement. The committee embarked on a 20-month long study that concluded with the publication of a detailed report.

The committee recommended the establishment of the National Library Board (NLB) to oversee the development and management of Singapore's public libraries. It also recommended the building of more than 20 new public libraries over the following two decades, including specialised libraries for business, art and other disciplines. Another important recommendation was to make all book loans free of charge to the public.

Tan's influence on the recommendations is evident in the report's focus on the adoption of IT to improve the operations and visitor experience in public libraries. For example, the committee recommended the development of digital records of libraries' holdings that could be shared with the general public and viewed on computers.

The government approved the committee's report and established the NLB in 1995. In the years that followed, the NLB made several improvements to the public library system. For example, book borrowing and returning procedures were automated, including through the introduction of self-service kiosks. Additionally, the NLB made many of its resources available online, enabling the public to access them without having to physically visit a library.

KNOWLEDGE AND NATIONHOOD

Tan strongly believed that the power of reading to expand one's knowledge and imagination, and enhance one's sense of imagination and creativity creates more opportunities for individuals to improve both self and society. In this way, libraries are signposts of a society's culture and progress.

Tan may have been describing the qualities of libraries and reading, but he could just as well have been describing the merits of computers and IT.

Library@Orchard, a public library located in the Orchard Road shopping district. In 1994, the government's Library 2000 Review Committee recommended several improvements to the public library system, including efforts to make library services more attractive to young Singaporeans. (Fahrul Azmi)

Dock workers at Tanjong Pagar Container Terminal, undated. (Maritime and Port Authority of Singapore Collection, courtesy of National Archives of Singapore)

6 The Port of Singapore

Singapore's post-independence government inherited an established maritime port and transformed it into an important global shipping hub.

Mr Wong Hung Khim entered the public service in 1964, serving in organisations such as the education and labour ministries.

In 1979, Wong was appointed the General Manager of the Port of Singapore Authority (PSA), where he introduced several innovations that expanded the port's facilities, improved the quality of its services and enhanced the productivity of its workers. Wong left the PSA in 1987.

Wong has also assumed leadership roles in the Public Service Commission and other public sector organisations. He was the General Manager of Singapore Bus Services from 1974 to 1979, and the Chief Executive Officer of SingTel from 1987 to 1995.

A COLONIAL TRADING POST

In 1819, the British established a trading post in Singapore. The island, situated at the southern tip of the Malay peninsula, was strategically located along the trade route between China and British India. The southern end of the island, at the mouth of the Singapore River, was surrounded by deep, calm waters, forming a natural harbour. Inland, there were abundant reserves of fresh water and timber that provided natural resources for the construction of port facilities. The new colony had natural advantages that boded well for the development of a flourishing port.

The port proved to be a spectacular success. In 1823, the British colonialists declared Singapore a free port, an early economic measure that spurred its rapid growth. By the mid-19th century, companies had built wharves, docks, warehouses, transit sheds, shipyards, anchorages and other facilities at the harbour. As the century drew to a close, the Tanjong Pagar Dock Company rose to a position of prominence at the port, owning almost three-quarters of all wharf space at the harbour. Following a merger with its biggest competitor in 1899, the company effectively owned the entire stretch of wharves at the harbour, assuming a monopolistic role in the port and shipping business.

In 1905, the colonial government acquired the Tanjong Pagar Dock Company, which had racked up huge debts to undertake ambitious expansion plans, to form the Tanjong Pagar Dock Board. As the global shipping industry continued to grow in the early years of the 20th century, the British government undertook efforts to modernise the port industry and the existing infrastructure at the harbour, such as by reconstituting the dock board as the Singapore Harbour Board (SHB) in 1912. In the subsequent decades, the SHB implemented many plans to develop and expand the port of Singapore, including rebuilding efforts after the Second World War.

In 1957, a report commissioned by the Governor of Singapore found that the SHB had, over the years, taken on too many diverse functions and was no longer able to focus on its primary responsibility of port administration. After Singapore gained full self-governance in 1959, the leaders of the country recognised there was a need to improve the management and administration of Singapore's port, in order to fully realise its potential as a major trading and trans-shipment hub. In 1963, Singapore's Legislative Assembly approved a proposal to establish the PSA to administer the port of Singapore.

In 1979, the newly appointed Chairman of the PSA, Lim Kim San, picked Wong Hung Khim to lead the organisation as General Manager. Wong had reported to Lim, who previously served as the Minister for Transport, when he led Singapore Bus Services as General Manager earlier in his career.

AN ESTABLISHED PORT

When Wong joined the PSA in 1979, the agency was already an established organisation. Although worldwide shipping and port industries were affected by the global recession of the 1970s, shipping tonnage at the port of Singapore continued to increase year-on-year as the scale and quality of its operations improved.

By the end of the decade, the PSA was

operating six different port facilities: Keppel Harbour, Pasir Panjang Wharves, Jurong Port, East Lagoon Container Complex, Telok Ayer Wharves and Sembawang Wharves. These facilities were all well-equipped, modern and efficient.

Wong recalled that in the 1960s, Singapore was already ranked the world's fifth busiest port. In 1975, it surpassed London, moving into fourth position; in 1978, it overtook New York to become the world's third busiest port; and in 1979, the year that Wong joined the PSA, it overtook Yokohama to become the second, just behind the port of Rotterdam.

Singapore's prospects were bright, but Wong knew that it would be difficult to outrank Rotterdam, Europe's largest sea port. The Dutch port served the world's greatest trade zone across the whole of Europe, and was at least a decade ahead of Singapore in terms of the sophistication and quality of its port facilities, technical expertise and service systems.

According to Wong, the government placed great emphasis on the management and expansion of the PSA, and wanted to ensure its position as one of the world's largest and busiest shipping ports. The year Wong joined the PSA, the government had begun ambitious efforts to move Singapore's economy up the value chain, and was encouraging productivity improvements across industry sectors. Wong was tasked with implementing many changes at the PSA.

Immediately after joining the PSA, Wong spent some time learning about the organisation. Thereafter, he formulated a 10-year plan for Singapore to become the world's busiest seaport. Many people were not convinced of Wong's ambition for the port of Singapore, but he was confident that the plan would succeed.

A BUSINESSMAN'S MINDSET

One of Wong's key priorities was to position Singapore's port system as safe, efficient and accessible. He believed the PSA must be operated as a service-oriented business, with the needs of customers coming first. There must be a streamlined documentation process, reasonable handling and administrative fees, and a reliable corps of traffic controllers and dock workers who could provide round-the-clock service. This would give ships passing through the port a quick and seamless transit.

In 1978, the PSA introduced the Appropriated Berth (AB) Scheme at Keppel Harbour. Under the AB scheme, a shipping line is given priority in berthing its vessels at a designated berth and has exclusive use of the warehouses behind it. In return, the shipping line has to guarantee a minimum cargo throughput.

This arrangement was a departure from the pre-existing arrangement under which Singapore's port was a multiple-user facility with no preferential berthing rights extended to individual shipping lines. The AB scheme was very well-received by large shipping lines willing and able to guarantee a minimum berthing period for its vessels in exchange for the first right of use of a specific berth. It gave these companies full control over the amount of time their vessels could remain at port, and where they could be berthed.

The scheme was a good way for the PSA to retain major shipping lines and clients. It also enabled the PSA to make better and earlier projections about the amount of fees and charges it could collect from shipping lines. Under Wong's leadership of the PSA, the AB scheme was expanded and enhanced. In 1981,

Tanjong Pagar Container Terminal in 1978, with a view of the CBD in the background. (Ministry of Information and the Arts Collection, courtesy of National Archives of Singapore)

the scheme was extended to Pasir Panjang Wharves, to the west of Keppel Harbour. In 1986, the PSA made the scheme more competitive by reducing each client's required annual throughput, and introducing discounts on port service charges based on shipping volumes.

Another innovation undertaken by the PSA was to consolidate its port service operations at Tanjong Pagar Terminal in 1980. Previously, units of the PSA were located in different areas across the entire port, leading to administrative inefficiencies and causing inconvenience to port clients seeking to complete clearance and other processes. With the consolidation, the shipping administrative unit, maritime and port security unit, traffic control unit and port operations centre were housed in the same location. This made it more convenient for shipping clients and customers to seek and obtain the PSA's administrative and support services.

Wong also recognised that shipping vessels plying international routes could choose to dock at any of the many ports in the region for replenishing supplies. In order to attract these vessels to the port of Singapore, the PSA had to provide high quality port services, and at competitive rates. One of the initiatives undertaken by the PSA to make Singapore a compelling choice for these companies was to introduce a flexible tariff structure, where companies would enjoy lower tariffs at certain times. The PSA also streamlined the list of supplies which were subject to taxes.

Additionally, the PSA adopted computerisation to provide better and more efficient services to its shipping clients. Many service-oriented operations, including the reservation of loading and unloading facilities, cargo delivery systems and payment of port service fees, were automated and computerised during the 1970s and 1980s.

Shipping containers being unloaded at Tanjong Pagar Container Terminal, 1988. (Ministry of Information and the Arts Collection, courtesy of National Archives of Singapore)

LEVERAGING TECHNOLOGY

As the Singapore government made a big push to promote computerisation and the adoption of information technology (IT) innovations across government agencies in the early 1980s, the PSA also explored ways to capitalise on technology to enhance port operations.

"Information technology was pivotal in the development of the maritime industry," observed Wong. When Wong assumed the role of General Manager, he appointed an officer named Lee Chee Yeng to lead the full computerisation of the PSA in the shortest time possible.

Lee led a team to develop a system called BOXNET in 1984. This computer-based system, which was introduced after nearly two years of research, enabled port operations to be conducted in a much more efficient manner—including by speeding up the berthing of vessels, as well as the loading and unloading of shipping containers.

The system employed an internet-based network that enabled shipping lines and freight forwarding companies to obtain real-time information on their containers. This functioned as a kind of delivery-tracking mechanism, enabling companies to more accurately plan their arrivals at port, and better coordinate subsequent operational needs with hauling, transportation and delivery businesses.

BOXNET also included a feature that automatically generated ship stowage and yard layout plans. This allowed the PSA to easily decide on the optimal allocation of berth spaces for individual vessels. Berth spaces could also be reserved ahead of time. This greatly sped up the loading and unloading of shipping containers.

Immediately following the development of the system, the PSA approached one of its major clients, Maersk Line, to be its inaugural user. Maersk found the system to be very effective in enabling logistics arrangements to be conducted in a much better coordinated and more efficient manner. The PSA thereafter offered the use of the system to a larger number of shipping clients, who readily adopted it.

The BOXNET system was upgraded in 1989, and renamed PORTNET. The system remains in use. Currently, it facilitates more than 20 billion transactions across the PSA's facilities each day.

THE WORLD'S LARGEST BUNKERING PORT

Apart from strengthening the PSA's container facilities and services, Wong also looked to build up the port's bunkering infrastructure. Bunkering is the supply of fuel for use by ships, including the distribution of fuel among available bunker tanks.

The PSA sought to attract more vessels to call at the Port of Singapore for bunkering, including by offering them competitive prices, quality fuel and reliable services. In 1986, 52% of the vessels calling at the Port of Singapore required bunkering services, with half this figure specifically needing refuelling services.

In 1980, the PSA, Temasek Holdings and other investors established a joint venture company to build an oil refinery at Pulau Sebarok, an island off Singapore's southern coast. One of the project's aims was to substantially improve Singapore's bunkering capacity and services. It constructed 18 oil storage tanks and a 16 m deep jetty that would allow oil tankers of up to 80,000 deadweight tonnes to dock. The facility started operating in 1982. By 1988, Singapore had overtaken the port of Rotterdam to become the world's top bunkering port, measured by bunker sales volume.

INFRASTRUCTURE INVESTMENTS

Throughout the 1980s, the PSA also spent extensively on infrastructure to enhance its services and facilities for shipping clients.

In 1985, the PSA built its new headquarters at Alexandra Road at a cost of S$180 million. The new development was an integrated complex comprising an office block for the consolidation of PSA's administrative departments, and a large warehouse. It also contained retail, postal and medical services to meet the needs of port users and the general public.

In the 1980s, the PSA invested heavily in infrastructure to house and process shipping containers. It invested S$800 million to build the Brani Container Terminal, upgrade the Tanjong Pagar Container Terminal, and construct a causeway linking Pulau Brani to mainland Singapore to facilitate the movement of shipping containers and other cargo.

The PSA also spent more than S$1.5 billion to upgrade its container delivery facilities. This included adding more extensive basic infrastructure and purchasing additional equipment such as cranes and forklifts. These investments increased the mechanisation of the PSA's container terminals. As a result, the PSA's container throughput quadrupled in the early 1980s. By 1990, Singapore had become the world's largest container port, with annual transaction volumes at the port reaching 4 million twenty-foot equivalent (shipping container) units, or TEUs.

Apart from this, the PSA invested heavily in building and enhancing warehouses. In 1980, for example, it spent S$120 million to overhaul many existing warehouses, including by installing computers to check inventory and manage the allocation of storage space. With the addition and construction of new buildings and facilities, Singapore became an important regional warehousing and distribution hub.

The Port of Singapore in 1994, a few years after it was announced to be the world's busiest port. (Ministry of Information and the Arts Collection, courtesy of National Archives of Singapore)

WORKFORCE IMPROVEMENTS

Wong shared an interesting anecdote about a faulty light bulb in his office, and how it had convinced him of the need for workforce improvements at the PSA.

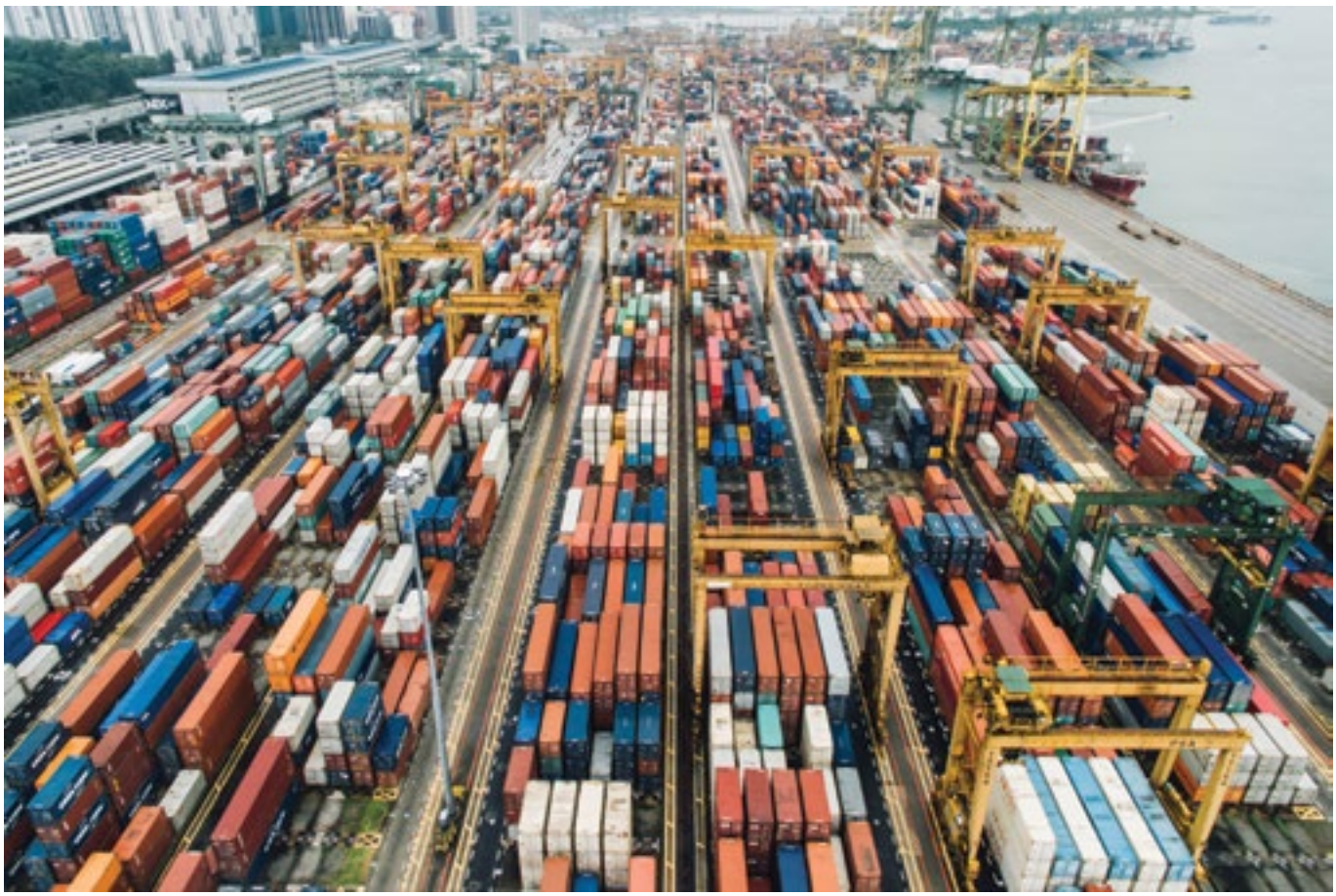
When Wong first joined the PSA, he requested his secretary to send for a worker to replace a blown light bulb in his office. After waiting several hours, three men finally arrived. One of them steadied the ladder which the second man scaled to replace the blown light bulb. The third man was the duo's supervisor.

The episode prompted Wong to reflect on how grossly overstaffed the PSA was, and the need to trim the organisation's workforce numbers and enhance overall productivity. These problems, he felt, had to be addressed in order for the PSA to perform at its best.

One of the first measures that Wong took was to reduce the PSA's workforce numbers. In 1982, the PSA cut its staff from 15,000 to 9,500. This was not done through direct retrenchment, a difficult process that would have caused suffering to those who had been let off. Instead, Wong achieved this in two ways.

First, the PSA retrained hundreds of low-skilled port workers to enable them to become machinery operators. These and subsequent batches of workers underwent continuous skills upgrading programmes to enable them to keep up with improvements in automation, mechanisation and computerisation of port facilities throughout the 1980s.

Second, the PSA rolled out an early retirement scheme to encourage workers who were still unable to adequately meet their work targets to retire from the organisation. Those



A view of Tanjong Pagar Container Terminal today. (Chuttersnap)

who accepted the PSA's offer enjoyed various payments and subsidies.

These efforts helped reduce the PSA's workforce needs and improve the overall quality of its remaining staff. Wong also focused on the need to improve the welfare of port workers, many of whom were engaged in manually arduous roles.

Soon after joining the PSA, Wong learnt that crane operators had to leave their roles at a relatively young age because of the need to climb up and down the very high cranes. Wong saw this as a waste of resources because it took several years of training and experience to produce a good crane operator. To solve this problem, the PSA introduced elevator cabins to convey operators up and down cranes, making their work much less physically difficult. These cabins were subsequently upgraded with air-conditioning, a luxury unheard of in shipping ports at the time.

According to Wong, the PSA managed to train many excellent traffic controllers. As vessels arrived at the harbour, controllers were already on site to direct traffic. Their efforts greatly shortened the waiting time for vessels entering their allocated berths.

Also, in 1983, workers at the Tanjong Pagar Container Terminal set a world record for their speed in loading and unloading shipping

containers. The terminal continues to be widely recognised in the global shipping industry for its operational efficiency.

As Singapore's economy grew rapidly in the 1980s, the PSA also gave attractive salary increases to its workers. In 1980, it gave almost 10,000 workers an annual pay increment totalling S$3.5 million, representing an average pay increase of almost 8%. In 1982, the agency signed a collective agreement with its lower ranking employees, including many who were paid by the day. Under this agreement, some 9,000 port workers enjoyed a 10% to 12% increase in their wages.

THE WORLD'S BUSIEST PORT

During the 1970s and 1980s, the number of shipping containers handled at the port of Singapore increased substantially. In fact, between 1979 and 1984, the PSA's throughput grew by 35% despite a recession in many developed economies and a 12% decline in shipping transactions worldwide. In 1984, the amount of shipping containers handled by the port of Singapore reached 112 million tonnes, up from 50 million tonnes in 1971.

Wong revealed that the Port of Singapore had overtaken Rotterdam as the world's busiest port in 1982. But this fact was not made public then, because the PSA wanted to shelter the port from increased competition and attention from rivals. It was only announced in the 1990s, some years after Wong had left the PSA. By then, the port of Singapore had already established itself as one of the world's most important container terminals.

Reflecting on his tenure at the PSA, Wong said that organisations should not be afraid to set bold and ambitious targets for themselves. Wong had aimed for Singapore to overtake Rotterdam as the world's busiest port. This target was met with scepticism from many in the organisation and within the government, but he managed to lead the PSA to this target in just three years.

Wong shared another important observation from his time in the PSA. Government agencies have always played the role of monitoring and regulating the private sector, but too much regulatory supervision hinders the growth of enterprise. They should therefore also carefully consider the needs and interests of businesses.

At the PSA, Wong understood that investing in world-class port infrastructure would be futile if there were no customers to use it. In order to build up the PSA's client roster, Wong and PSA Chairman Lim travelled extensively to the United States, Europe, Taiwan and elsewhere to meet the world's major shipping lines and successfully convinced many of them to dock their vessels at Singapore.

GRIT, ACUMEN AND RESOURCEFULNESS

Although Singapore's status as the world's busiest port has since been overtaken by the port of Shanghai, it still remains an internationally important and admired shipping and transit hub. Much of its success can be attributed to the efforts of Wong and his team at the PSA.

Wong's management of the PSA was resourceful, outcome-driven and informed by business acumen—all of which are, in many ways, qualities shared by many of Singapore's pioneering leaders in developing the country.

Traffic on North Bridge Road, in the heart of Singapore's city centre, 1968. (George W. Porter Collection, courtesy of National Archives of Singapore)

7 The Land Transport Network

Adopting an integrated and comprehensive approach to land transport planning, Singapore resolved the problems of traffic congestion and pollution that plagued many motorists and commuters.

Mr Joseph Yee has four decades of experience in the transport, planning and engineering sectors.

Yee was the Director of Roads and Transportation at the Public Works Department (PWD) from 1992 to 1995. He moved to the newly formed Land Transport Authority (LTA) in 1995, where he first served as the Director for Engineering and Traffic Management (1995–1999) and then as the Director for Planning and Transportation (1999–2003). During his public service career, Yee participated in the planning of Singapore's Area Licensing Scheme (ALS) and the Electronic Road Pricing (ERP) system.

After leaving the LTA, Yee joined CPG Corporation as a Principal Consultant, where he has worked on transportation and engineering projects in China, India, Vietnam, Malaysia, Brunei, Singapore and the United Arab Emirates.

When Singapore gained self-governance from the British in 1959, the country's city centre was in a chaotic state. The 7 km^2 district was over-populated, polluted and congested, and many of its residents suffered from poverty and unemployment. The Singapore River flowed through the city centre and transported many light vessels and boats that carried goods to and fro the shipping port at the southern end of the country. However, it was filled with effluent discharged from warehouses, shops and residences that lined its banks.

Singapore's leaders made it a priority to develop the economy and raise living standards as quickly as possible. It established the Housing and Development Board (HDB) in 1960 to quickly construct new residential buildings in and around the city centre. Many squatters and other residents in the city centre were resettled in the newly built apartment units. The HDB's Urban Renewal Department planned and implemented much-needed urban infrastructure such as sanitation, street lighting and green spaces, to improve the quality of the physical environment.

However, the government understood that development efforts could not simply focus on rehabilitation and expansion of the city centre. For one, many of the privately-owned land parcels in and around the city centre had already been developed, with limited remaining land for new buildings. Moreover, the roads and transport arteries in the city centre, already heavily congested, would not be able to cope with the expected increase in commuting workers, motor vehicles and buses. The bus-only public transportation system comprised a handful of privately owned bus companies. Bus services were erratic and unreliable, operation and service standards were poor, and the vehicles were poorly maintained and prone to frequent breakdowns.

To fully unlock Singapore's potential for economic growth and provide a better quality of life for its people, more extensive development plans would be required.

After Singapore gained full political independence in 1965, the government sought the technical and financial assistance of the United Nations Development Programme (UNDP) to establish a land-use plan to guide the physical development of Singapore over the next two decades. It initiated the State and City Planning Project in 1967, assembling a group of foreign experts and local officials to prepare a plan for Singapore's physical development.

Unsurprisingly, a central focus of the group's efforts was to study the transportation- and traffic-related problems in Singapore, and propose a comprehensive plan to improve connectivity across the island. The group ascertained that for Singapore to achieve sustainable economic and social development, it must establish a comprehensive transport network.

The resulting land-use plan, the Concept Plan of 1971, proposed the building of high-density satellite towns around the Central Catchment Reserve (which would be safeguarded as a water catchment area), with the country's main commercial and industrial facilities planned along a development corridor in the southern part of the country stretching from Jurong in the west to Changi in the east. A comprehensive transport network comprising an urban rail system and various expressways would connect the different parts of the island to the city centre. This plan reflected an understanding of the need to integrate transport planning with land-use.

MANAGING TRAFFIC FLOWS

A longstanding feature of the government's transport policies has been the management of motor vehicle traffic, in particular to relieve traffic congestion in densely populated areas such as the city centre. Starting from the mid-1960s, the government built a network of expressways to connect the city centre with regional centres in other parts of the island. The expressways were further connected to a series of increasingly smaller roads to enable drivers to access their neighbourhoods and other localities.

The government established a formal hierarchy of roads based on size and capacity, with all roads grouped into one of five categories. These included expressways and semi-expressways (category 1), major arterial roads (category 2), arterial and primary access roads (categories 3 & 4), and local access roads (category 5). The creation of these categories, each with its own planning, design, landscaping and other requirements, provided for efficient road planning and management.

The longest and oldest expressway in Singapore is the Pan-Island Expressway (PIE). According to Joseph Yee, the PIE was a major and complex feat of engineering. Construction on the expressway commenced in 1964, and ended 16 years later. Today, the PIE stretches nearly the entire length of Singapore, from Tuas in the west to Changi in the east. The Central Expressway (CTE), which started operating in 1989, stretches from the city centre in the south to new towns such as Ang Mo Kio and Bishan in the north. The PIE and CTE, together with nine other expressways, are Singapore's main major land transport arteries.

Many of Singapore's expressways include sections that run underground. In many cases, this was because of the unavailability of surface space. For example, the Kallang-Paya Lebar Expressway (KPE), which was opened in September 2008, includes a 9 km long tunnel that is the longest subterranean road in Southeast Asia.

PLANNING SINGAPORE'S ROADS

The development of expressways and other roads required careful planning and consideration. This was especially true in the case of expressways running through the city centre.

For example, the CTE passes through the key commercial districts of Chinatown, Singapore River and Orchard Road. At the time of the CTE's construction, these districts were already densely developed. The PWD had realised that construction of a major expressway would exert a negative visual impact on these districts and create additional noise pollution in the city. There was also the consideration that the expressway would artificially divide the city into two separate districts, disrupting ground-level urban connectivity. The PWD therefore designed and built the CTE as a series of underground tunnels that cost approximately four times more than if it had been built as a surface expressway.

The government also considered how road construction affected communities and individuals. For example, given Singapore's limited land resources, there has been a need to acquire privately-owned land in order to construct new roads or widen existing ones. This process requires substantial engagement and

A newly opened section of the CTE, 1985. The CTE is one of Singapore's 11 expressways. (Ministry of Information and the Arts Collection, courtesy of National Archives of Singapore)

mediation. The government also compensates affected land owners at market rate and offers other forms of assistance to parties who may be affected by the acquisition.

Yee explained that all major road construction projects in Singapore are planned and implemented considering two key objectives. These are to improve the quality of life for residents by enhancing connectivity and convenience; and promote the country's economic growth by facilitating the smooth movement of goods, services and workers. For example, the PIE was planned to run through Singapore's main development corridor stretching from Changi Airport to Jurong Industrial Estate. Additional expressways such as the CTE and the Bukit Timah Expressway (BKE) were built to connect the city centre to key regional centres.

By the 1990s, Singapore had one of the highest road densities in the world, with more than 4,000 m of road for every 1 km^2 of land. In comparison, Japan had only 2,930 m and Hong Kong 1,090 m of road per 1 km^2 of land. Given the country's small land area, the government could not simply continue building more viaducts, roads and expressways or widen existing ones. It would not be tenable to keep allocating more land for roads, because there were other development needs such as housing and industry. A more qualitative approach had to be taken to disperse traffic and alleviate congestion, such as through the introduction of systems and infrastructure to control and manage traffic.

DEVELOPING A ROBUST PUBLIC TRANSPORTATION SYSTEM

In the 1970s, the government observed that as Singapore's population continued to grow, the demand for motor vehicles and other forms of land transport would increase. The government saw the need to develop a

comprehensive public transportation system to meet the needs of commuters.

The basic contours of the Mass Rapid Transit (MRT) system had been established in the 1971 Concept Plan. In the years immediately following the publication of this plan, infrastructure sector officials, with the help of private sector consultants and experts, carefully planned MRT lines and stations, safeguarding tracts of land for their development.

The MRT took 16 years of careful deliberation and planning, continuing even without certainty on whether the project would proceed. A key objection to the MRT expressed by many in the Cabinet, Parliament and the general public centred on cost. In the late 1970s—a period of global economic turmoil—the cost of building the MRT was estimated at S$5 billion, a substantial sum. Many government leaders felt that Singaporeans would be adequately served by the public bus system, which would have been much less expensive to expand and improve.

But proponents of the MRT, including the then Minister for Communications Ong Teng Cheong, disagreed. They observed that a bus-only public transport system would worsen traffic congestion in the city centre, creating traffic delays and other inconveniences to commuters. Massive traffic jams could also slow down the movement of goods, services and workers. These problems would affect the quality of life for many Singaporeans, and have a negative impact on economic development.

The government ultimately decided to build the MRT, announcing its commitment to do so in 1982. It saw the MRT as a strategic investment with enduring benefits. Beyond providing a convenient form of transport to the people, it would also boost Singapore's economic competitiveness by promoting greater connectivity between the city centre and other parts of the country. Additionally, the MRT would provide better accessibility to areas beyond the Central Area, facilitating the development and more optimal use of Singapore's land resources.

The government committed to paying the construction cost of S$5 billion, which was equivalent to one-sixth of Singapore's gross domestic product (GDP) in 1982. Ticketing sales and other sources of revenue would be used to foot the MRT's operating costs. MRT fares were kept affordable to the general public, mainly because the government did not intend to recover the capital cost through commuter charges. Instead, the government believed the construction of the MRT would significantly increase the value of state-owned land parcels located close to the network. As the government sold these land parcels to private developers, the higher revenues obtained from land premiums would allow the country to indirectly reap the returns on its investment in the project.

By the early 1980s, Singapore had a well-operating public bus system. This was the result of successful efforts by the government to overhaul the sector since the early 1970s. Prior to this, bus services were provided by almost a dozen private bus companies. The sector was plagued by economic inefficiencies, and services were delivered at varying levels of reliability, quality and comfort.

In 1973, the government consolidated the privately-owned bus companies into the Singapore Bus Services (SBS) company and assembled a team of government officials to improve the operations of the bus network. In the

An MRT train, public bus and other vehicles at Clementi, 1988. The development of a public transportation network integrating the MRT and bus system helped to reduce Singaporeans' reliance on private motor vehicles. (Ministry of Information and the Arts Collection, courtesy of National Archives of Singapore)

years that followed, SBS implemented several improvements, including training programmes for bus service workers, standardisation of bus models and streamlining of service routes. The government also paid for the development of bus interchanges and terminals.

By the time the MRT started operations in 1987, the basic infrastructure was in place to support the government's plans for an integrated public transportation system. In many regional centres and new towns, for instance, MRT stations were located next to bus interchanges, enabling commuters to switch easily and conveniently from one mode of transport to another. Another innovation, the introduction of a common fare system between the MRT and buses, also enhanced commuter convenience, as a single ticket could be used across both systems.

The establishment of a comprehensive and convenient public transportation network significantly reduced Singaporeans' reliance on private motor vehicles. It alleviated traffic congestion in many parts of the country, especially the city centre, and relieved pressure on the government to build more roads and expressways.

REDUCING PRIVATE VEHICLE USE

The government also took many steps to minimise traffic congestion on Singapore's roads. Apart from developing a comprehensive road network and public transportation system, there have been direct measures to reduce the public's use of private motor vehicles.

In the early 1970s, traffic congestion had become a serious problem in the Central Business District (CBD), especially during the morning rush hour. This was largely due to the growth in Singaporeans' household incomes and the increased demand for cars. In fact, car-ownership grew at a rate of almost 9% each year between 1962 and 1973. Without quick and direct intervention, traffic conditions in the city would have worsened considerably.

AREA LICENSING SCHEME

The government introduced the ALS in June 1975 to relieve peak-hour traffic congestion in the CBD by up to 30%.

Under the ALS, motorists were required to purchase a special licence to enter a "restricted zone" within the CBD during the morning peak hours of 7:30–9.30 a.m. from Mondays to Saturdays. The paper licence was to be clearly displayed on the vehicle's windscreen. Gantries were erected at some 27 entry points to the 6.7 km^2 restricted zone, with traffic officers standing guard to ensure that each entering vehicle had a licence. Buses, taxis, motorcycles, ambulances and fire engines were exempted from the licence. To encourage car-pooling, cars ferrying at least four passengers were also exempted.

The ALS was successful in reducing the number of cars entering the CBD. In the first six months of the scheme's operation, the number of cars entering the restricted zone decreased by more than 73%. The ALS also led to improvements in air and noise pollution within the CBD, and reduced the cost of maintaining and improving public roads.

According to Yee, the idea for the ALS was drawn from the work of British statistician and transport researcher Reuben Jacob Smeed. In 1964, Smeed published a paper arguing that

roads were a valuable commodity and that individuals should pay in order to use them.

It took some years of planning and design before Singapore implemented the ALS. During that time, the government carefully deliberated on the optimal price of the licence. Ultimately, transport planners decided to peg the price of the licence to the average monthly parking fee in the CBD, which was about S$60. Assuming that there were four weeks in a month and five work days per week, the daily parking fee would be S$3. This was established as the ALS's daily fee.

The government implemented several measures to prepare motorists for the introduction of the ALS. For example, anticipating that many motorists commuting to work each morning would choose to park their vehicles just beyond the restricted zone, the government built more parking spaces and expanded the road network at the fringe of the CBD. It also provided exit paths for motorists who wanted to avoid entering the restricted zone. Apart from these infrastructural measures, the government promoted car-sharing schemes and rolled out a public education programme to explain the need for the ALS.

The ALS was not always well-received by motorists. In response to an appeal from the government for feedback on the scheme, many members of the public offered critical comments. The owner of a hotel in the CBD protested against the inclusion of his property within the restricted zone and responded in dramatic fashion by riding a trishaw to work on the first day of the ALS' operations. One respondent, a doctor, argued that he should not have to purchase a licence to drive to his workplace, since he was performing the noble work of saving lives.

Despite the objections of some motorists, the ALS brought about a significant improvement to traffic conditions in the CBD. It also represented an innovative approach to traffic flow management by directly controlling the use of roads by private vehicles, rather than seeking to reduce the population of these vehicles. The ALS was the world's first area-based licensing scheme to tackle traffic congestion. Subsequently, major European cities like Oslo, London and Milan implemented similar schemes.

The government has made many enhancements to the ALS over the years, such as extending the licensing hours to include the evening rush hour, and then the entire work day. The restricted zone was also enlarged by about 0.5 km^2 between 1975 and 1978. To complement the ALS, the government imposed higher parking fees in the city centre to discourage motorists from entering the area.

In 1998, the ALS was replaced by the ERP system, which is still operational today. The ALS was a manually operated system that required motorists to purchase paper licences and traffic officers to monitor compliance. The ERP, a fully automated system, corrected these inefficiencies. Today, vehicles in Singapore are fitted with a device containing a card with stored monetary value; when passing under an ERP gantry, the licence fee is electronically deducted by the vehicle's device. Motorists can also pay the licence fee through an automatic deduction on a registered debit or credit card, each time they pass under an ERP gantry.

CERTIFICATE OF ENTITLEMENT SYSTEM

The government also sought to manage traffic by controlling the demand for cars, most

People in front of a kiosk selling "daily area licences" to motorists entering the CBD, 1975. The Area Licensing Scheme was introduced that year to relieve peak-hour traffic congestion in the CBD. (Ministry of Information and the Arts Collection, courtesy of National Archives of Singapore)

notably through the Certificate of Entitlement (COE) system, introduced in May 1990.

Under the system, anyone who intends to own and use a motor vehicle must first bid for and obtain a COE under one of various vehicle categories. Each certificate allows the holder to own a vehicle for an initial period of 10 years. The number of COEs released in each bidding exercise is determined by a quota for each category of vehicles that is revised by the government at regular intervals. Each round of revision takes into account figures such as the number of recently de-registered vehicles, as well as expired or cancelled COEs. As a quota-based system, the COE has been effective in managing the number of vehicles on Singapore's roads.

For the first decade the COE was in effect, the bidding system was a closed one. After a parliamentary review of the COE in 1999, the government piloted an open bidding system in June 2001. This system, which was formally adopted in April 2002 and remains in place today, allows prospective bidders to monitor COE prices across the various vehicle categories and price their bids accordingly, preventing large fluctuations in COE prices.

Although the COE system was only introduced in 1990, there had been various forms of car ownership controls since the 1950s. Despite these controls, which mostly took the form of taxes and fees, the vehicle population in Singapore continued to grow at a rapid rate. In the 1960s and 1970s, the number of vehicles increased by almost 9% each year, contributing to greater traffic congestion, especially in the CBD.

In January 1990, a parliamentary committee on transportation submitted a report proposing the establishment of the COE system to regulate motor vehicle numbers. The proposal was approved after a period of debate in Parliament. To prepare the country for the introduction of the system, the government launched an

A view of the Pan-Island Expressway, with an Expressway Monitoring Advisory System (EMAS) signboard showing estimated travel times to various destinations. (Marcel Gnauk)

exercise to seek public feedback on the COE in March 1990. The exercise was an opportunity for members of the public to share their views on the system, and raise questions about implementation details.

The COE was officially launched in May 1990, and has had a significant and enduring impact on the growth of vehicles. Between 2018 and 2019, for example, the number of private cars in Singapore increased by only 1.1%.

EXPRESSWAY MONITORING ADVISORY SYSTEM

To promote smooth traffic on Singapore's roads and expressways, the government also leveraged technology to enhance traffic monitoring and accident-response efforts.

With the completion of Singapore's eighth expressway in 1990, the government embarked on plans to implement an electronic system to monitor traffic flows on all of Singapore's expressways. The Expressway Monitoring Advisory System (EMAS) was first planned for in the mid-1990s, and construction of the system began in late 1996. The system was officially launched at the CTE in March 1998.

The system employs a network of electronic cameras and light-emitting diode (LED) signboards installed at various locations along each expressway. The cameras record and transmit data on traffic conditions to a monitoring centre. When an accident occurs, officers at the monitoring centre instantly relay

information on the accident to first-responders such as the Singapore Civil Defence Force (SCDF) and the traffic police. Messages on the LED signboards inform motorists approaching the accident site to reduce their driving speeds, or make alternative travel plans. The system also conveys this information to media organisations such as television and radio stations, to more widely broadcast news about traffic disruption and advise drivers to avoid the affected expressway stretch.

Yee said the system has been very effective at giving motorists a smooth travel experience on expressways. It has done this by giving motorists detailed information on traffic flows and disruptions, and by cutting down the time needed to respond to accidents, thus minimising the period of traffic disruption.

EFFECTIVE ORGANISATIONS

According to Yee, one of the key factors in driving the successful planning and implementation of Singapore's transportation policies has been the establishment of dedicated agencies and organisations.

Examples of these include the Singapore Mass Rapid Transit (SMRT) and SBS Transit companies. The SMRT was formed to operate the MRT, while SBS Transit was the former SBS. Today, both companies are multi-modal transport organisations that operate different sections of the MRT and public bus networks.

Currently, the LTA, a statutory board under the Ministry of Transport (MOT), is the public agency that oversees all land transport in Singapore, including the planning, design and implementation of land transport infrastructure and systems such as the EMAS, COE and ERP. The LTA was formed in 1995 with the merging of the Road and Transportation Division of the PWD, the Registry of Vehicles, the Mass Rapid Transit Corporation and the Land Transportation Division of the Ministry of Communications.

Yee recalled that the move to merge these different organisations under a single authority was viewed with some scepticism within the public sector. Many were concerned the organisation would prove to be inefficient and ineffective, given its many different operational purviews and focus areas. In fact, Fock Siew Wah, the LTA's first chairman, had to be invited several times to assume this position before he agreed to do so.

The move eventually paid off. Putting diverse land transport-related functions under a centralised body allowed transport planners and officers to leverage the connections and synergies between their various work areas. It also allowed operations to be carried out in a more coordinated, efficient and effective way.

Coupled with good corporate governance, this approach has enabled Singapore to plan and implement its transport strategies successfully.

Rows of Mass Rapid Transit (MRT) railway tracks in Singapore. (Esaias Tan)

8 The Mass Rapid Transit System

The Mass Rapid Transit (MRT) system took almost two decades of planning and faced many detractors when initial plans for it were first proposed. But the foresight and determination of its proponents convinced decision-makers and the general public of the country's need for a comprehensive, reliable and accessible urban rail system.

Mr Bruno Wildermuth is a Swiss-born transport expert and consultant. He arrived in Singapore in 1972 to conduct planning and feasibility studies for the MRT, and was involved in the development of the system for several years thereafter.

In 1982, Wildermuth served as the lead planner of the MRT, taking charge of efforts such as the design of control systems and other basic infrastructure. He was also involved in planning the MRT fare structure, and the integration of public transport fares with the bus system.

Apart from his work on the MRT, Wildermuth has also participated in the planning of public transport networks in cities like Kuala Lumpur, Hanoi, Dubai, Hong Kong, Melbourne, Sydney, Bangkok, Buenos Aires and Almaty.

Mr Pok Sheung Foo joined the public service in 1962 as an engineer in the Housing and Development Board (HDB). Pok also served other roles in the public service, including at the Ministry of Communications from 1974 to 1976 and the Public Works Department (PWD) from 1976 to 1983.

In his four-decade long public service career, Pok spent almost 20 years on the planning and implementation of the MRT. During this time, he worked on a variety of key areas, including land-use, financing and research. As a member of the government's Mass Transit Study Unit, Pok also oversaw the 1982 publication of a Comprehensive Traffic Study Report recommending the development of the MRT.

Pok has also participated in the planning of public rail systems in Kuala Lumpur and Bangkok.

Passengers on an MRT train, 1987. The MRT system was officially opened in November 1987. (Ministry of Information and the Arts Collection, courtesy of National Archives of Singapore)

In a poll conducted by the Chinese language newspaper Lianhe Zaobao to mark the 50th year of Singapore's independence in 2015, the public voted the launch of the MRT as one of the top 10 most significant events in Singapore's history.

The idea to develop an urban rail system was first explored by the government in 1967, just two years after Singapore achieved its independence. But it was only in 1982 that the government formally announced its plan to proceed with building the MRT. Five years later, the MRT officially opened.

The development of the MRT took 16 years of research, deliberation and planning, and cost the government S$5 billion in initial capital. With more than 120 stations along a 200 km route and daily ridership of over three million, the MRT is an important part of the daily lives of many Singaporeans today.

PLANNING FOR AN URBAN RAIL SYSTEM

In the years after independence, Singapore's leaders sought to establish a comprehensive urban master plan to guide the long-term development of the country. The government turned to the United Nations Development Programme (UNDP) for technical and financial assistance in this effort, launching the State and City Planning Project. This project was implemented by public service officers and foreign experts, leading to the creation of a long-term developmental blueprint for the country.

One of the project team's key areas of focus was transportation. Observing the massive traffic congestion in and around the city centre, the team devised a plan to decentralise many economic, commercial, residential and employment functions to other parts of the island. The city centre would be redeveloped,

with the construction of skyscrapers and other high-density developments, to support industries such as trading and finance.

The team observed that for this plan to work, Singapore would require a comprehensive transport system to connect the new regional centres to its city centre.

The plan that was finally conceived—the 1971 Concept Plan—featured several key innovations. Among them was the construction of a rail transit system comprising a railway line spanning north to south, and another line extending from east to west. In this way, the Concept Plan established the contours of the MRT's North-South and East-West lines. The intention was for the MRT to complement the public bus system. Together, the public transportation system was planned in anticipation of the social and economic needs of the country up to the early 1990s.

In 1972, the government set up the Singapore Mass Transit Study Committee to conduct a comprehensive assessment of the feasibility of developing the MRT. The committee aimed to establish the financial requirements for building the MRT, and to formulate a long-term plan for its implementation. During this period, the government also issued a Land Use and Transport Planning Review (1975–1978) which reported that a bus-only public transport system would meet the commuting needs of a maximum of 260,000 workers in the Central Business District (CBD). Beyond this, a mass rail system would be necessary to avoid exerting excessive pressure on the road network.

Pok Sheung Foo was an engineer at the HDB between 1962 and 1972. In 1966, Pok won a government scholarship to pursue a graduate degree in urban transportation planning at Northwestern University in the United States. Upon his graduation a year later, Pok returned to Singapore and was assigned to the State and City Planning Project, where he helped conduct transportation studies and surveys. He was subsequently appointed Project Manager of the Mass Transit Study Committee.

Pok recalled that the team's studies and reports resulted in clear recommendations on future MRT stations. Even during the early stages of the committee's work, the government had started to safeguard land parcels for the future development of the MRT. In the early 1970s, the Standard Chartered Bank submitted a proposal to the government to build an office complex at Raffles Place. As the proposed site was located above a future underground MRT station, the government rejected the proposal immediately.

AN EXPENSIVE UNDERTAKING

In 1980, the government conducted a study which estimated that it would cost about S$5 billion to construct the MRT, and a further S$76 million to operate it annually.

During this period, many major economies worldwide were experiencing a deep economic crisis, and Singapore's economic prospects looked uncertain. Then Deputy Prime Minister Dr Goh Keng Swee publicly questioned if it was prudent for the government to spend S$5 billion on building the MRT. Several ministers and Members of Parliament (MPs) also raised objections to the MRT, which they felt would cost too much money.

Goh appointed a group of transportation experts from Harvard University in the United States to study if Singapore should commit

to building the MRT. The Harvard team, led by Professor Kenneth Hansen, concluded that an MRT system was unnecessary, and that a comprehensive bus network could adequately meet the public transportation needs of Singapore. The government also sought the views of experts from the World Bank, who supported the Harvard team's assessment.

Bruno Wildermuth, a Swiss-born transport expert who had been engaged by the Singapore government to study the feasibility of the MRT, recalled that the cabinet sought a detailed explanation of the impact and significance of the MRT, and all other options for creating a quality public transportation system.

In particular, the government was keen to facilitate a robust debate to provide an opportunity for those supporting the MRT to present their opinions. Among those in this camp were experts from the American transport consultancy Wilbur Smith and Associates (where Wildermuth worked), which the government had engaged in 1972 to conduct preliminary planning for the MRT. In October 1980, the government organised a televised debate pitting the Harvard team against the experts from Wilbur Smith.

The team from Wilbur Smith delivered a point-by-point rebuttal of the Harvard report, arguing in particular against an all-bus public transportation system, and questioning if such a system would indeed ease traffic congestion in the CBD during peak hours. The team's arguments were compelling and persuasive, but it would still take two years for the government to publicly announce its intentions to build the MRT.

In March 1981, then Minister for Communications Ong Teng Cheong argued against the Harvard team's report during a series of parliamentary debates on the MRT. Ong questioned the assumptions and figures used by the team, and said that his ministry would conduct further studies to verify and confirm the report's conclusion. In particular, the Ministry of Communications would determine if Singapore will eventually require an MRT system to meet the needs of its people in the long run.

A year later, the government published the Comprehensive Traffic Study, Phase A, indicating that the total volume of traffic in the CBD in 1990 would be 37% higher than what it currently was. During the Parliamentary budget debates in March 1982, Ong made a strong case for building the MRT, saying that the question was not whether an MRT system was necessary, but when such a system would be needed:

> **The MRT is much more than a transport investment, and must be viewed in its wider economic perspective. The boost it'll provide to long-term investors' confidence, the multiplier effect and how the MRT will lead to the enhancement of the intrinsic value of Singapore's real estate are spin-offs that cannot be ignored.**

The MRT debate finally came to an end.

On 28 May 1982, Ong delivered a speech at the annual dinner of the Singapore Institute of Architects, officially announcing that the government had decided to proceed with plans to build the MRT.

Work on the MRT began on 22 October 1983, 16 years after the State and City Planning Project first envisioned an island-wide urban rail network to ease congestion in the city

Toa Payoh MRT station on the official opening day of the MRT system, 7 November 1987. (Ministry of Information and the Arts Collection, courtesy of National Archives of Singapore)

centre. On 7 November 1987, that vision became reality, with the opening of the first 6 km stretch of the North-South MRT Line from Yio Chu Kang to Toa Payoh.

SINGAPORE SENDS FOR WILDERMUTH

In 1972, Wildermuth was working at Wilbur Smith when he was sent to Singapore to conduct a feasibility study on building the MRT. What was supposed to be a nine-month study turned into a four-year sojourn. Even after the study concluded, Wildermuth made several trips to Singapore for follow-up studies and discussions. (Eventually, he moved to Singapore permanently.)

In the 1980 televised debate on the MRT, it was Wildermuth who represented Wilbur Smith in arguing the case for the system. He recalled that it was not particularly challenging for him to participate in the debate, since he had already spent many years studying the issue. During that time, he had personally walked many streets and visited several areas in Singapore to develop a first-hand understanding of the country's transportation needs. He even took the local buses and surveyed pedestrian flows, once standing at Orchard Road for several hours to determine the ideal location for an MRT station.

Wildermuth was not in Singapore on the eve of the October 1980 debate. When Ong called Wildermuth's superiors at Wilbur Smith inviting them to participate in the debate, he was immediately sent back to Singapore. In his hotel room near Changi Airport, Wildermuth read the local newspapers and was struck by the vocal opposition expressed by many members of the public to building the MRT. This made him reluctant to participate in the debate, a sentiment he expressed to then Permanent Secretary of the Ministry of Communications Sim Kee Boon.

Sim told him that if he did not join the debate, there would be an empty chair laid out onstage with his name on it. Sim's response persuaded Wildermuth to take on the challenge.

A ROBUST DEBATE

The televised debate was chaired by Dr Liu Thai Ker, who was then the Chief Executive Officer of the HDB. The debate was between the teams from Wilbur Smith and Harvard, but other participants were invited to pose questions to the experts and share their views. These included representatives from the Automobile Association of Singapore, Singapore Bus Services Company, National University of Singapore and PWD. In addition, the Group General Manager of the Oversea-Chinese Banking Corporation and Deputy News Editor of The Straits Times were also invited.

During the debate, Wildermuth said that in the first four years of planning the MRT from 1972 to 1976, he had focused on comparing the various options for a public transportation system. Eventually, he reached the conclusion that a system comprising both the MRT and public bus network would benefit Singapore more than a bus-only system.

Wildermuth argued that Singapore would suffer from heavy traffic congestion if it chose to rely on a bus-only public transportation system. For one, it would be necessary to widen bus lanes and pedestrian walkways where the bus stops would be located. This would lead to a reduction in road widths and, consequently, the traffic-carrying capacity of each road. Traffic speeds would also fall.

He questioned the Harvard team's assessment that only 2,700 buses would be required to cope with transport demands by 1992, noting that Singapore already had 2,400 buses in operation in 1980. If a marginal increase of only 300 buses could provide the same amount of commuter convenience as a comprehensive MRT system, there would be no point in even discussing the issue.

Moreover, if the government was to proceed with the MRT, the system would significantly reduce Singaporeans' reliance on cars. By 1992, 52% of Singapore's population would reside within 1 km of an MRT station. As much as 53% of workers' places of employment would be located within 1 km of an MRT station. Wildermuth added that the MRT trains would travel at a speed of about 54 km/h. This was not especially quick, but much speedier than buses. Train services would also be more stable and reliable.

Several of the invited representatives at the debate expressed views that supported Wildermuth and the rest of the team from Wilbur Smith.

Joseph Yee, a senior traffic engineer at the PWD, said that it would be difficult for buses to travel at speeds of 50 km/h on expressways without affecting the speeds of other road users. A large number of buses on highways would also reduce the amount of space on the road for cars, forcing them to be diverted to other roads and potentially causing worse congestion there. Cheng Feng Mao, President of the Automobile Association of Singapore, said that Singapore workers did not wish to take one-hour bus rides home after being at work for eight hours.

These and other similar arguments convinced many watching the debate on the need for the MRT.

COMPELLING ARGUMENTS FORMULATED THROUGH CAREFUL STUDY

Wildermuth recalled many of the arguments

he helped formulate in defence of the MRT. These arguments indicated that in the course of his work, he had considered the issue in a holistic way, tackling matters such as land-use, pollution, population growth and economic development.

One of his most compelling arguments was related to cost. Wildermuth projected that the operating cost of the MRT would grow at a relatively steady rate of about 8.5% each year. In comparison, the operating cost of a public bus system would increase by 8% in 1979 and 24% in 1980. The growth in the annual operating cost of an all-bus system was not only expected to be higher but more difficult to predict.

Wildermuth was also convinced that the MRT would not substantially affect the profits of the Singapore Bus Services (SBS) company, which operated the public bus fleet at the time. In fact, the MRT would enable SBS to streamline many of its service routes, allowing it to reap efficiencies of scale and cost savings that could be channelled towards improving its buses and service levels.

Ultimately, Wildermuth saw the MRT as a worthwhile investment that would give Singapore an excellent and affordable public transport system. Otherwise, Singaporeans would have to grapple with increased traffic congestion, longer traveling times and increased fuel use.

Wong Hung Khim, who was then General Manager of SBS, recalled that then Prime Minister Lee Kuan Yew had requested his participation in the televised debate. For Wong, there was no need to debate this issue at all. Although Singapore had an adequate and well-managed public bus system, Wong was not confident that this system alone would adequately meet Singapore's transportation needs in 20 years.

Wong recalled that the reliability of the buses was questionable, given their high maintenance costs and the fact that they were generally less safe than the MRT. Moreover, a bus system was much more labour intensive. Back then, there were two workers on each bus. Each worker had to be adequately trained, incurring substantial costs for the bus company.

There was also the issue of road capacity. Wong explained that buses occupied too much road space, and there was a strict limit to how much existing roads could be widened. At the time, there was a bus stop along Victoria Street that always had a whole line of buses in front of it, backed up like a row of train cabins. The traffic congestion and pollution were unbearable, along with the increased waiting times suffered by passengers eager to board the buses.

In a statement to the media at the time, Ong expressed a similar view that was substantiated by detailed statistics. Quoting transport experts, Ong said that by the 1990s, about 2.6 million people would use Singapore's public transport each day. If Singapore were to rely on a bus-only system, it would require a fleet of 120 smaller buses, 1,800 normal-sized buses and 2,000 larger buses. In the CBD, the number of bus lanes would have to double, and each lane would have to carry 250 buses per hour. The CBD would be overrun with these vehicles.

A COMPREHENSIVE TRAFFIC STUDY

In the early 1980s, the Mass Transit Study Unit released a two-part Comprehensive Traffic Study Report that confirmed many of the

Many of Singapore's public housing estates are located within walking distance of MRT stations. (Pang Yuhao)

observations by Wildermuth, Ong and other proponents of the MRT.

Pok, the unit's project manager, helped prepare this report, which was the most detailed traffic-focused study on the MRT. The first part of the report, released in early 1982, concluded that there were too many buses entering the city centre each day, causing traffic congestion and passenger delays. The report also projected that over the next decade, the volume of bus traffic and private motor vehicle traffic in the city centre during the morning rush hour would increase by 24% and 14% respectively. These were, in fact, conservative figures, because the study used statistics and assumptions developed on the basis of household information collected in 1968.

However, these conservative figures were compelling enough to substantiate the report's conclusion that the city centre would not be able to cope with the projected increase in traffic volume. This was especially the case since there were limits to how many bus lanes could be built, and the extent to which existing roads could be widened.

EFFECTIVE POLITICAL LEADERSHIP

Wildermuth recalled attending several meetings with then Prime Minister Lee during his working visits to Singapore. He revealed that Lee had been supportive of plans to build the MRT long before the cabinet nod. However, he did not impose his views on his cabinet colleagues, preferring to maintain an open stance while allowing the government to undertake a careful study of the issue.

The televised debate had taken place on a Friday. The following Monday, Wildermuth received a telephone call from Lee's secretary requesting a meeting immediately. During the meeting, he questioned Wildermuth in detail about the building and design of the MRT: how land would be allocated and used to build the stations and network; how the MRT would complement the bus system, and even how the cabins and seats would be designed. Lee's attention to detail left a deep impression on Wildermuth.

Lee had also made the right move in picking Ong to oversee the MRT project. Wildermuth described Ong as a dedicated leader who greatly appreciated Singapore's need for the MRT, perhaps because of his professional training as an architect. Ong had visited several countries with successful urban rail systems, developing a deep understanding of the issue. He delivered many speeches and gave many interviews to the media that clearly and persuasively explained the need for the MRT.

During a dinner at Kim Keat Community Centre to mark National Day in August 1980, Ong said, "Certainly, the MRT can contribute to the growth and vitality of a city and allow for more intensive development". He added, "New York, London or Tokyo would not be able to support the amount of urban and economic activity that they do today without their subway systems".

For Ong, the MRT was primarily intended to meet the public transport needs of Singapore by improving connections between the city centre and residential areas, as well as easing traffic congestion. But the benefits that the MRT could bring to urban planning and design were equally evident.

For one, with the MRT in place, bus service routes could be redrawn in a way that would complement the rail network. This would create

an integrated, efficient and comprehensive public transportation system around Singapore. The improvements to accessibility and connectivity would also create opportunities for more land parcels across the island to be developed and used.

Ong also felt the MRT would promote the development of innovative architectural and design concepts. For example, offices, shopping centres and other developments could be built in clusters around MRT stations, and designed in a way that would facilitate human movement and activities within each cluster. This inward spatial design would create a fresh ambience in Singapore's urban centres, providing public spaces free from traffic noise, congestion and pollution.

Perhaps the most compelling and straightforward argument for the MRT was how it would improve the quality of life for Singaporeans. The system would give them an excellent public transportation system and bring greater convenience to their daily lives.

The MRT was planned to be built and opened in phases. The initial capital investment of S$5 billion was spent on building a network of 42 MRT stations on the North-South Line and East-West Line. The network aimed to cater to a daily ridership of one million.

On the morning of 7 November 1987, Ong officially opened the MRT at Toa Payoh station. "This is like a 20-year affair from conception to delivery," he said. "Now the baby is born. Well, to say that I am happy and pleased is an understatement."

Pok recalled that the MRT featured several ground-breaking features that had not even been adopted in more established urban rail systems overseas. For example, glass screen doors were installed at station platforms in order to conserve energy. As the underground MRT stations were air-conditioned, these doors minimised the seepage of cool air into train tunnels. They also played an important safety

Orchard MRT station, pictured here in the late 1980s, was built to link directly to a number of shopping malls. (Singapore Tourism Board Collection, courtesy of National Archives of Singapore)

function and reduced the level of noise from trains pulling into the station.

The MRT also featured a sophisticated control system. According to Pok, the system was the most advanced and automated kind of its time. Through it, MRT controllers could easily monitor a range of parameters such as the distances between trains, ensuring that trains ran safely, smoothly and on schedule.

In August 1987, just before the MRT started operating, the government established Singapore Mass Rapid Transit (SMRT) Limited to take over the operation of the system. SMRT was tasked with ensuring the quality and affordability of train services, and to ensure that there was enough revenue to pay for maintenance and repairs.

The government did not expect or require SMRT to recoup the construction costs of the system, which had been paid for through government funds safeguarded for the development of national infrastructure. The government would also bear the cost of building future MRT lines. SMRT was therefore able to use the revenue generated from commuter fares to fund its operations and expenses. Pok recalled that the government set a profit ceiling on the company, however, to prevent it from profiteering at the expense of commuters.

AN INTEGRATED PUBLIC TRANSPORTATION SYSTEM

In August 1986, a year before the MRT started operating, the government formed a task force comprising more than 30 transport experts to conduct detailed planning on the integration of the MRT and bus systems. They included representatives from local bus companies and British transportation consultants.

The task force spent three years conducting detailed analyses and studies on both transportation systems. Their work resulted in several important recommendations. For example, because MRT stations were planned to serve a relatively large geographical radius, a network of buses would provide the “last mile” connection to a commuter’s final destination, be it their place of employment or residence. This transportation model was applied in many HDB new towns, where bus routes that started and ended at MRT stations were designed to transport people over short distances. This not only avoided service overlaps with the MRT, but allowed the buses to run more efficiently, quickly and frequently.

The task force also studied matters such as shared services, complementary fare structures, public education and ticketing. On the issue of ticketing, for example, the experts recommended the use of a single ticket for both bus and MRT trips, and even considered details such as the material to be used for these tickets, how they should be printed, and the types of machines to be used to dispense them.

KEEPING FARES AFFORDABLE

In March 1987, about half a year before the opening of the MRT, the government formed the Public Transport Council (PTC). The main task of the PTC, one that it continues to perform today, was to study and make recommendations to the government on MRT and bus fares. Pok was appointed the PTC’s founding secretary. Among other findings, the council assessed that the integration of the MRT and bus systems would minimise the

An MRT train travels over a canopy of trees. (Jason Goh)

duplication of service routes and enable each system to operate more efficiently, thus helping keep public transport fares low.

An important move to integrate the MRT and bus systems was to establish a common ticketing system and distance-based fare structure. Commuters would only need to buy a single ticket to travel interchangeably on both buses and the MRT. Regular commuters could also purchase monthly concessionary passes to save on transport costs.

The government made it a priority to ensure that MRT fares were affordable to the Singapore public. In December 1987, then Deputy Prime Minister Goh Chok Tong delivered a speech at the opening of Orchard MRT Station, stating:

> **The government has paid S$5 billion for the tunnels, the tracks and the stations. These are handed over to the company that will run the MRT system. Passengers won't have to pay for them. They have been paid for. That is why our MRT fares are reasonable and should remain reasonable.**

In fact, Singapore had one of the lowest urban rail transport fares in the world. Commenting on MRT ticket prices, Lim Leong Geok, a former Executive Director of SMRT, said the company was even prepared to suffer operating losses in its early days. This was to ensure the system was accessible to all Singaporeans.

AN INDELIBLE PART OF SINGAPORE LIFE

The MRT has been operating for more than 30 years. An entire generation of Singaporeans have come of age not knowing life in the country without it. MRT stations and the public spaces around them are common meeting points, and when asked where they live, many Singaporeans describe their addresses relative to the closest MRT station.

In recent years, overcrowded trains and service breakdowns have affected Singaporeans' trust and confidence in the MRT system. SMRT and government officials have made efforts to address public concerns and committed to continual improvements to the system. The public dissatisfaction is a clear demonstration of the centrality and importance of the MRT to Singaporeans' daily lives.

The coming years will see a further expansion of the system, with some 63 new stations and two more railway lines. The total length of the network will reach 360 km, up from about 200 km today. This is almost twice the length of Singapore's coastline.

Wildermuth and Pok's respective roles in the planning and development of the MRT are a vivid reminder of the conviction and hard work that led to the success of the system. The future success of the MRT will depend greatly on these same qualities, and a commitment by transport sector officials to continue providing excellent public transport infrastructure to Singaporeans.

Changi Airport's Control Tower, seen through the windows of a nearby building, 1996. (Civil Aviation Authority of Singapore Collection, courtesy of National Archives of Singapore)

9 Singapore Changi Airport

Building a new international airport at Changi was an ambitious undertaking initially viewed by experts as unfeasible and overly expensive. But government leaders saw the need for a major facility to meet the growing demand for commercial air travel. Completed in just six years, Changi Airport quickly established itself as one of the world's best civil aviation hubs.

Mr Lim Hock San joined Singapore's Department of Civil Aviation in 1975, rising to the position of Director in 1980. When the department was restructured into the Civil Aviation Authority of Singapore (CAAS) in 1984, Lim was appointed the authority's first Director-General.

During his career in the aviation sector, Singapore moved its main civilian airport from Paya Lebar to Changi, which developed into a major international air transport hub. Lim played a crucial role in the planning, development and management of Changi Airport. During his leadership of the CAAS, the airport garnered several international awards for its service and operational standards.

In 1989, Lim was selected as the Chairman of the International Civil Airports Association (ICAA), a global trade organisation for the airport sector. Following the establishment of Airports Council International (ACI) to replace the ICAA in 1991, he was appointed the council's inaugural chairman. His leadership at these organisations is a reflection of Singapore's important role in the global civil aviation industry.

Lim left CAAS in 1992. Since then, he has been appointed Chairman and Chief Executive Officer of the United Industrial Corporation, and Chairman of the Ascendas Real Estate Investment Trust (REIT).

A CENTURY OF AIR TRAVEL

Singapore's first air base was established by the British colonial government in 1921, on the eve of the global rise of commercial air travel. The air base, located at Seletar in Singapore's northeast region, was also used as a dock for flying boats. This base was subsequently used as the British Royal Air Force's base in the Far East.

In 1931, the then Governor of Singapore, Sir Cecil Clementi, announced plans to build a new civil airport in Kallang Basin. To construct the airport, the authorities had to reclaim some 1.2 km^2 of mangrove swamp in the area. Completed in June 1937, Kallang Airport was the first purpose-built civil international airport in Singapore. During the Second World War, the airport played an important role as the only operational airfield in Singapore capable of supporting the Allied forces' war efforts against the invading Japanese Army.

Four years after the end of the war, the British colonial administration embarked on plans to build a new international airport at Paya Lebar, with construction to be funded in part by the Colonial Development and Welfare Fund. Paya Lebar Airport was completed in 1955 and served as one of two bases for Malayan Airways (its other base was in Kuala Lumpur).

Paya Lebar Airport was used as a civil aviation facility for almost 25 years. During this time, the government made several improvements to the airport, such as by extending the runway and building a passenger terminal. In 1981, with the completion of Changi Airport, the facility was fully converted for military use as Paya Lebar Airbase.

PLANNING A NEW AIRPORT AT CHANGI

According to Lim Hock San, Singapore's Director of Civil Aviation from 1980 to 1992, the colonial authorities had decided to build a commercial airport at Paya Lebar mainly because the soil quality suited construction. The British did not anticipate the boom in commercial air travel from the 1950s, and the future need to expand the airport into a much larger facility to accommodate the demand of passengers and airline companies.

However, Singapore's post-independence leaders saw limitations to the extent Paya Lebar could be expanded, and felt the country needed a much larger airport to serve the needs of international travellers and facilitate economic growth.

Planning for such an airport began in 1968. The government chose a site at Changi, in the eastern reaches of Singapore. Half of the site planned for the new airport's construction had to be reclaimed from the sea, and much of the existing land had to be acquired from private land-owners. The government also realised that much of the basic infrastructure required to support a major international airport—road networks, for instance—was not in place.

These early plans for Changi Airport, therefore, were still an abstract vision. However, the government was determined to see them through. In the early 1970s, the global economy was roiled by instability, due in part to the 1973 oil crisis. In Singapore, which had experienced almost a decade of stellar economic growth since independence, the government was concerned that more austere economic conditions were just around the corner.

Why did the government choose to proceed

The Singapore International Airport at Paya Lebar, 1964. The airport, which opened in 1955, was Singapore's third civilian airport. It was converted into a military airbase in 1981, after the opening of Changi Airport. (Courtesy of National Archives of Singapore)

with such a huge infrastructural investment amid such economic uncertainty? For Lim, the answer was a simple one: far-sightedness.

DECIDING ON THE LESS VIABLE OPTION

In the early 1970s, the government had consulted overseas experts on increasing the country's civil aviation capacity. Constructing a new airport at Changi was not deemed the best or most viable option. Then Prime Minister Lee Kuan Yew recalled in his memoirs:

> In February 1971, the Cabinet had accepted the recommendation of a British aviation consultant that we build a second runway at Paya Lebar, to be operational by 1977–1978. The Serangoon River would have to be diverted for this to be done. There were engineering problems because of the doubtful load-bearing qualities of the soil below the riverbed, but it would entail the lowest land acquisition costs and require the least resettlements.

Another group of experts, this time consultants from the United States, also recommended that Singapore expand its civil aviation capacity by building another runway at Paya Lebar. Lee recalled, "I was not satisfied and wanted the option of moving to Changi reconsidered". He instructed the government to establish an Airport Construction Committee to undertake a detailed study of plans to build two runways at Changi by 1977. But the committee reached the same conclusion as the British and American experts.

Lee's reluctance to expand Paya Lebar Airport centred on his concern about noise pollution. He felt strongly against building a second runway at the airport, since this would increase the frequency of airplanes flying across Singapore's central area. There would be an unbearable din from the country's skies.

Changi Airport under construction, November 1980. The airport officially opened on 29 December 1981. (Civil Aviation Authority of Singapore Collection, courtesy of National Archives of Singapore)

In 1975, Lee appointed Howe Yoon Chong, who was then the head of Singapore's civil service as well as Chairman of the Port of Singapore Authority (PSA), to chair a Special Committee on Airport Development to further study the possibility of building a new airport at Changi. Lim recalled that Howe, for whom he had worked at the PSA, was known by public servants as a "bulldozer", with a reputation for being determined and strong-willed in executing policies.

This time, Lee urged Howe and other members of the committee to consider not just the technicalities and constraints of building a new airport, but what would be in the best interest of Singapore. The committee ultimately recommended that a modern airport be built at Changi, and that plans for the expansion of Paya Lebar Airport be scrapped.

THE OBVIOUS CHOICE

Lee gave due credit to Howe for his role in pushing through the development of Changi Airport. For one, he asked Howe to officiate the ceremonial opening of the airport on 29 December 1981. Howe, who was then the Minister for Defence, delivered an emotional, reflective speech that clearly explained the government's decision to build the new airport.

Few people have stopped to ponder over the consequences of constructing the second runway and the long-term implications of expanding Paya Lebar Airport. Land clearance, resettlement, air and noise pollution were only some of the complicated and messy

problems. The work could not be completed before 1984.

Also, noted Howe, "Further expansion would be almost impossible".

Meanwhile, Changi would be "completed faster, would have less noise and air pollution and upset few people with resettlement, was within easy expressway communications with the city, and had vast land reserves for future expansion". Changi, he said, was the "obvious choice".

Howe also described the economic dividends the country could expect to reap from Changi Airport. Located in the heart of rapidly developing Southeast Asia, the airport would promote greater connectivity between Singapore and the rest of the world, allowing it to further develop its trade and tourism sectors, as well as other parts of its economy.

Lim was one of the people that Howe thanked in his speech for seeing through the completion of Changi Airport. Lim was Howe's assistant when the minister had chaired the airport committee in 1975, and had subsequently been appointed Director of Civil Aviation. Lim recalled that Howe was not just an excellent executor of plans, but a visionary leader and thinker.

For example, Howe was aware of the limitations to the expansion of the seaport at Tanjong Pagar, and was concerned with finding a new location more conducive to the port's growth. Given the abundance of land at Changi, on the eastern coast of Singapore, he was keen to explore the building of a combined sea and airport complex there. Unfortunately, these plans fell through because of budgetary concerns.

FUNCTIONALITY, DURABILITY AND COMFORT

Lim recalled that as soon as the government decided to build Changi Airport, it sent two teams of planners on overseas visits to study the design of major international airports in Asia, Europe and the United States. Following their study visits, the teams prepared a comprehensive masterplan for Changi Airport that combined the best qualities of overseas airports with features that would meet Singapore's specific demands.

The plan included two parallel runways, a 78 m high airport control tower to be built between the two runways, a series of aircraft hangars and a passenger terminal building measuring 222,000 m^2 in floor area.

The priorities that shaped the design of Changi Airport and its facilities were simplicity and flexibility. The planners also considered the need to ensure that the airport's operational systems were able to function over a long period of time, to enable the best returns on the government's sizeable investment in the project.

When Changi Airport opened in 1981 after six years of construction, it was clear to all that the development fulfilled the design brief. There were no grand architectural flourishes or superfluous elements such as a majestic façade and ornate interiors. What it did feature was well-designed internal spaces that provided a comfortable, peaceful and pleasant environment for passengers, workers and other visitors. Majestic trees and other forms of tropical landscaping lined the outdoor spaces fringing the passenger terminal, while the interior spaces were adorned with evergreen shrubs and climbing vines. Wide-canopied *Rain*

Trees lined the boulevard stretching toward the control tower.

Lee was proud of this achievement.

For an airport of that size, the building period was usually 10 years. We completed Changi Airport in six. We demolished hundreds of buildings, exhumed thousands of graves, cleared swamps and reclaimed land from the sea. When it opened in July 1981, it was Asia's largest airport.

BUILDING ASIA'S LARGEST AIRPORT

After the masterplan for the airport was adopted in 1976, the PSA immediately commenced reclamation works to create land for the new airport. The work involved a new and innovative method of reclamation that was thereafter widely adopted in subsequent reclamation projects.

The government also established a development team of 350 people to supervise and manage the project. The team consisted of officers from across the public service. For example, the Public Works Department (PWD) deployed 120 technical experts, staff and administrative officers in various roles, including the development of traffic infrastructure; the Housing and Development Board (HDB) resettled residents in the area to new houses, and the Parks and Recreation Department (PRD) took charge of landscaping the airport complex.

The construction of the airport involved more than 2,500 labourers, 300 site supervisors, and almost 200 contractors and suppliers from Singapore and abroad. Work on this mega-project proceeded with speed and efficiency. After three years, internal finishing works, landscaping, and the installation of machinery and electrical equipment, were all in place.

Lim said that then PWD Director Yap Neng Chew described the airport as the most complex development project undertaken by his department at the time. Indeed, apart from being Singapore's largest building, the airport also boasted Asia's largest stand-alone passenger terminal. According to Lim, Yap saw the developmental process of the airport as a valuable experience for the PWD. It was an opportunity for PWD officers to contribute to this important national project, as well as to enhance their technical skills and expertise. In addition, those from the private sector who worked on the project—architects, engineers, surveyors, technicians and others—also had the chance to substantially improve their professional skills and experience, including by learning from foreign experts and advisors who were part of the project team.

In fact, by the 1990s, Singapore was ready to export technical expertise on airport development. In June 1993, the CAAS established a private company to share expertise on airport planning, design and management. Its clients have included authorities in countries like China, India, Indonesia and the Philippines.

SECOND PHASE OF DEVELOPMENT

The development plans for Changi Airport—established in 1976—were implemented in two phases over several years. In the first phase, the key structures constructed included a control tower, runway and standalone passenger terminal building (now known as

Terminal 1). The idea was to allow Singapore to have a new international airport as soon as possible. This phase of development was successfully completed in 1981.

In the second phase, the goal was to substantially increase the capacity of Changi Airport in anticipation of greater passenger arrivals to Singapore in the following decades. The government had projected that with the rapid pace of economic growth in the Asia-Pacific region and the increasing demand for air travel, the number of passengers entering and leaving Singapore by air would rise to more than 20 million a year by the mid-1990s. Terminal 1 did not have sufficient capacity to accommodate these numbers.

The second phase of development commenced in 1984. It involved the construction of another runway, a second passenger terminal building and other key structures. The 285,000 m^2 terminal building—Terminal 2—had 30% more floor area than Terminal 1, and began operations in late 1990. The airport also built a light rail system—the Changi Airport Skytrain—to transport passengers from one terminal to another. Constructed just after the opening of Terminal 2, the automated, driverless system could ferry passengers between terminals in just under two minutes.

With the opening of Terminal 2, Changi Airport had become more than just a mere air transport development. The airport complex was like a small town, with a comprehensive

Changi Airport's departure hall, 1985. There were fountains and tropical landscaping in many of the airport's common areas. (Civil Aviation Authority of Singapore Collection, courtesy of National Archives of Singapore)

array of passenger services as well as attractions and offerings for locals and tourists. There were shops, restaurants, recreation spaces, entertainment outlets and business centres spread across four expansive, comfortable and inviting halls.

Lim recalled that then CAAS Chairman Sim Kee Boon was particularly concerned about ensuring that the products and services offered at the airport were kept as reasonably priced as possible. In many airports around the world, products and services are usually priced higher than in local stores. But Sim wanted Changi Airport to be different. He understood that higher prices at the airport lowered the competitiveness of its shops and diminished passengers' shopping experience. Sim frequently sent his staff to check that the prices of items sold at the airport were comparable to or even lower than those in the city. He also instructed them to seek feedback from airport visitors on their shopping experience.

The expansion of Changi Airport into a two-terminal development cemented the airport's position as a leading air transport facility. The first two phases of the airport's development had ended by 1990. However, the government continued to make plans for the future, including the development of two additional passenger terminals; as well as the enhancement of existing operations. That year, it announced an investment of S$1.6 billion over the following decade to improve services and facilities.

Baggage claim at Changi Airport, 1985. The airport's service standards at the time required the first piece of luggage from an aircraft to reach the baggage claim within 12 minutes of arrival. (Civil Aviation Authority of Singapore Collection, courtesy of National Archives of Singapore)

EFFECTIVE AIRPORT MANAGEMENT

The government understood that an airport's physical infrastructure must be complemented by excellent management.

Airport officials put in place training and development programmes to ensure that passenger assistance and other frontline staff were able to extend high quality customer service. Trainees even included police, customs and border control officers, and tax officers processing duty refunds. The airport also encouraged independent contractors such as airline companies and retailers to provide adequate training to their employees. It even inserted contractual conditions on airport tenants that they provide customer service training to their staff.

The airport identified well-performing members of staff for recognition, including through gifts of air tickets. The management also ensured there were adequate rest and recreation areas for staff. Lim emphasised the importance of staff welfare, saying that it was important to take good care of staff in order for them to provide the best care to passengers.

There were also training schemes for staff who were not in frontline roles. For example, the CAAS established a Civil Aviation Training Centre for air traffic control officers that aimed to enable these officers to take on a variety of roles within the sphere of control operations. Trainees were even sent on attachments to air traffic control centres in other countries.

By the early 1990s, Changi Airport had collected many accolades from travel magazines and industry groups. In particular, it received praise from travellers for its high standard of passenger service and amenities, as well as its operational efficiency. The airport became known for the short time taken to clear customs procedures, among other qualities.

Lim recalled that customs clearance procedures at Changi Airport were inspired by the Walt Disney Company's visitor management system at its theme parks. At places like Disney World and Disney Land, attractions and rides consistently featured six to seven entry points for visitors, all of which were kept open. This was replicated at Changi Airport, where arriving passengers are greeted by a long row of immigration counters that are kept open to reduce queuing and process people quickly.

The airport established performance targets for key passenger services, often investing heavily in computer-based technology to enhance operational efficiency. One of these services was luggage handling. According to Lim, the airport's service standards required the first piece of luggage from an arriving aircraft to reach the baggage claim carousel within 12 minutes of landing, and the last piece within 29 minutes. The speed of luggage handling meant that the airport could process 17,000 pieces of luggage an hour—roughly the amount of luggage that can be stored in 24 large passenger planes.

CREATING THE CIVIL AVIATION AUTHORITY OF SINGAPORE

Prior to 1984, the Civil Aviation Department of the Ministry of Communications managed Singapore's civil aviation affairs, including the operation of civil airports and provision of air traffic control services. With the opening of Changi Airport in 1981 and the implementation

of the second phase of development for the complex, the government decided to convert the department into a standalone statutory board, the CAAS.

The government believed the CAAS, as an independent entity, would enjoy full flexibility in planning and organising its operations, enabling it to carry out its work more effectively. The primary role of the CAAS was to manage Changi Airport. Later it would also take over all the functions of its predecessor (the Civil Aviation Department of the Ministry of Communications), including the provision of air traffic control services, and the enforcement of rules and regulations on air safety. Then Acting Minister for Communications Dr Yeo Ning Hong, who tabled the parliamentary bill proposing the formation of the CAAS in March 1984, said the CAAS would be "better able to contribute significantly to the continued development of Singapore as a major air junction and communications centre".

AN "OPEN SKIES" POLICY

Another one of the CAAS' key tasks was to implement the government policy to maximise the use of Changi Airport by foreign airline companies. The goal was to attract more foreign airlines to offer flight routes to and from Singapore and promote the airport as an important air transport hub.

Adopting an "open skies" policy, the CAAS sent delegations to negotiate with

Changi Airport Terminal 2, early 1990s. The opening of the new terminal in November 1990 cemented Changi's position as a leading air transport facility. (Singapore Tourism Board Collection, courtesy of National Archives of Singapore)

airline companies overseas. These efforts succeeded in establishing Changi Airport as not only a popular stopover point for international flights, but also strengthened Singapore as a destination in itself, driving up Singapore's tourism revenues. In subsequent years, many countries sent delegations to Singapore to conclude agreements to use Changi Airport as a regional base.

The government pursued a non-protectionist, liberal aviation policy. In the short term, the presence of more foreign airlines at Changi may have affected the revenues of the national carrier Singapore Airlines by competing with the company to serve the same flight routes to and from Singapore; but greater competition ultimately spurred the carrier to do better in the long term. The larger number and range of international flights stopping at Changi also enabled Singapore Airlines to offer more connecting routes and streamline its offerings.

In 2007, the then Minister for Transport Raymond Lim summed up Changi Airport's success as: "Developing hardware and infrastructure, enhancing Changi's software, anchoring the airlines in Changi and liberalising the aviation regime."

THE WORLD'S BEST AIRPORT

In August 1988, the British magazine International Traveller published the results of a reader survey that ranked Changi as the world's best international airport. The magazine had more than 200,000 readers, the majority of whom were senior corporate executives and business leaders. These individuals had high expectations when it came to air travel and transit. The publication of the survey was an emotional and gratifying movement for Lim, his colleagues and all who helped build the airport. For Lim, it was the "foresight of government leaders, the hard work and sacrifice of those who implemented the airport plans, and the customer-oriented attitude of airport staff" that made the then barely 7-year old airport a global success.

This was to be the first of countless accolades heaped on Changi by the media and international travellers in its four decades of operation.

In 2019, the international air transport rating agency Skytrax named Changi the world's best airport for the seventh consecutive year. Skytrax's annual ranking of airports is based on surveys with millions of air travellers from over 100 countries that seek feedback on almost 30 service and performance parameters, including the language ability of staff, shopping experience and customs clearance procedures. In all, the agency surveys more than 500 airports.

In its report, Skytrax described Changi's multiple wins as a "truly fabulous achievement", and predicted that the opening of its then upcoming retail and entertainment complex Jewel would "add another unique dimension to the experience for Changi Airport customers".

Jewel, which opened on 17 April 2019, has indeed become a popular attraction for international visitors and Singaporeans. Conceived as a project to maintain Changi's status as a major aviation hub, the complex was built over the former open-air car park at Terminal 1. It includes retail, recreational and hotel uses, and passenger-specific amenities

An indoor waterfall at Jewel, a mixed-use development within the Changi Airport complex that opened in April 2019. (Touann Gatouillat Vergos)

such as ticketing counters, baggage transfer services and early check-in facilities.

In 40 years, Changi has expanded into an airport complex with three runways, five passenger terminals, and a mixed-use attraction. In 1984, the number of visitor arrivals at Changi was 8.4 million, and the airport handled 200,000 tonnes of air cargo. In 2018, visitor arrivals topped 14 million, and air cargo tonnage exceeded two million.

AN EXCELLENT INTRODUCTION TO SINGAPORE

Former Prime Minister Lee was especially proud of Changi's achievements. In his memoirs, he wrote: "Changi is a beautiful site at the easternmost corner of the island. The approach to the city from the east coast runs along a new 20 kilometre expressway built on land reclaimed from the sea, with no problems of congestion, beautiful glimpses of the sea on one side and vistas of HDB estates and private condominiums on the other."

"The airport and (the) pleasant 20-minute drive into the city made an excellent introduction to Singapore", he said, adding that Changi was "the best $1.5 billion investment we ever made".

A view of MacRitchie Reservoir, 1985. (Ministry of Information and the Arts Collection, courtesy of National Archives of Singapore)

10 Water Security

Having historically depended on the Malaysian state of Johor as a key source of water, Singapore faced new challenges to its water supply upon gaining political independence in 1965. But a series of innovative water planning initiatives and projects have helped to diversify its sources of water and enhance its water security.

Mr Tan Gee Paw is a former chairman of the Public Utilities Board (PUB). In a five-decade long public service career, Tan has contributed to the planning and implementation of many policies to manage and enhance Singapore's water resources.

Tan graduated from the University of Malaya in 1967 with a bachelor's degree in civil engineering, and joined the public service as an engineer in the Public Works Department (PWD). He later moved to the PUB, followed by the Ministry of the Environment (ENV) in 1974. During his time at the ministry, Tan worked on the clean-up and rejuvenation of the Singapore River and Kallang Basin. In 1987, then Prime Minister Lee Kuan Yew presented him a gold medal for his role in the clean-up.

In 1995, Tan was appointed Permanent Secretary of the ENV. He served in that role until 2001, when he was appointed PUB Chairman. At the PUB, he led Singapore's water reclamation and desalination efforts, including the development of NEWater. He stepped down in 2017.

Located just south of the equator, Singapore has a tropical climate and annual rainfall of about 2,400 mm. Yet, Singapore is one of the most water-stressed countries in the world. The country's small land mass and shallow, narrow and short rivers limit the collection and storage of rain water and surface run-off. It also lacks underground water sources such as aquifers.

For many years following Singapore's independence in 1965, the country was heavily reliant on Malaysia for its water supply. In fact, the Malaysian state of Johor—to the country's immediate north—had been a key source of water since 1927. As Singapore's economy grew rapidly in the decades after independence, the water needs of its industries, businesses and population increased the country's demand for water. Its main water sources—the MacRitchie, Peirce and Seletar Reservoirs—were inadequate to meet these needs.

In 1961, Singapore's City Council signed an agreement with the Johor State Government that gave the country full and exclusive rights to draw water from the designated catchment sites at Gunong Pulai, Sungei Tebrau and Sungei Scudai in Johor. The agreement would last for a period of 50 years, until 2011. Two years later, a second agreement—the 1963 Water Agreement—was signed by both parties. Valid for 99 years, the agreement gave Singapore the right to draw 250 million gallons of water a day from the Johor River.

Then Prime Minister Lee Kuan Yew ensured that the two water agreements were enshrined in the 1965 Separation Agreement that gave the country its independence. This was an important step to safeguard the country's water security in the years ahead. Despite this legal safeguard, Singapore was often on the receiving end of threats from the Malaysian leadership. On the day Singapore obtained its independence, Malaysia's then prime minister Tunku Abdul Rahman told the British High Commissioner in Malaya, "If Singapore's foreign policy is prejudicial to Malaysia's interests, we could always bring pressure to bear on them by threatening to turn off the water in Johor".

For Lee, the Tunku's threat was a reminder of the historical vulnerability of Singapore's water supply. Just two decades prior, during the Second World War, the Japanese Army had bombed the pipes that carried water from Johor to Singapore, effectively cutting off all water supply to the island. Just two weeks later, the British surrendered the colony to the Japanese.

In 1971, the government established a Water Planning Unit (WPU) under the Prime Minister's Office (PMO). For Lee, plans to safeguard Singapore's water sources was of paramount importance, and would take precedence over other policies for the development of the country.

ESTABLISHING A WATER MASTER PLAN

Just days after Singapore won independence in August 1965, Prime Minister Lee called Lee Ek Tieng, the chief engineer of the PUB, and asked him if Singapore would be fully water-sufficient if every drop of rain that fell on the country could be captured.

The prime minister's preoccupation with the issue of water security—just one of the many development challenges facing the young nation—was a key driver in the government's decision to establish the WPU. The unit was intended to complement the work of the PUB, which had been set up in 1963. Lee Ek Tieng was subsequently appointed to head the WPU.

He was assisted by Tan Gee Paw, who was then a young engineer in the PWD.

The two men worked together to prepare Singapore's first Water Master Plan. According to Tan, in the initial stages of preparing this plan, the WPU had sought the expertise of water consultants from Israel. After the first phase of preparations, then Minister for the Environment Lim Kim San—a leader who always sought to draw out the potential of his staff—had asked the WPU officers if they still required the help of the Israeli experts. Lee and Tan replied to the minister that they were willing to give it a shot on their own.

To prepare the Water Master Plan, Tan and his colleagues relied on computers to conduct studies and simulations of Singapore's precipitation patterns. These simulations showed that although Singapore received high rainfall, a proportion of it was lost to evaporation, pollution or insufficient catchment systems. Infrastructure would have to be developed to capture and retain as much rainwater as possible.

The team also calculated that for daily life and economic activity to continue even in the event that water supply from Johor was cut, Singapore had to develop the means to provide 75% of its water supply through domestic sources. The actual volume of water this represented would keep increasing as Singapore's domestic and industrial needs continued to grow.

Another challenge faced by the planning team was the need to balance the allocation of water catchment areas and water drainage infrastructure. This was because Singapore's land mass was barely 5 m above sea level and thus susceptible to floods, especially in lower lying areas. In December 1969, a series of heavy downpours flooded some 29 districts in Singapore, killing five people and causing more than S$4 million in damage to property and infrastructure.

RENEWING THE 1961 WATER AGREEMENT

In August 2011, the 1961 Water Agreement between Singapore and Malaysia expired. On 31 August 2011, Tan (as PUB Chairman) and Johor State Secretary Datuk Obet Tawil signed a series of documents that led to Singapore's handover of the Gunong Pulai and Scudai Waterworks, and the Pontian and Tebrau Pump Houses, to the Johor state government. The facilities were in good working order. The ceremony was witnessed by the Crown Prince of Johor, the Chief Minister of Johor, Singapore's environment minister and other senior government officials from both countries.

The 50-year agreement was concluded in a cordial fashion. Both sides were aware that by then, many of Singapore's earlier water challenges had been resolved. Tan recalled, "I didn't really feel anything much at that time. I had long known that this day was bound to come. What we had been working for all those years was just to create more sources of water for Singapore."

EXPANDING THE WATER CATCHMENT AREAS

Singapore's main domestic source of water is its network of reservoirs and waterways, including the protected catchment areas at MacRitchie, Peirce and Seletar.

In accordance with the Water Master Plan,

A view of Bedok Reservoir, 2011. The reservoir was part of the Sungei Seletar-Bedok Water Scheme, Singapore's first urban catchment. (Lee Leng Kiong Collection, courtesy of National Archives of Singapore)

which was finalised and published in 1972, the government undertook efforts to expand the Seletar and Peirce Reservoirs. At Seletar, the government established a system to channel water from seven adjacent streams into the reservoir. At Peirce, which featured an existing dam, an additional, higher dam was constructed to increase the reservoir's water storage capacity.

The increasing land demands of housing and industry meant there was limited land for the development of new protected water catchment areas such as the existing reservoir areas, which were extensive in size and located in relatively undeveloped parts of Singapore. This situation compelled the government to create unprotected water catchments and catchments in urban areas. Tan recalled that the first unprotected catchment was created in 1975, and the first urban catchment was the Sungei Seletar-Bedok Water Scheme in 1986.

However, the competition for land persisted, particularly between the water and public housing agencies. In the early 1980s, the Housing and Development Board (HDB) set out to build 140,000 new flats. It planned new towns in areas that were designated as unprotected water catchments, including at Bedok and Sungei Seletar. A balance had to be struck in order to avoid compromising the amount and quality of water collected in these areas.

After a series of discussions, the Ministry of National Development (MND) and the ENV agreed on a policy that would cap the amount of land which could be developed within unprotected water catchment areas at just above 30%. There would also be a developmental cap of 198 residential units per hectare and strict rules on pollution control. This policy was approved by Prime Minister Lee and his Cabinet in 1983.

A village in Kallang Basin, 1966. Lacking proper drainage, many villagers dumped their waste into the water. (Courtesy of National Archives of Singapore

According to Tan, the government encountered several challenges in creating the Sungei Seletar-Bedok urban catchment.

For example, in the early 1980s, the banks of the Seletar River were dotted with pig farms, which dumped animal manure and other forms of waste into the water. To clean up the river, the government had to relocate all the pig farms in the area, including by offering monetary compensation to the farmers. At Bedok, the government had to convert a sand quarry previously used by the HDB for its public housing projects into the Bedok Reservoir.

With the imposition of pollution control and strict rules limiting new developments in the area, the urban catchment project became a success. The water from the Sungei Seletar-Bedok Water Scheme was even assessed to be of better quality than that obtained from protected catchments.

CLEANING UP THE SINGAPORE RIVER AND KALLANG BASIN

The creation of the Sungei Seletar-Bedok Water Scheme illustrated the importance of cleaning up polluted water ways in order to develop successful urban catchments and reservoirs.

In 1977, the government established a plan for the cleaning up of the Singapore River and the Kallang Basin. The river flowed through the city centre and was populated along many sections of its banks by residents, shops and industries. Lacking proper drainage and sanitation facilities, many riverside residents and workers discharged waste into its waters, turning the river into an open sewer.

Earlier, in 1971, the government had published the Concept Plan, the country's first comprehensive island-wide urban planning blueprint. Under the plan, the city centre was to be renewed and redeveloped, with new office

A section of the Singapore River at Boat Quay, 1983. The clean-up of the Singapore River, which started in 1977, took about ten years to complete. (Courtesy of National Archives of Singapore)

towers, hotels, housing and other developments. As urban redevelopment proceeded, the government also saw the need to clean up the Singapore River. Then Prime Minister Lee instructed the environment ministry to make the river clean enough for fishing, and promised to give each officer involved in the clean-up a gold medal if the effort succeeded.

The clean-up was a multi-agency effort. The government established a taskforce comprising the PUB, MND, Ministry of Trade and Industry (MTI), Ministry of Law, HDB, Urban Redevelopment Authority (URA), PWD, Primary Production Department (PPD), Parks and Recreation Department (PRD) and other agencies.

The 1977 plan not only considered the technical aspects of the clean-up but also focused on changing the way that residents, workers and others along the river conducted their daily activities. In this way, water pollution could be controlled in a more sustainable manner. Indeed, the clean-up effort improved the hygiene and lifestyle habits of residents, and had a positive impact on public health by tackling waterborne and other related diseases.

Another important feature of the clean-up was its role in the evolution of Singapore's economy. During the clean-up, polluting economic activities such as pig farming, textile production and bumboat delivery services were slowly phased out. The areas formerly allocated for these activities were taken over by less polluting economic uses.

Tan recalled that there were more than 600 pig farms in the Kallang Basin. Collectively, these farms reared more than 60,000 pigs and were a major source of water pollution. The PPD was keen to protect the pig farming industry, which it saw as an important domestic food supply source. But the government decided to phase out pig farming altogether in order to conserve limited land and water resources, and eradicate all polluting economic activities that threatened public hygiene. The closure of the farms significantly reduced the amount of organic waste that drained into the Kallang Basin.

The move to close the pig farms was a tough and costly one. The government paid monetary compensation to the farmers, many of whom were residing on these farms and had to be resettled in HDB flats. But many farmers were unhappy at having to abandon their farms and old ways of life. Former Prime Minister Lee recalled that many farmers refused to support the government in elections for several years thereafter.

The Singapore River clean-up was a mammoth task. The taskforce had to resettle almost 50,000 squatters, 26,000 households, 610 pig farms and 2,800 businesses. All Singaporean households and business establishments affected by the project were offered replacement houses or premises, as well as monetary compensation. Almost 5,000 street hawkers were relocated to markets and hawker centres, and wholesalers of produce were relocated to the Pasir Panjang Wholesale Market.

The clean-up of the Singapore River and Kallang Basin was completed in 1987. The effort took 10 years and cost the government S$300 million, excluding the compensation paid to resettled residents, farmers and others. In September 1987, keeping his promise, Prime Minister Lee awarded commemorative medals to 10 officers involved in the river clean-up. Each medal contained one troy ounce of gold.

The clean-up of the Singapore River in progress at North Boat Quay, 1980. (Ronni Pinsler Collection, courtesy of National Archives of Singapore)

Among the recipients were Lee Ek Tieng and Tan Gee Paw.

As former Prime Minister Lee recalled in his memoirs, the clean-up effort brought significant changes to Singapore:

> **Clean rivers made possible a different quality of life. The value and use of land rose significantly, especially in the city and at sites abutting rivers and canals. We bought sand from Indonesia to lay a beach along the banks of the Kallang Basin where people sunbathe and water-ski today. Waterside high-rise condominiums have taken over from unsightly small shipyards. For those who remember the Singapore River when it was a sewer, it is a dream to walk along its banks. Shophouses and warehouses have been restored and turned into cafes, restaurants, shops and hotels, and people wine and dine al fresco by the river or on traditional Chinese barges parked alongside.**

The Singapore River clean-up also made possible the creation of a new urban reservoir at Marina Bay at the southern tip of Singapore, into which the river drained. It was former Prime Minister Lee's idea to construct a barrage at Marina Bay to create a large body of water that would not only serve as a freshwater reservoir but also control water levels to prevent flooding.

Efforts to construct Marina Barrage commenced in 2005. On its completion in 2010, the barrage created Marina Reservoir, Singapore's fifteenth freshwater reservoir. It was situated in Singapore's largest urban catchment area, at a size of 100 km^2 or about one-seventh of Singapore's total land area, and would supply about 10% of the country's water needs.

DEVELOPING A COMPREHENSIVE SEWERAGE NETWORK

In 1971, only 57% of the population was served by the main public sewerage network. The rest relied on other forms of household waste disposal, including "night soil collection", an unsanitary process in which workers collected household waste door-to-door.

Tan vividly recalled the state of waste collection at the time. The system left behind by the British colonial authorities was grossly inadequate. The network of sewers, pumping stations and treatment plants that were installed mainly served the relatively wealthier parts of the country.

In other areas, night soil collectors would place their buckets at central locations. Each day, residents would fill these baskets with their excrement and other forms of household waste. The collectors would replace the filled buckets with empty ones, loading the waste onto a truck that would carry it to a central processing plant.

It was only in the 1980s, after the government had built an island-wide public sewerage system, that night soil collection was phased out. For Tan, the night soil collectors did humble work that was shunned, but that contributed greatly to keeping the environment clean before there was a proper sanitation system in place. They, too, were the builders of modern Singapore.

On the final day of operations at a collection site, Tan witnessed the last bucket of waste being loaded onto a truck. It was dirty and difficult labour, but many workers had been unwilling to leave their jobs. The workers were given their retrenchment payment from the government, and Tan shook their hands in appreciation of their hard work. "Even today, when I recall that scene," said Tan, "I still feel their tight grasps and see the reluctance in their eyes. I couldn't say a single word".

The PWD first established a master plan for sewage treatment in the late 1960s. This plan helped guide the implementation of sewage control and treatment measures as Singapore's population and economy grew rapidly in the years that followed. The plan called for an expansion of the sewerage network, including infrastructure to collect and treat sewage. Among other features of the plan was its approach to divide the country into six used water catchment zones, each of which would be served by a water reclamation plant.

In 1972, the ENV established a Drainage Department to manage storm water and prevent floods. The department worked closely with agencies like the URA and HDB to develop plans for the expansion of the water drainage network, and establish drainage requirements for different types of developments across the island. Specific drainage plans were developed for many areas in Singapore, including low-lying regions such as Opera Estate near Bedok.

In the 1970s and 1980s, the government spent a total of S$1.8 billion to develop the sewerage network and waste water treatment infrastructure. By 1991, Singapore had a comprehensive drainage and water treatment network that covered almost 98% of the island. These efforts made it possible for Singapore to consider using water reclamation technology to create an additional source of potable water for the country.

DEVELOPING WATER RECLAMATION CAPABILITIES

The PUB first experimented with water reclamation in 1974. That year, the PUB and ENV jointly established the country's first water reclamation plant at the Jurong Industrial Waterworks. Unfortunately, the plan stalled after a trial period due to lack of funding and uncertainty about the reliability of the technology used to treat the water.

At the time, the technology used for water reclamation was still very new and expensive to adopt in large scale projects. The reclamation process, known as reverse osmosis, involved the use of a membrane to separate water from impurities under a high-pressure system. In the 1960s, the main user of this technology was the United States' National Aeronautics and Space Administration (NASA), which employed reverse osmosis to treat waste water during space missions.

By the 1990s, advances in technology made it possible for manufacturers to produce the membranes used in reverse osmosis at much lower cost. The price of these membranes fell by about half, enabling the technology to be more cheaply used in large-scale water reclamation projects. Although the PUB and ENV had closed the water reclamation plant at Jurong some years earlier, the PUB was abreast of these technological advancements and changes.

By the end of the 1990s, the PUB was ready to revive its earlier abandoned plans.

In 1998, the PUB sent two engineers on a two-week trip to the United States to study water recycling technologies and infrastructure. The engineers visited various cities in Southern California and Florida, developing a greater

A night soil collector at Clarke Quay, 1981. Night soil collectors provided an essential service in areas which lacked proper sanitation and drainage. (Ronni Pinsler Collection, courtesy of National Archives of Singapore)

understanding about the use of membrane technology and reverse osmosis.

On their return, the engineers reported that the technology could be adopted in Singapore and recommended the establishment of water reclamation facilities. Lee Ek Tieng and Tan approved the construction of a demonstration water reclamation plant at Bedok to determine the feasibility of using reclaimed water as an additional supply source for Singapore. The facility started operating in May 2000. The government formed a steering committee to oversee this project, and appointed Tan as its chairman.

According to Tan, the PUB conducted more than 20,000 tests over two years to assess and determine the quality of the reclaimed water. The committee also sought to ensure that the quality of reclaimed water would conform to the World Health Organization's (WHO) guidelines on drinking water, and pose no health risks to those who consume it. In addition, the committee convened an independent panel of experts comprising local and foreign individuals to test and verify the reclaimed water's purity.

Tan described the quality of the reclaimed water: "I went to the pilot water reclamation plant at Bedok where they stored the reclaimed water in a concrete-lined well that was about two storeys deep. I looked down into that well and I had never seen water so crystal clear. I could see right down to the bottom of the well. It is an experience I will never forget."

For Tan, water reclamation was another important innovation in enhancing Singapore's water security: "a solution to our water woes".

Tan invited a number of cabinet ministers to visit the plant and view the facility. The ministers were satisfied with the PUB's work and endorsed the creation of more water reclamation plants.

PROMOTING THE CONSUMPTION OF RECLAIMED WATER

The government was concerned that the public would be hesitant about consuming reclaimed water. It was, after all, waste water that had been treated and purified. Such public reluctance was common even in the United States, where water reclamation had already been in use for several years.

To tackle the psychological barrier of consuming reclaimed water, the steering committee decided to name it "NEWater." This name would minimise the impression of it as "used" water, and encourage people to view it as a fresh and clean product. The steering committee also organised visits to the Bedok NEWater plant for Members of Parliament (MPs), grassroots leaders and other members of the public. The NEWater discharge chamber was intentionally painted a pristine white to reflect the purity of the water. The sight of pristine blue-hued water swirling against the white backdrop of the chamber made for a strong visual selling point, and effectively conveyed the message that NEWater was clean enough to drink.

To promote greater public acceptance, the PUB bottled NEWater for public sampling and consumption at large-scale events such as the National Day Parade. At the 2002 parade, 60,000 spectators joined then Prime Minister Goh Chok Tong in a NEWater toast to Singapore. This moment was captured on television and marked a turning point in the public's acceptance of NEWater.

The Singapore River today. Conserved buildings at Boat Quay, now housing restaurants, cafés and bars, can be seen on the right. (Jason Goh)

One of the factors in the success of NEWater was the extensive promotional campaign launched by the government. Today, NEWater is used and consumed widely by Singaporean households and industries.

WATER FROM THE SEA

By the end of the century, Singapore had managed to diversify its water sources and enhance its water security. It did this through efforts such as expanding and developing water catchment areas, and adopting water reclamation. The PUB vividly termed these sources of water Singapore's "national taps".

In the mid-1990s, the government embarked on another effort to augment its water security. This effort entailed the treatment of seawater through desalination. This was a feasible option for Singapore, since it is surrounded by the sea and also because salty water flowed in the country's rivers and estuaries.

In 1995, a team of officers from the PUB, URA, MTI and the National Science and Technology Board (NSTB) visited Saudi Arabia, the United Arab Emirates and Malta to study the use of desalination technology there. These countries, all located in arid regions, were forerunners in the use of desalination to meet their water needs. The study trip provided useful information and knowledge to the officers in their plans to establish desalination facilities in Singapore.

The PUB developed and adopted membrane-based desalination technologies to treat and process saline water. This effort

was greatly informed and aided by the PUB's earlier research and development that led to the creation of NEWater. In 2003, the PUB established a partnership with the company SingSpring to develop Singapore's first desalination plant, creating another source of water for the country.

SINGAPORE'S "WATER LOOP"

Tan and his team had worked hard to boost Singapore's water supply. The creation of "national taps"—water catchments, NEWater, desalinated water—that drew water from domestic sources established a "water loop" that formed the basis of a more secure water supply system for the country.

EFFECTIVE WATER MANAGEMENT

Apart from the creation of the national taps, the government maintains pricing and public education strategies to reinforce the country's water security.

In many countries, water is treated as a public good and prices are highly subsidised. This is not the case in Singapore, where water is priced not only to cover the full cost of its supply and production, but also the higher cost of producing it through innovative methods such as desalination and reclamation. The PUB prices water using the marginal cost of production concept, meaning the increase in total cost arising from producing an additional unit of water. This has enabled Singapore to supply water on the basis of full cost-recovery.

Apart from this pricing strategy, the government also discourages wastage and overconsumption of water through tools such as tariffs and the installation of water conservation devices in residential, industrial and other developments.

The government has also introduced several campaigns to raise awareness about water conservation. These public education programmes encourage people to appreciate the scarcity of water in Singapore and practise water-saving habits in their daily lives. Over the years, generations of Singaporeans have internalised these messages.

In recent years, the PUB has sought to foster in Singaporeans a deeper sense of aesthetic appreciation for the country's waterbodies. One of the most prominent expressions of this is the Active, Beautiful and Clean (ABC) Waters programme. Through this programme, the PUB has converted utilitarian-looking drains, canals and reservoirs into beautifully landscaped streams, rivers and lakes. Many of these sites were formerly protected areas that had been opened for public access as waterside parks. Describing one of the main purposes of this programme, Tan said that if Singaporeans came to see that the country's drains, canals and water catchments could also make the environment more pleasant, they would be more likely to keep them clean.

REFLECTIONS ON SINGAPORE'S WATER JOURNEY

During his term as PUB Chairman, Tan oversaw the PUB's 2001 separation from the MTI and its merger with ENV's Sewerage and Drainage Department. The change saw PUB relinquishing its regulatory authority over the electricity and piped gas sectors, to focus on the management and governance

Visitors at Marina Bay sitting on steps extending into the waters of Marina Reservoir. (Eugenia Clara)

of water. In this role, the PUB would regulate the provision, operation and maintenance of Singapore's water supplies; and the treatment and discharge of industrial wastewater.

Tan said that many PUB officers viewed their work with a sense of mission, because they perceived water to be the most critical resource that any country could have. Fortunately, Singapore's leaders also shared this view. Even as they pursued high-growth economic development, they prioritised protecting Singapore's water resources.

Tan believed that the significant improvements to water security, particularly the milestone developments of NEWater and desalination technology, would not have been possible without the economic advancements experienced by Singapore in the 1970s and 1980s. Tan recalled that plans for water reclamation and desalination had been included in the 1972 Water Master Plan, but were put on hold due to factors such as the high cost of development then. With improved economic conditions in the 1990s, the government immediately worked on realising these plans.

Without question, these innovations have enabled Singapore to overcome many of its earlier water vulnerabilities.

A view of Jurong Lake Gardens, a 90-hectare park that opened in April 2019. It is located in the suburban "heartland" of Singapore's western region. (Clement Chai)

11 The Garden City

Efforts to enhance green cover and landscaping across the country mitigated the negative impact of development and urbanisation as Singapore's economy grew rapidly in the years following independence. These efforts have yielded a lush, green environment, giving Singaporeans parks, reserves and other nature areas.

Mr Wong Yew Kwan was Singapore's first Commissioner of Parks and Recreation.

In 1970, Wong joined the Primary Production Department (PPD) as a researcher, and was subsequently transferred to the Public Works Department (PWD) to head the Parks and Recreation Division. He was appointed Commissioner of Parks and Recreation following the establishment of the division as a department under the Ministry of National Development (MND). He held this position from 1974 to 1983.

Dr Chua Sian Eng succeeded Wong as Commissioner of Parks and Recreation in 1983, serving in that role until 1995.

Chua began his career as a researcher at the Rubber Research Institute of Malaya in 1963. In 1970, he moved to Singapore to lead the agriculture division of the PPD, where he was appointed Deputy Director in 1978. Chua thereafter joined the Parks and Recreation Department, helping oversee many of the country's greening and landscaping policies.

THE VISION OF A GARDEN CITY

Founding Prime Minister Lee Kuan Yew's vision of Singapore as a Garden City was conceived in the early years of Singapore's independence.

At the time, Lee was concerned about Singapore's international image, in part because he wanted to attract foreign investments to help drive economic growth. He decided that Singapore would be a modern, orderly and attractive city; and lush greenery would be a key element of the country's appeal.

However, Lee's concerns extended beyond attracting foreign investors. He wanted to develop a people-centric, harmonious society, and saw greenery as something that all citizens could equally enjoy.

In his 1998 memoirs, Lee wrote:

> **After independence, I searched for some dramatic way to distinguish ourselves from the other Third World countries. I settled for a clean and green Singapore. One arm of my strategy was to make Singapore into an oasis in Southeast Asia, for if we had First World standards, then businessmen and tourists would make us a base for their business and tours of the region.**
>
> **Greening raised the morale of people and gave them pride in their surroundings. We did not differentiate between middle-class and working-class areas. The British had superior white enclaves in Tanglin and around Government House that were neater, cleaner, greener than the 'native' areas. That would have been politically disastrous for an elected government.**
>
> **If we did not create a society which is clean throughout the island, we have two classes of people: the upper class, upper middle and even middle class with gracious surroundings; and the lower middle and working class, in poor conditions.**

Wong Yew Kwan, Singapore's first Commissioner of Parks and Recreation, recalled that in the early years, Lee approached greening policies not in visionary terms but in practical ones. He was anxious to grow more trees and to counteract the effects of rapid industrialisation and urban blight. His concern was that Singapore would otherwise become a concrete jungle, suffering irreparable damage to its natural environment.

Singapore's earliest greening measures, therefore, were counter-measures, with Lee instructing that all new roads, housing estates, schools, car parks and open spaces be lined with tall, wide-canopied trees.

LEE PLANTS A TREE

In a demonstration of his political will to green Singapore, Lee planted a *Mempat* tree at Farrer Circus on 16 June 1963. In the years that followed, the PWD carried out large scale greening and landscaping across Singapore. These efforts culminated in a 1967 speech by Lee that described his vision for Singapore to become a Garden City.

In 1971, he led a group of political leaders to launch a tree planting campaign across

Tree Planting Day event at Havelock Road, 1983. The national tree planting campaign, launched in 1971, was intended to encourage Singaporeans to play a part in greening the country. (Ministry of Information and the Arts Collection, courtesy of National Archives of Singapore)

Singapore. Dr Goh Keng Swee, then the Minister for Defence, planted a *Rain Tree* at the summit of Mount Faber and declared that the first Sunday of November each year would be Tree Planting Day.

The launch of a national tree planting campaign was a signal of the government's view that greening the country must be an effort in which each citizen plays a part. Following independence, the government's greening efforts had yielded lush landscaped parks and nature areas. Singaporeans must continue to play their part in ensuring the country remains a green oasis.

Beyond Tree Planting Day, the tree planting campaign introduced a variety of community events and programmes. For example, the government encouraged Singaporeans to plant trees and cultivate plants in their homes and neighbourhoods. The country's politicians led by example by planting trees to commemorate special events across the country.

Each year, citizens planted an estimated 30,000 trees on Tree Planting Day. By 1983—two decades after Lee planted the *Mempat* tree at Farrer Circus—there was one tree for every four people in Singapore.

ESTABLISHING THE GARDEN CITY ACTION COMMITTEE

The government established the Garden City Action Committee (GCAC) in 1970 to oversee the country's greening policies. Wong recalled that the GCAC coordinated greening efforts across multiple government agencies to ensure they were effectively and efficiently implemented.

The committee was chaired by the

Permanent Secretary of the MND, with committee members comprising officers from the MND, PWD, PPD and the Singapore Botanic Gardens. The committee met monthly to review progress reports, resolve delays and address other implementation problems, and discuss new proposals. It also wielded executive powers as a decision-making body, approving the implementation of many greening proposals.

The years that followed saw the restructuring of many agencies. For one, in 1973, the Parks and Recreation Division of the PWD was reconstituted as a stand-alone Parks and Recreation Department (PRD) reporting directly to the MND, with Wong assuming the newly created role of Commissioner of Parks and Recreation. None of these changes affected the work of the GCAC or the Garden City project. On the contrary, they gave the project greater momentum.

Lee extended his personal support to the GCAC. Wong recalled a 1978 meeting at which Lee himself was present. In a discussion on plans to landscape Singapore's Changi Airport and the areas around it, committee members had encountered some resistance from the Permanent Secretary of the Ministry of Finance (MOF), who had questioned the large sums of money requested to implement these plans.

Lee had turned to the permanent secretary and insisted that MOF allocate the requested funds to the committee. To him, the expenses were necessary; if it took a single dollar to plant one tree, an additional S$0.20 was to be spent on its maintenance. Lee's interjection made it clear to all present that sufficient financial resources must be set aside for the greening effort.

Overhead bridge in Telok Blangah, 1990. Mr Wong Yew Kwan, Singapore's first Commissioner of Parks, proposed the installation of troughs along overhead bridges to house flowering shrubs like *Bougainvillea*. (Ministry of Information and the Arts Collection, courtesy of National Archives of Singapore)

To Wong, this marked a turning point for the work of the GCAC and PRD. Prior to this, the PRD had faced challenges securing funds for its work, because the MOF was more concerned with channelling government funds towards building the economy and, in particular, developing public housing. Wong recalled an MOF officer once telling him that there was no need for him to submit detailed budget proposals to the ministry for greening projects, since they would all be rejected anyway.

Lee's intervention was a key factor that enabled the PRD to complete ambitious projects such as East Coast Park and West Coast Park, and the landscaping of Changi Airport.

SOFTENING THE URBAN LANDSCAPE

Lee paid careful attention to details of the PRD's greening plans. He instructed that as far as possible, greenery should cover the concrete surfaces of all forms of urban infrastructure: walls, fences, road barriers, highways and even street lamps.

One of the PRD's earliest greening initiatives was to plant trees and shrubs along public roads, traffic islands, car parks and open spaces. In many cases, the PRD chose fragrant plants such as the *Angsana* tree that provided shelter from the sun and rain, and emitted a light, pleasing scent at night.

The PRD's plans demonstrated a high level of innovation and sensitivity. For example, wide-canopied trees were planted between vehicle lots in open car parks to prevent vehicles from over-heating under the sun. Buttress roots were anchored by specially designed concrete aeration slabs that allowed air and water to reach the soil, and the slabs had holes in them that allowed for grass to grow through.

Lee was also concerned about spaces beneath the many flyovers planned for construction during the 1960s and 1970s to accommodate Singapore's growing population of motor vehicles. These flyovers were utilitarian, monolithic structures, stretching over extensive void areas that would be poorly lit and visually unattractive. He had asked the PRD to landscape these areas.

However, with limited exposure to natural light and moisture, plants would not grow well there. Wong suggested installing artificial light sources, but Lee rejected this as a waste of energy. Wong ultimately devised a solution where the flyovers were to be designed as two carriageways separated by a gap that would allow light and rain to reach the void areas. This would provide a conducive environment for plant life, and enable the void areas to be landscaped. His suggestion was endorsed by Lee, and implemented with the cooperation of the land transport authorities.

Wong also successfully proposed the idea of installing landscaped troughs along overhead pedestrian bridges to house flowering shrubs such as *Bougainvillea*. With adequate moisture and unhindered access to sunlight, these shrubs flourished year-round.

SCOURING THE NATURAL WORLD

Bougainvillea, like many of the plant species in Singapore today, was not indigenous but imported and cultivated here by the PRD. The government had dispatched teams of PRD officers on missions to countries across tropical and subtropical zones to study and collect new plant types.

In 1983 alone, PRD officers imported some 150 species of tree saplings and flowering shrubs from South America. Lee urged "great variety and more colour" in the greening efforts, and encouraged the PRD to "import more trees, palms, creepers from all over the equatorial and tropical regions to try out which will take under Singapore's soil and climatic conditions".

This was no easy task. Dr Chua Sian Eng, who succeeded Wong as parks commissioner in 1983, recalled that imported plants had to be sent to the Botanic Gardens or the PRD's Pasir Panjang nurseries for periods of experimental gestation, with only the most successful varieties selected for widespread planting. It could take up to five years to establish the suitability and adaptability of each plant to Singapore's soil and climate. For tall trees, the assessment period could stretch to a decade.

The government's efforts to inject diversity into Singapore's natural landscape through importing non-native plant species were very successful. The vast majority of trees, shrubs and other plants grown in Singapore today are imported, including familiar and much-loved species such as *Flame of the Forest*, *Rose of India* and *Oleander*.

INTEGRATING GREENERY IN THE BUILT ENVIRONMENT

The government's greening efforts were not limited to the development of parks and nature areas, or the landscaping of transport infrastructure. There were also many measures to incorporate greenery in the built environment.

A good example of this is the landscaping of public housing estates, an effort to provide green spaces around densely populated, high-rise residential areas. The Housing and Development Board (HDB) established a department to oversee and implement these greening efforts, which the PRD supported with technical expertise and guidance.

The HDB introduced policies to ensure that at least a third of the land in new housing estates was allocated for parks and greenery, with guidelines on how and where they were to be located. The HDB's policies aimed at softening the harsh quality of building facades and beautifying each neighbourhood.

In the private housing sector, the government introduced urban design guidelines requiring developers to provide landscaping along the perimeter of new high-rise buildings, and green areas within their projects. It also imposed strict landscaping requirements on the developers of industrial parks, intended to soften the polluting effect of activities such as manufacturing and processing.

GREENERY AS AN INTEGRAL PART OF LAND-USE

Singapore's leaders understood the importance of urban planning in facilitating the development of the economy and providing a liveable, high quality environment to its people. The Concept Plan of 1971, developed by a project team comprising officers from the MND and other agencies with the assistance of experts from the United Nations (UN), is perhaps the best expression of this.

As the Garden City project progressed in the first two decades of Singapore's independence, the government saw the need to more closely integrate greening measures with broader

urban planning initiatives. An example of efforts in this regard is the 1985 Central Area Structure Plan, a blueprint released by the Urban Redevelopment Authority (URA) to guide the development of the city centre and the districts immediately surrounding it. This plan included proposals to develop open green spaces within the Central Business District (CBD) and elsewhere.

The government also set aside land parcels for nature reserves in their plans for the development of new towns and other forms of urban infrastructure. In 1990, it issued the Master Plan for the Conservation of Nature in Singapore to protect many of these sites, including in and around satellite towns, as nature reserves.

The second iteration of the Concept Plan, issued in 1991, introduced a Green and Blue Plan that incorporated many Garden City initiatives. In fact, one of the key features of the 1991 Concept Plan was to realise a country "nestled in a lush mantle of tropical greenery, evoking the imagery of a city growing out of a garden".

In 1992, the government issued the Singapore Green Plan (SGP), indicating that 5% of the country's land mass would be safeguarded as nature reserve sites, up from 3% previously. Today, Singapore has nature reserves at Bukit Timah, Sungei Buloh, Labrador Park and the Central Catchment Area, collectively measuring more than 30 km^2 in size.

The SGP also introduced a planned network of landscaped corridors to connect various parks, nature reserves and other open spaces, creating a ring of greenery around the island. The plan featured secondary connections between the network and residential areas, giving people direct and easy access to greenery. This plan provided the blueprint for the development of the Park Connector Network (PCN).

Singapore's third Concept Plan was published in 2001, and translated in finer detail as the Master Plan of 2003. The Master Plan introduced a supplementary plan, the Parks and Waterbodies Plan, which would guide the development of Singapore's nature areas up to 2018. This plan provided for the creation of more than 12 km^2 of natural scenic spots, marina areas, park connectors and other nature areas, including a PCN spanning more than 160 km in length.

FOSTERING THE GROWTH OF THE BOTANIC GARDENS

The Singapore Botanic Gardens was first established in 1859 by an agri-horticultural society and had, by the 1960s, established itself as an important regional centre of research in the fields of botany and horticulture. In the post-independence years, the government capitalised on the Botanic Gardens' rich institutional expertise to further the aims of the Garden City project, such as by establishing an academy there to conduct research and training on tropical horticulture.

In 1973, the government merged the Gardens with the Parks and Trees Branch of the PWD, giving the institution a direct role in the implementation of Garden City initiatives. For Wong and Chua, the Botanic Gardens filled a critical gap in horticultural and botanical knowledge and expertise, especially in the early years of the Garden City project. The resources provided by the Botanic Gardens' researchers and experts expedited the implementation of

A view of Pasir Ris Park in the rain, 2009. The tranquil 70-hectare park, one of Singapore's largest, opened in 1989. (Lee Leng Kiong Collection, courtesy of National Archives of Singapore)

Lush landscaping lining the roads leading to Changi Airport, 1990. (Singapore Tourist Promotion Board Collection, courtesy of National Archives of Singapore)

Singapore's ambitious greening initiatives, most notably because there was an acute lack of qualified local professionals at the time.

ADDRESSING THE GAP IN PROFESSIONAL CAPABILITIES

As Commissioner of Parks and Recreation, Wong prioritised the development of professional capabilities not only within the PRD but across Singapore's horticultural and landscaping sector. He correctly saw that Singapore required a corps of professionals in both the public and private sectors to implement the Garden City project in an efficient and productive way.

The government shared Wong's view. Starting in the early 1970s, it awarded scholarships to talented individuals to pursue disciplines such as landscape design in countries like Germany. On their return to Singapore, these graduates took up key roles in the PRD.

By the 1980s, there were several hundred horticulturists and landscape designers working in the department, supported in their duties by a sizeable group of gardeners and maintenance workers. The PRD and, in later years, its successor organisation the National Parks Board (NParks), was to benefit from many of Wong's pioneering policies to raise professional standards in the private sector. Levels of professional expertise in the sector rose so quickly that the government was able to outsource some of its gardening, landscaping and park management work to private firms by the 1980s.

A BEAUTIFUL SINGAPORE WELCOME

Wong described two greening projects as important milestones in the Garden City endeavour: Changi Airport and the East Coast Parkway (ECP), the expressway linking the airport to the city.

These were particularly important projects to Lee, who intended to give all visitors to Singapore a beautiful first impression of the Garden City. During a visit to the Changi Airport construction site, he told a PWD officer, "Work hard to make this place green!"

Wong recounted that it was especially challenging to cultivate trees and plants around the airport and along the ECP because both developments had been built on land reclaimed from the sea. The land had a complex soil profile, composed of different sand and stone textures. Wong, who had studied coastal sand early in his career as a researcher in Malaysia, relied on much of this technical knowledge to select appropriate trees and plants for the area.

The PRD had to fulfil Lee's brief to create a lush, forest-like atmosphere. It also had to consider arboreal varieties that could reduce the amount of airborne dust particles generated by aeroplanes and motor traffic. The PRD decided to plant tall, wide-canopied *Rain Trees* along the ECP carriageways. In other areas around the airport, the PRD picked varieties such as *Casuarina* and *Indian Almond* that could grow well in saline soil. Wong recalled that getting the trees to flourish was no easy task: they had to be rooted in layers of sticky and sandy earth, overlaid with a porous stratum of topsoil. Moreover, it took time for the trees to reach full height; to expedite the process, the PRD adopted innovative cultivation methods such as the injection of growth hormones.

By the time Changi Airport officially opened in late 1981, the PRD had planted more than 6,000 trees in the area. It had also planted shrubs and other flowering trees along the ECP to add visual depth and colour, as well as in other spaces and structures such as the airport's control tower. On Lee's instruction, even the concrete crash barriers along the expressway were cloaked in greenery.

Two thousand trees lined an 8 km stretch of the ECP leading to and from the airport. Inside, the PRD's landscape designers installed green features and indoor gardens, mirroring the lush environment beyond its walls. It was precisely as Lee had intended: every visitor's trip to Singapore would be book-ended by vivid images of verdant greenery.

FROM GARDEN CITY TO CITY IN A GARDEN

By the early 1990s, it was evident that Lee's vision of a Garden City, an "oasis in Southeast Asia", had come to fruition. Singapore had become a country of parks, nature reserves and open spaces; its city centre, housing estates and other urban infrastructure featured well-designed landscaping, and its people enjoyed a high quality, clean environment. At this time, Singapore's greening policies underwent a number of important shifts.

For one, the government increasingly promoted the natural environment as a source of leisure and enjoyment, seeking to reposition and activate Singapore's parks and green spaces as vibrant lifestyle destinations.

There was the opening of even more public parks featuring playgrounds, community gardens, barbeque pits and other recreational facilities. Also, NParks introduced programmes and events to draw more visitors to its parks. For example, Fort Canning Park hosted an annual series of outdoor performances called "Ballet Under the Stars"; and the Botanic Gardens opened the National Orchid Garden in 1995 to showcase more than 60,000 orchid plants.

Another defining feature of Singapore's greening policies during this period was a focus on encouraging the public to participate in greening and nature conservation. The intention was to give Singaporeans a deeper understanding and appreciation of nature, and to instil a sense of ownership and stewardship over the natural environment. A good example of this is NParks' Adopt-a-Park programme, launched in 1996 to allow institutions such as schools, residents' committees and other groups to partake in the maintenance of Singapore's public parks.

These changes set the stage for the government's 2004 announcement of a new vision to guide Singapore's greening policies in the years to come. The Garden City would thenceforth aspire towards becoming a City in a Garden. The government's greening policies would focus on developing even more world-class parks, gardens and nature areas; creating a vibrant and sustainable living environment, and building a sense of rootedness and cohesion in the community.

THE CITY IN A GARDEN TAKES SHAPE

The years that followed saw the implementation of several innovative and imaginative greening projects; and improved public accessibility and proximity to nature spots. Prime examples of these are the extension of the Park Connector Network and development of Gardens by the Bay.

The PCN has its roots in the PRD's development of scattered walking, running and cycling paths in and around many of Singapore's parks during the 1970s. It was only in 1991 that the government introduced formal plans to connect these paths into a comprehensive green perimeter around the island.

Over the years, the PCN has been further developed and extended, including through a series of innovative planning and landscaping measures. These included the amalgamation and greening of adjacent empty plots of state land, and the integration of existing landscaped areas flanking many parts of the network. Several sections of the PCN were also re-designed as rustic paths and waterside avenues through careful landscape design interventions, giving visual and sensorial variety to the overall user experience.

Gardens by the Bay, a 101-hectare urban park and visitor attraction located in Marina Bay, grew out of an idea that Singapore should have an extensive green space in the heart of the city. The precursor to the Gardens was Marina South, a large green space that was created on land that had been reclaimed at the mouth of the Singapore River, just south of the CBD.

Chua recalled that plans to transform Marina South into Gardens by the Bay, first announced in 2005, attracted criticism from many quarters. Questions were raised about the wisdom of developing a park on prime land, as well as the large sums of money required for the project. However, the early detractors were ultimately persuaded by the government's clear vision for the Gardens to be a park for the people, one that would be collectively owned by all Singaporeans. It would be a place that all citizens could take pride in and freely enjoy regardless of their economic status.

Gardens by the Bay officially opened in 2012. Today, it is one of the world's top tropical gardens, featuring a unique site layout and features such

An aerial view of Gardens by the Bay, which opened in 2012. The 101-hectare urban park grew out of an idea that Singapore should have an extensive green space in the heart of the city. (Sreehari Devadas)

as two climate-controlled greenhouses and a grove of "Super Tree" structures. The gardens are a stunning showcase of architectural and horticultural creativity, and come into full view as one traverses the ECP en route the city centre.

SECRETS OF THE CITY'S CHIEF GARDENERS

More than half a century has passed since Singapore planted the seeds of the Garden City project. From the recollections of Wong and Chua, one discerns that this journey has been marked with both success and hardship.

At the end of CLC's interviews with both men, they were each asked the same question. What, in their view, were the secrets to the success of the Garden City project? Both emphasised the same qualities: will power, foresight, reason and cooperation.

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