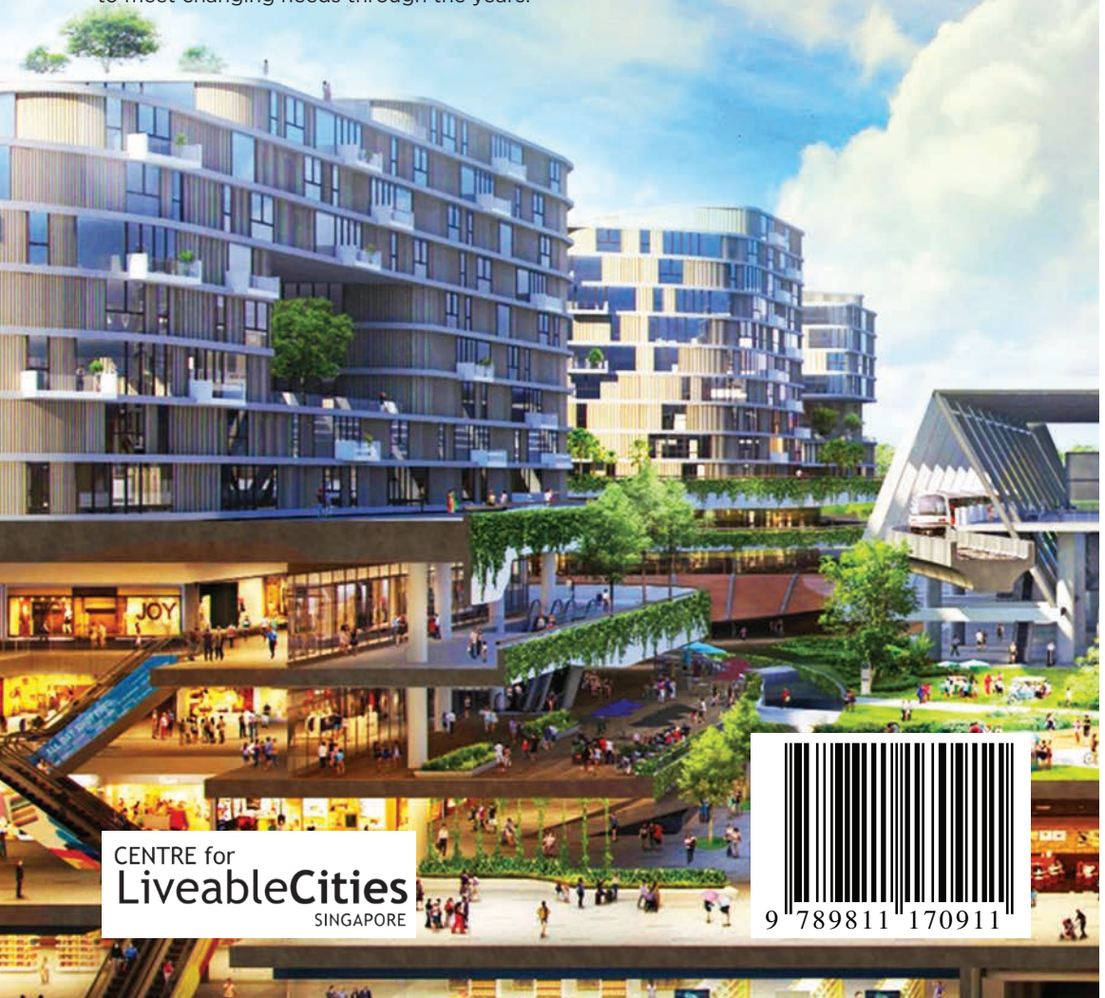
INTEGRATING LAND USE & MOBILITY: SUPPORTING SUSTAINABLE GROWTH

In Singapore, a small and densely built-up city state, an integrated approach to transport and land use planning is essential to creating a highly liveable and sustainable environment. This Urban Systems Study traces more than five decades of integration between the planning and development of transport and land use, to minimise congestion and inefficient use of land. Singapore's visionary, long-term planning enables the development of housing estates and commercial centres outside of the Central Area, closely served by a robust transport network of roads and a rail-based mass rapid transit (MRT) system. At the local level, comprehensive urban design guidelines ensure close integration between transport nodes and their surrounding developments, enhancing accessibility and connectivity. This integrated framework for land use and transport development continues to evolve to meet changing needs through the years.



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URBAN SYSTEMS STUDIES

INTEGRATING LAND USE & MOBILITY: SUPPORTING SUSTAINABLE GROWTH

CENTRE for LiveableCities SINGAPORE

First Edition, Singapore, 2018

Editorial Team

Writers:	Clarice Chow, Manager, Centre for Liveable Cities
	Jean Chia, Senior Assistant Director, Centre for Liveable Cities
	Mina Zhan, Senior Assistant Director, Centre for Liveable Cities
Research Advisor:	Wong Kai Yeng, Expert, Centre for Liveable Cities
Editor:	Amit Prakash, Adjunct, Centre for Liveable Cities
Production Supervisor:	Eunice Rachel Low, Adjunct, Centre for Liveable Cities

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Set up in 2008 by the Ministry of National Development and the 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". The CLC's work spans four main areas—Research, Capability Development, Knowledge Platforms, and Advisory. Through these activities, the CLC hopes to provide urban leaders and practitioners with the knowledge and support needed to make our cities better. For more information, please visit www.clc.gov.sg.

Research Advisors for the CLC's Urban Systems Studies are experts who have generously provided their guidance and advice. However, they are not responsible for any remaining errors or omissions, which remain the responsibility of the author(s) and the CLC.

For product information, please contact
CLC Publications
+65 66459576
Centre for Liveable Cities
45 Maxwell Road #07-01
The URA Centre
Singapore 069118
MND_CLC_Enquiries@mnd.gov.sg

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Cover photo:
Conceptual image of Tengah, a car-lite forest town. Tengah will have the first "car-free" HDB town centre in Singapore, with roads, parking facilities and services plying below ground. The town centre will be nestled in a large "Central Park"—integrated with water bodies and a 100-m wide and 5-km long "Forest Corridor" that would be safe for walking, cycling and recreational activities.

Perspective courtesy of the Housing & Development Board.
Illustrations are artist's impressions only. Actual developments may differ.

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FOREWORD

At the start of its journey as an independent nation, Singapore was already familiar with the woes of urbanisation. Congestion was a critical issue in the 1960s, with vehicles crawling along narrow and winding roads in a crowded city centre. The government was quick to recognise that to develop in a liveable and sustainable manner, Singapore's biggest challenge would be to make the best possible use of scarce land for facilitating mobility. Singapore is today a densely populated and built-up city, equipped with a modern transport system comprising a growing number of commuter train lines and a comprehensive road network, which are aligned tightly with its most developed areas. This is the result of a long-term vision and decades of planning to integrate land use and mobility.

Singapore embarked upon long-term urban planning in 1967, with the commencement of the State and City Planning Project (SCP). Undertaken jointly by the government and the United Nations Development Programme, the SCP led to the creation of Singapore's first Concept Plan in 1971 to guide the city's physical development. The SCP recognised that along with large-scale land development for housing and industries, it was equally important to build a comprehensive transport system to serve these newly developed areas. It proposed a network of expressways, but warned that excessive reliance on private cars would be the bane of a land-scarce city as road-building alone would not be sufficient to meet growing demand. Therefore, it also recommended building a rail-based Mass Rapid Transit system (MRT) as a reliable and comfortable form of public transport.

However, given the heavy financial burden of the MRT, it took 10 years of feasibility studies before the government gave the go ahead for construction in 1982. Strict safeguarding and acquisition of land in the interim helped to ensure that construction proceeded smoothly from the point of approval, and Singapore's first MRT lines opened in 1987.

Meanwhile, self-contained satellite townships were already being built to decongest the city centre and create employment opportunities closer to home. Toa Payoh, the first of such townships, was equipped with light industries along with town and neighbourhood centres that provided shopping and entertainment options—all within walking distances of homes. Such decentralisation strategies also prevented the overloading of planned transport systems, underscoring the importance of integrating land use and mobility.

The Constellation Concept developed in the 1990s led to the creation of suburban commercial centres—zones of employment and activity to complement the Central Area. At the same time, the Central Area itself was reshaped to become highly walkable and so well-connected by public transport that there would be less reason to drive. Today, air-conditioned passageways and outdoor walkways allow commuters to move seamlessly around the Central Area. These are the results of specific urban design conditions that guided developers to make the area pedestrian-friendly.

More recently, Singapore's mobility ecosystem has expanded to include active modes of transport, such as cycling, which require dedicated infrastructure and place new demands on scarce land. This further increases the importance and complexity of integrating land use and mobility to meet the needs of a growing population in an increasingly dense urban environment.

Integrating Land Use & Mobility: Supporting Sustainable Growth captures Singapore's journey over the past five decades towards building a comprehensive transport network to serve a modern and vibrant global city. While there have been tremendous successes, significant challenges and some hard lessons, it remains critical to retain and build upon the fundamentals of good planning for achieving optimal outcomes. I hope that you will find Singapore's story both insightful and inspiring.

Loh Ngai Seng
Permanent Secretary
for the Ministry of Transport

PREFACE

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

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

The CLC would like to thank the Housing & Development Board, Land Transport Authority, Urban Redevelopment Authority and all those who have contributed their knowledge, expertise and time to make this publication possible. I wish you an enjoyable read.

Khoo Teng Chye
Executive Director
Centre for Liveable Cities

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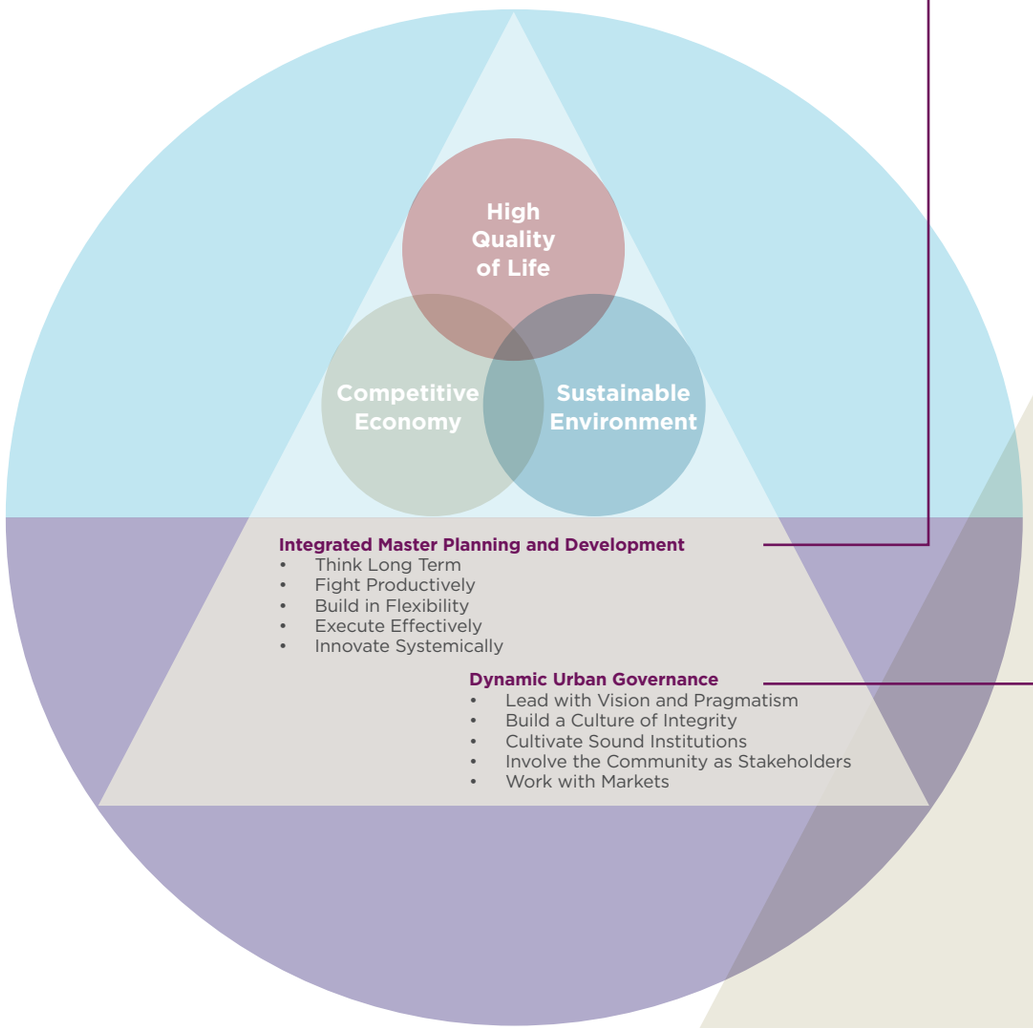
The Centre for Liveable Cities (CLC) is grateful to the following interviewees and partners for their contributions: Cheng Hsing Yao, Fong Chun Wah, Fun Siew Leng, Hengky Tay, Michael Koh, Dr Liu Thai Ker, Mohinder Singh and Wong Kai Yeng. The CLC is also grateful for the inputs and assistance provided by the Housing & Development Board, Land Transport Authority and Urban Redevelopment Authority in the publication of this study.

The researchers, Clarice Chow, Jean Chia and Mina Zhan, would like to thank their CLC colleagues for their inputs and support in the publication. In particular, they would like to extend special thanks to research advisor Wong Kai Yeng for his knowledge sharing and guidance.

THE SINGAPORE LIVEABILITY FRAMEWORK

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

The general principles under **Integrated Master Planning and Development** and **Dynamic Urban Governance** are reflected in the themes found in *Integrating Land Use & Mobility: Supporting Sustainable Growth.*



Integrated Master Planning and Development

Think Long Term

Singapore, with its land scarcity and growing population, could not hope to rely solely on private transport and yet avoid urban congestion. The 1971 Concept Plan called for an efficient public transport system to meet travel needs, and proposed a rail-based Mass Rapid Transit system.

(See The MRT Solution to Road Congestion, p. 21)

Build in Flexibility

Development of rail infrastructure and surrounding buildings may not always be synchronised. However, the option to integrate future developments adjacent to train stations can be preserved through urban design guidelines and mechanisms such as knock-out panels. These are used to ensure proper linkages to enhance walkability, and encourage the use of public transport.

(See Going Underground in the Central Area, p. 32)

Execute Effectively

Due to the hefty costs, construction of the MRT system only commenced 10 years after it was proposed. During that period, strict safeguarding measures and land acquisition helped to ensure that construction could proceed without a hitch when the go-ahead was finally given.

(See Constructing the Compass Line, p. 28)

Dynamic Urban Governance

Cultivate Sound Institutions

The Land Transport Authority (LTA) was formed in 1995 to consolidate land transport responsibilities that were previously fragmented among multiple government agencies. The LTA works closely with the Urban Redevelopment Authority and Housing & Development Board to ensure proper integration of transport infrastructure in land use plans.

(See Setting up the Land Transport Authority, p. 50)

Work with Markets

Developers and building owners in the Central Area were incentivised to contribute to the construction of underground pedestrian links. These would connect to the extensive Underground Pedestrian Network to help create a pedestrian-friendly Central Area.

(See An Engaging Walking Experience, p. 74)

OVERVIEW

In the 1960s, urban congestion was a common problem as land-scarce Singapore began charting its course as an independent nation. Reliance on private vehicles as the main mode of transportation would have been unsustainable, hence there was a need to provide viable alternatives.

Integrated planning for land use and mobility was considered essential for maximising the utility and value of spaces surrounding transport nodes. This was achieved by aligning key transport networks with high-density developmental corridors comprising housing townships and commercial centres. Integration of facilities was also emphasised at the local level. Such transport nodes have today become vibrant places that typically constitute Mass Rapid Transport (MRT) stations and bus interchanges connected to surrounding developments. By encouraging the use of the public transport system over driving, they provide Singaporeans convenient ways to travel and meet their everyday needs.

By 2030, 80% of Singaporean households will be within a 10-minute walk from the nearest train station and a ride away from a growing number of destinations island-wide. Buses will also be available to ferry them to the nearest MRT station, or all the way into the city along strategically aligned expressways. Seamless transfers between transport modes would be possible via air-conditioned walkways, with the option of visiting some retail facilities conveniently located along the way. Beyond motorised options, infrastructure will be in place to complement the growing public interest in cycling to cover the last mile.

This study examines the development of land use and transport planning in Singapore. It covers the principles and strategies that have enabled a high level of integration, and the systemic manner in which successes were built upon and hard lessons learned. Case studies of selected integrated developments are used to illustrate the importance of good land use planning and sustainable transportation strategies, backed by effective regulatory and financing frameworks.

CHAPTER 1

EARLY INTEGRATION: SELF-SUFFICIENT RESIDENTIAL TOWNS

A fundamental principle of integrated land use and transport planning is to reduce the need for people to travel long distances on a regular basis. This was evident in the early stages of urban planning in Singapore. Even before the start of the State and City Planning Project (SCP), and the development of Singapore's Mass Rapid Transit (MRT) system, self-contained townships were being built to serve the majority of their residents' daily needs.

In 1964, development began on the first self-sufficient satellite township comprehensively planned by the Housing & Development Board (HDB) —Toa Payoh New Town. The main structure of Toa Payoh was put in place by 1972, and the town continues to be developed over the years. In preparation for a growing population, it was built to house up to 200,000 residents, twice as many as Queenstown which was built in the 1950s by the HDB's predecessor, the Singapore Improvement Trust. The new town was developed based on the "Neighbourhood Principle" to reduce the need for commuting, with a town centre surrounded by five neighbourhoods, each equipped with their own markets, shops and schools. Other necessary amenities such as clinics, post offices and theatres were also provided in the town.[1] This would be applied to all future townships as one of the HDB's comprehensive town planning principles, equipping them with a full range of facilities and creating a self-sufficient environment for their residents to "Live, Work, Play and Learn".

In Toa Payoh, the HDB successfully implemented the satellite town concept, which envisioned the island "dotted with self-contained, skyward-reaching complexes of homes and services" surrounding the city centre, a precursor to future decentralisation.[2] Land was set aside for employment-generating light industries, such as toy and electronics assembly lines. Dr Liu Thai Ker, who headed the HDB's Design and Research Section from 1969 to 1975, and later became its Chief Executive Officer, highlighted that commercial centres—which acted as employment, retail and transport hubs—accounted for the bulk of journeys made:

> *Traffic planning cannot [be done] without land use. In fact, I want to highlight that the basic purpose for traffic is to move people from home…to commercial centres. Of course people will say, "What about schools and factories and so on?" The volume is small. If you solve the movement from home to commercial centres, you solve the majority of traffic need[s].*
>
> Dr Liu Thai Ker[3]

However, transportation remained an issue, especially for residents needing to travel elsewhere for work. It was only in 1967 that public buses began operating in Toa Payoh, with the Singapore Traction Company plying three services towards the Central Business District (CBD).[4] Before that, residents who did not drive had been relying on illegal pirate taxis.[5]

Within the township, good walkability was prioritised to reduce the need for additional motorised transport. Dr Liu recalls that studies showed a sharp decline in people's willingness to walk beyond 400 m given Singapore's tropical climate. Dr Liu's team also studied the population density required to create demand levels that could support an acceptable variety of shops in neighbourhood centres. As a compromise, the HDB built neighbourhoods within an average radius of 500 m of a nucleus of shops. The town centre itself was designed to be pedestrian-friendly, with an unobstructed pedestrian-only mall and ample greenery to provide shelter from the sun.[6]

Toa Payoh Town Centre in the 1970s.
Photo from the Ministry of Information and the Arts Collection, courtesy of National Archives of Singapore.

Passengers disembarking at the Toa Payoh Bus Interchange.
Photo from the Ministry of Information and the Arts Collection, courtesy of National Archives of Singapore.

In 1971, an interchange capable of accommodating 300 buses was built to improve Toa Payoh's internal and external connectivity. It was situated in the town centre along with a pedestrianised shopping complex that was touted as the largest in Singapore at the time,[7] nurturing a bustling mixed-use environment. This model would subsequently be implemented in other townships, where town centres formed the hub of activity anchored around the bus interchange which, in future, would be integrated with MRT stations.

In 1973, the Singapore Bus Service (SBS) was formed through the merger of disparate bus operators that controlled services in different areas. The consolidation of the fragmented bus industry resulted in better coverage, efficiency and profitability.[8] HDB residents could now take feeder services from near home to the interchange, where they could hop onto trunk services connecting to other towns, or to the CBD. This also helped to lower operational costs by concentrating demand at a central point and reducing the overlapping of routes.[9] The HDB and the Public Works Department (PWD) also worked closely with the SBS to locate bus stops at ideal intervals and facilitated access by ensuring good connections to footpaths.[10] However, buses of the day were crowded, filthy and unreliable, with brand new and older buses equally liable to breakdown. People found themselves aspiring to travel in greater comfort by private car if they could afford to.[11]

The congestion that plagued Singapore throughout the 1960s went beyond residential towns and highlighted an urgent need for a better island-wide transportation system. Fortunately, planning for such a system had begun years before it was eventually implemented in the 1980s. For example, during the construction of Toa Payoh, land was already set aside for future MRT infrastructure that would eventually cut through the township.[12]

CHAPTER 2

A LONG-TERM VISION

THE FIRST CONCEPT PLAN

Upon gaining independence in 1965, Singapore entered a phase of rapid nation building focused on industrial development and housing a growing population in satellite towns. These developments would lead to more people living outside the Central Area and a corresponding increase in travel demand. However, the main mode of local transportation at the time was by car, and the existing road infrastructure was already congested.[13]

Recognising that Singapore needed a more sustainable solution for land use and transportation, the government approached the United Nations Development Programme (UNDP) for assistance in 1967. The UNDP awarded a $4 million grant for the State and City Planning Project (SCP), which culminated in Singapore's first Concept Plan to guide land usage. The Concept Plan has since become an integral part of the country's urban planning. It guides development over 40 to 50 years to ensure that "there is sufficient land to meet long-term population and economic growth needs, while providing a quality living environment for the people".[14] The plan is reviewed every 10 years, taking stock of changing trends in Singapore's economy, population and demographics. Based on these, land requirements are derived for major uses such as housing, industries and supporting infrastructure including transportation and community facilities.

Completed in 1971, the SCP was a joint undertaking with the UNDP and technical consultancy firm Crooks Michell Peacock Stewart, with the objective of developing a comprehensive plan for land use and transportation in Singapore.[15] The authors observed, "With a comprehensive development plan and the machinery and determination to put it into effect, a government can shape a city's future. In Singapore, the opportunities for such a plan are especially favourable."[16]

Many young engineers and planners, some of whom had been sent overseas for training as part of the UNDP's assistance for the SCP, were involved in the project so that they could ensure its effective implementation upon completion. One of them, Joseph Yee, who joined the SCP as a young urban planner in 1968, recounted that prior to the commencement of the project, transportation-related work mostly involved road-building by the Public Works Department (PWD) to relieve bottlenecks in the city and in the immediate suburbs.[17]

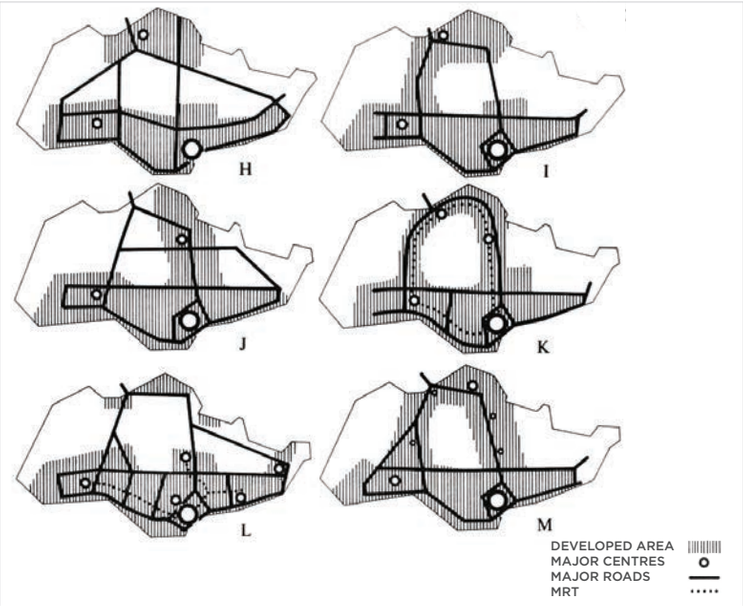
The SCP employed four strategic thrusts that would endure and become the fundamental principles for all future developmental plans:[18]

i. Very long-term planning for land use and transport requirements
ii. Expanding the road network to serve a growing population
iii. Managing travel demand
iv. Improving public transportation

However, as this was Singapore's first foray into comprehensive long-term planning, there existed no database that planners could use for modelling. Hence, a significant portion of the four-year study was spent collecting data suitable for transportation planning. A wide range of surveys—from premises and land use to population size, household income and employment—were conducted to study existing trends. These enabled planners to forecast traffic conditions as far as 25 years ahead. Only then could the real work on the Concept Plan and its accompanying Transportation Plan begin.[19]

Laying the Ring Plan

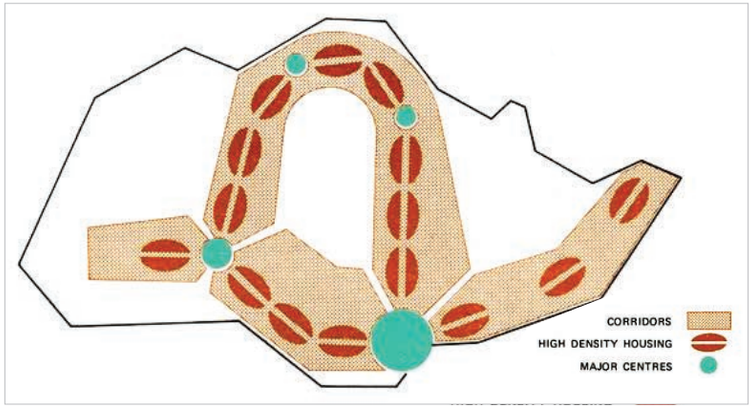
The first step was to decide on a long-term development pattern for the island. After multiple rounds of ideation, the "Ring Plan" was identified as the most suitable given Singapore's infrastructure and urbanisation pattern at that time. It envisioned high-density housing estates and commercial centres encircling the central catchment area, joined by a band of developments along the southern coast. An efficient transport network would serve these developmental corridors. The "Ring Plan" was essentially the draft that developed into the first Concept Plan, and all its successors retained the ring formation.[20]

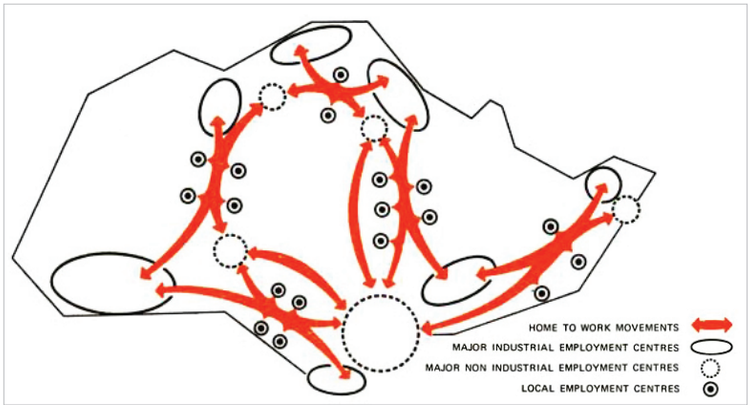


Draft of Ring Plan (diagram K) from Second Stage ideation of the SCP.

Principle of Decentralisation

> *A close relationship between place-of-living and place-of-work has long been regarded as a prime objective of a good plan, because it can have such a marked influence on the time and cost of the journey-to-work and can also help to reduce congestion and improve convenience.*
>
> Crooks Michell Peacock Stewart





High-density developmental corridors and home-to-work movements.

The SCP also recommended the creation of smaller employment centres, comprising industrial and non-industrial estates, along the developmental corridors outside the Central Area. This would shorten the average length of work trips and reduce the load on the transport system as workers could choose jobs closer to home. This contrasted with massive waves of commuters entering and leaving the Central Area, pressurising the system during peak periods. Spreading out demand would also help to optimise public transport operations because fixed-route carriers would not have to run empty as they moved away from the Central Area.[21]

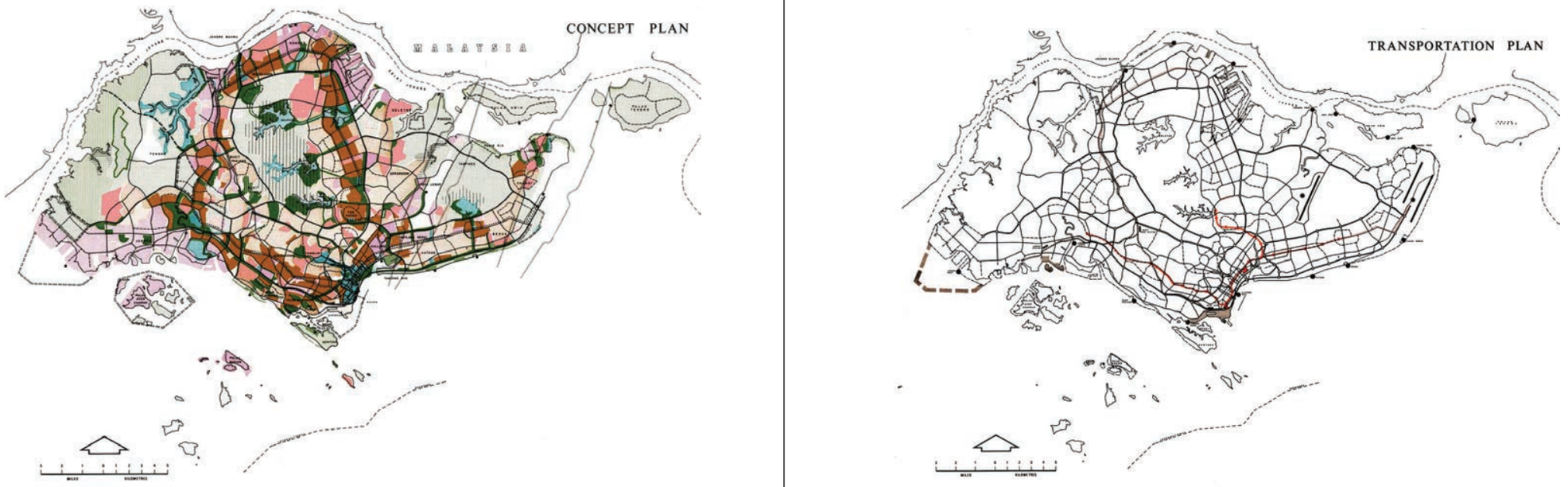
Recommendations

The SCP culminated in a 1971 report that became known as the first Concept Plan (CP 1971). It provided a long-term planning framework to guide Singapore's physical development and land use planning up to 1992, when its population was projected to reach 3.4 million. The CP 1971 also made recommendations towards an arbitrary Year X, when the population would hit four million. A Transportation Plan was produced in tandem with the CP 1971 and acted as the transport master plan up to 1992, addressing the long-term roles of private and public transport and their respective development programmes.[22]

Recommendations were provided in four key areas:

i. Expanding the road network
ii. Vehicle ownership and usage controls
iii. Improving public transport
iv. Implementing a mass transit system at the earliest opportunity

The plan was the first to give significant consideration to Singapore's transport needs and had a lasting impact on its planning approach for land use and mobility. Its major proposals included building an extensive network of expressways and a commuter rail system aligned with the developmental corridors. This would provide "efficient, fast transport facilities" linking all major activities and residential districts with the Central Area.[23]



The 1971 Concept Plan (left) and Transportation Plan (right).

UPGRADING ROADS

Road transportation provided the only means of travelling within Singapore before the rail-based Mass Rapid Transit (MRT) system started in 1987. Before 1971, the road network featured eight major radial routes converging in the Central Area and joined by two ring routes. Within the Central Area, roads were laid out in a rectangular grid pattern of one-way streets.[24] Prepared under the instructions of Sir Stamford Raffles himself, this layout had served the city well, being highly navigable and efficiently governed by traffic lights.[25] However, congestion had become a problem and the prevailing mindset was to simply build more parking spaces to accommodate a growing demand for cars.[26]

The SCP examined the deteriorating road congestion through detailed surveys and traffic counts. By 1970, the PWD had also seconded its traffic section to the SCP Department, where its officers worked closely with town planners and architects to develop a comprehensive transport solution. The team determined that the most congested area lay along the radial approaches to the Central Area, where the average speeds reached no higher than 20 miles (32.2 km) per hour. The study also uncovered drastic road fatalities and haphazard road-based public transport services provided by a range of private companies and illegal operators. It declared that major improvements were needed which required a significant increase in spending on road construction and maintenance.[27] Despite the scarcity of land, the study emphasised the importance of road development to handle Singapore's growing population. To be sustainable, this would have to be paired with restraints on the ownership and usage of private cars.[28]

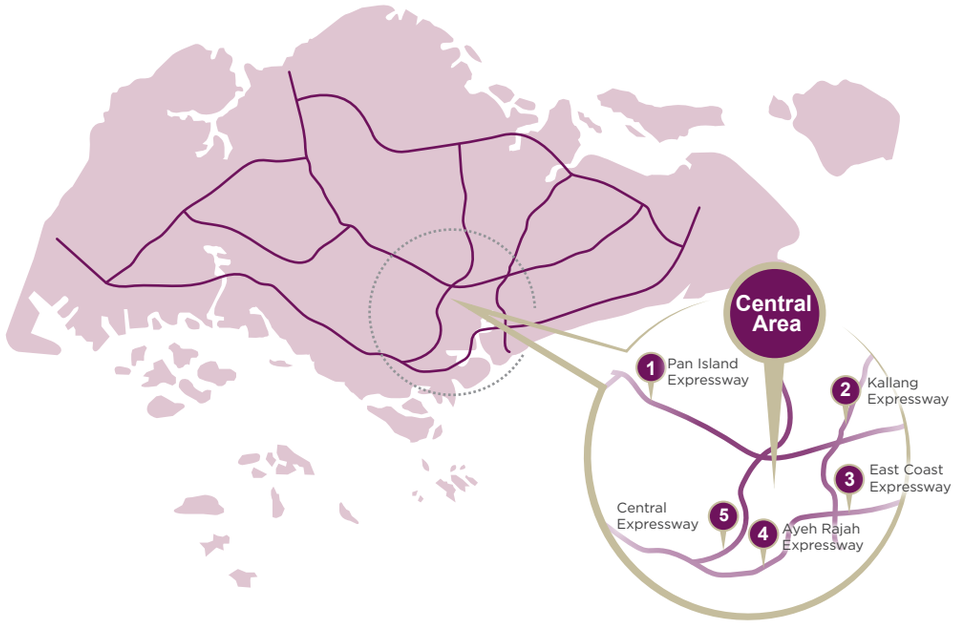
Drawing Up the Plans

The Transportation Plan presented a road network that was to be completed by 1992, improving capacity and connectivity to housing towns and industrial estates. It included a hierarchy of roads comprising nine expressways supported by arterial and collector roads connecting to developmental areas specified in the CP 1971. A hierarchical structure was crucial for optimising the road network's capacity, directness and accessibility of routes, and for preserving the surrounding environment. This way, heavy traffic volumes would not be forced through lower capacity corridors in concentrated residential or industrial areas.[29] With this broad and long-term vision, staging plans could be produced to guide near-term developments in greater detail. This included a short-term road programme that identified areas in more immediate need of attention.[30] The inter-ministerial Road Transport Action Committee (RTAC) was also formed in 1973 to coordinate transport planning and formulate policies.[31]

A slew of improvement works followed, such as the widening of junctions and the opening of slip roads. Safety features were also implemented, including the installation of traffic light controls and segregating pedestrian and vehicular traffic using footpaths, overhead bridges and underpasses.[32] The PWD also initiated the process of safeguarding land in preparation for the construction of new roads and the widening of existing ones. This required the PWD to work closely with the HDB and the Urban Renewal Department, Singapore's land use planning body that became the Urban Redevelopment Authority (URA) in 1974.[33] Mohinder Singh, formerly of the PWD and subsequently Director of Planning of its successor, the Land Transport Authority (LTA), recalls "there was very close coordination among the three agencies—the PWD, HDB and URA". This was especially important for defining the positioning of roads in developmental plans, such as aligning the Tampines Expressway (TPE) to serve new townships.[34]

A Central Area Expressway Study (CAES) was also conducted from 1974 to 1976 to map out in detail the configuration of the expressway network hugging the Central Area. A "box" was deliberately designed into the network, made up of segments of the Pan Island Expressway (PIE), East Coast Parkway (ECP), Kallang Expressway (KLE), Central Expressway (CTE) and Ayer Rajah Expressway (AYE). This "box" encompassed the boundaries of the Central Area, linking with roads inside it and creating a bypass for those wishing to avoid entering the city. This was essential given the presence of the Area Licensing Scheme (ALS), a traffic demand management system implemented in the CBD, charging motorists for entering restricted zones during peak periods.[35] Detailed planning was done in the CAES, building upon the broad, strategic proposals from the SCP. This included provisions for lanes and ramps, and enabled the PWD to safeguard the land efficiently.[36]

Exhibit 1:
Central Area Expressway Box



Large-Scale Construction

After the road alignments were planned, they had to be designed individually by the PWD, accounting for topographical features, land ownership, existing infrastructure and future island-wide development plans by the URA. Junctions were also incorporated where new roads crossed existing ones.[37] However, the presence of large transport infrastructure could become disruptive in key locations such as the Central Area. This was especially so for long roads and expressways that passed through areas with different "tolerances" with regard to visual impact. In these cases, a combination of viaducts and tunnels could be used to minimise the total cost of the entire route. For example, the CTE's underground segment through the Central Area was initially proposed as a viaduct in the SCP. However, the PWD decided to build a tunnel instead after thorough examination. While this made the CTE the most expensive expressway at the time, it helped to preserve the aesthetics of the "showpiece" Central Area, minimise environmental and noise pollution, and also prevented the creation of a potential barrier both physically and visually.

Beyond geometry and geology, there were a host of other factors to account for. Land acquisition, in particular, was complex and the PWD worked with the Land Office (today's Singapore Land Authority) to expedite the process. The land had to be valued and gazetted, and its owners compensated, before the government could move in to resettle the occupants. Only then could road construction begin. Heritage and religious buildings as well as embassies were considered "sensitive", and acquiring them was avoided where possible. However, road geometry—the maintenance of straight and level alignments—remained a priority. Hence, they were not completely exempt from acquisition and demolition. The difficulty of land acquisition was often closely tied to the provision of resettlement benefits. Construction was thus sometimes phased according to the progress of acquisition and resettlement rather than waiting for all the required land to become available, which could take years.

In some cases, the road alignments crossed into environments under the purview of other government agencies. Bridges across waterways had to be cleared with the Ministry of Environment, as with drainage systems along regular roads. Big trees, given their importance in maintaining Singapore's image as a garden city, were a source of friction between the PWD and the National Parks Board (NParks). As with all large-scale developments, the road network expansion was also subjected to a rigorous evaluation process in order to get funding approved.[38]

Construction of the East Coast Parkway (ECP).
Photo from the Ministry of Information and the Arts Collection, courtesy of National Archives of Singapore.

Shenton Way area, and the ECP passing through Marina South.

Photo courtesy of the Kouo Shang-Wei Collection 郭尚慰收集, National Library Board, Singapore 2018.

Backbone of Expressways

Expressways were prioritised in the road-building process, with the planned 135 km-long system forming the backbone of the entire road network.[39] The building of expressways was staged according to major developments unfolding across the island so that useful connections were created systemically. For example, as preparations began in 1975 for a new international airport at Changi to replace the one at Paya Lebar, alignments for the PIE and ECP—Singapore's first two expressways, completed in 1981—were designed to link the new airport to the city. The ECP was built on reclaimed land which, as Singh explained, "enabled quite a few things to be done".

> *East Coast Parkway was built as part of the shifting of the airport from Paya Lebar to the East Coast, to Changi. The idea was that the airport should be linked to the city. But then, how are you going to link it because the [existing] developments have been built up to the coastline? There wasn't such a thing as reserving the foreshores at that time. So, it would have necessitated either quite a massive acquisition of land along the route in order to build the expressway, or the alternative that was adopted, which was to reclaim.*
>
> Mohinder Singh[40]

The PIE had already been planned as a "super road" to link up all satellite towns from Jurong to Changi. It was built in phases from 1964, and was one of the PWD's costliest undertakings in the 1960s and 1970s.[41] The PIE was also extended to connect the Jurong Industrial Estate, which was being developed into a major employment centre. Construction of the other expressways proceeded through the 1980s and 1990s. These included the Bukit Timah Expressway (BKE), which was built in the 1980s to reach the Causeway, passing by Woodlands Town, a township primed to become a future Regional Centre and gateway to Malaysia (see Chapter 4). In 2008, the Kallang–Paya Lebar Expressway (KPE) opened as the last of the original nine, after a particularly rocky process (see Chapter 5).

Traffic Demand Management

The planners realised that physical improvements to the transport system alone would not suffice. These would need to be supplemented by restraints on car ownership and usage through pricing and demand-management policies. Additionally, the effectiveness of the public transport system relied in part on transfer of demand from users of private vehicles. Public transport fares were thus kept low, while charges were imposed on those who drove and parked in the Central Area.

Area Licensing Scheme gantry in operation at the Restricted Zone (left), and City Shuttle Services facilitating the Park-and-Ride Scheme (right).

Photos from the Ministry of Information and the Arts Collection, courtesy of National Archives of Singapore.

In June 1975, these concepts evolved into the Area Licensing Scheme (ALS) and the Central Area was designated as a Restricted Zone (RZ) guarded by 27 gantries. Commuters were given two options to avoid paying the higher fees. The first was to car-pool—a driver ferrying four or more passengers was exempt from paying the fee. To facilitate this, the government formed a Car Pooling Management Unit to help the public form car pools. Otherwise, motorists could make use of the "Park-and-Ride" scheme to park their cars at one of 15 fringe car parks outside the RZ and take special shuttle buses into the city.[42] These measures resulted in a 73% decrease in the number of vehicles entering the RZ during restricted hours between March and September 1975.[43]

ESTABLISHING THE NEED FOR PUBLIC TRANSPORTATION

> *If you want to curtail the travel [by] cars, you've got to provide a good public transport alternative. And the bus system at that time was very pathetic. They were breaking down on the roads, smoky exhausts and all kinds of problems.*
>
> Lim Leong Geok, former Executive Director of the Mass Rapid Transit Corporation[44]

In addition to the improved road network, an efficient public transport system was needed to cope with projected population growth and curb demand for private cars. The SCP report forecasted that unrestrained demand growth for private vehicles would bring about an almost fourfold increase in cars in 20 years, or by 1992. A corresponding increase in road space to accommodate this would turn busy thoroughfares such as Havelock Road into monster 18-laners. This would not only destroy Singapore's environment, but also quickly use up its scarce land. Congestion would squeeze out road-based public transportation by adversely impacting its quality, making car ownership and usage more attractive. This would only worsen the congestion, creating a vicious cycle.

The SCP assessed that Singapore's public transport system was in serious need of improvement and examined various options. The studies covered buses, taxis, informal road-based options such as trishaws (cycle-rickshaws or pedicabs) and a heavy rail system. It recommended the eradication of informal transport options and the regulation of taxis and shuttle services to serve specialised functions. By reducing clutter on the roads, efforts could be directed to improving formal public transportation in the form of buses and a possible rail-based MRT system.

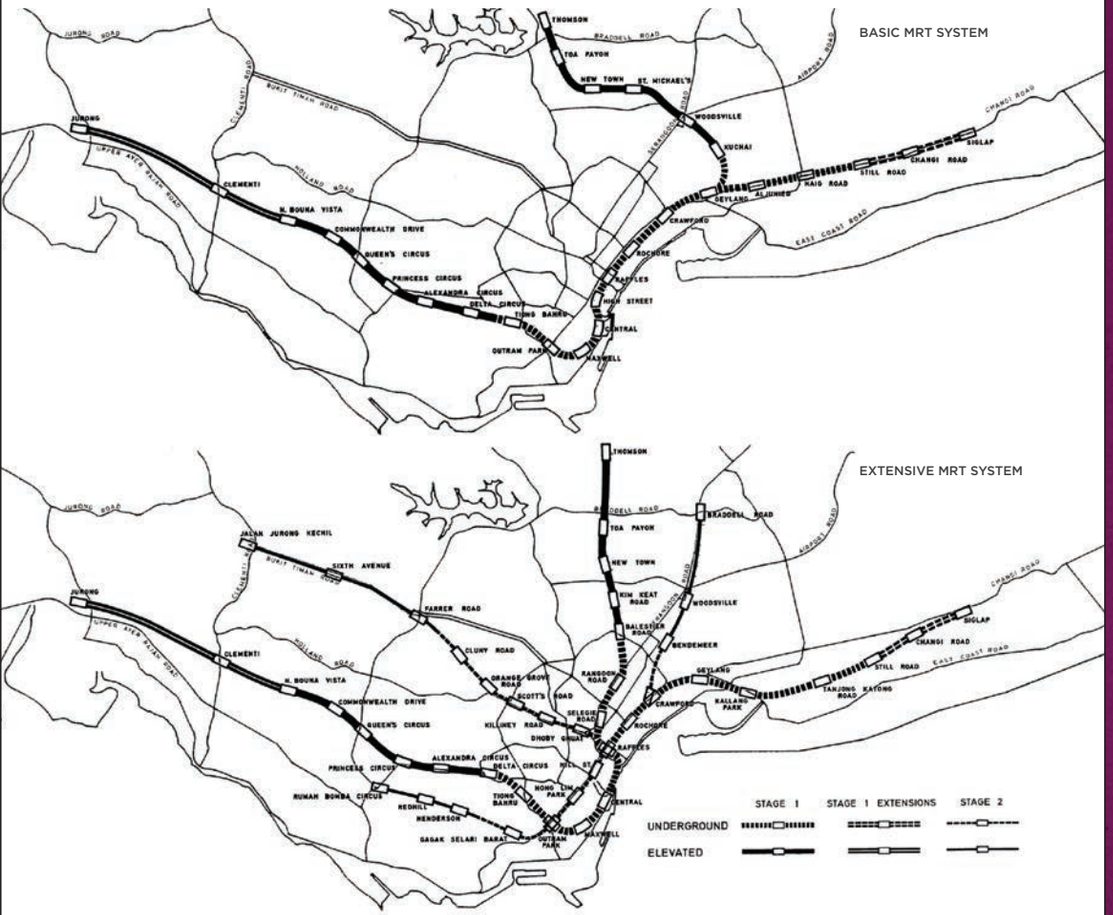
Conditions for these public transport options were simulated, and two wholly road-based scenarios were considered. In one, buses shared the streets with other vehicles, and in the other, buses would operate on the same streets but be given special right-of-way in the form of dedicated lanes. Both options proved impractical. The shared option would increase traffic volumes to unfeasible levels for existing road capacities. Dedicated lanes for buses would improve their carrying capacity, but at high cost and greater congestion on the narrowed road space for other vehicles. The cost of providing special right-of-way was estimated to match even that of a rail-based system. Each scenario failed to attain a standard of service that would be attractive to commuters, leading to the conclusion that strictly road-based options would not only fail to ease traffic congestion, but might even worsen it.

THE MRT SOLUTION TO ROAD CONGESTION

These simulations highlighted the need for a high-capacity system with exclusive right-of-way, away from road traffic. A rail-based MRT system was deemed best as it could provide both comfort and capacity for moving people. In existing rail-based MRT systems overseas, a single track can move up to six times more passengers per hour than one traffic lane.[45] Additionally, the MRT system had the propensity to bring other benefits, such as stimulating future economic growth.

The alignment for a basic MRT system was proposed, connecting existing housing estates such as Toa Payoh and Queenstown to the Central Area. The plan also specified that a stretch of the system cutting through the Central Area would be located underground. With construction plans still uncertain, the plan for the basic alignment of the MRT system would protect the route against possible encroachment in the meantime. Plans for an extensive system covering a larger area were also drawn up for consideration.

The basic system included seven stations in the Central Area conveniently situated within walking distance to areas of high employment concentration. This was also advantageous for developing at high plot ratios in the vicinity, creating new opportunities for coordinated urban renewal. However, planners remained mindful of the implications of development intensity on land values and the spread of activities in the Central Area. While a high concentration of commercial activities could yield the highest land values, it could potentially lead to "dead" areas outside of working hours. Instead, a more dispersed pattern would spread out activities and help minimise congestion in key areas. The SCP recommended a careful study of these conflicting implications and the development of a framework that would balance transportation considerations and the need for intensification to boost land values.[46]



Alternative MRT Systems: Proposed Basic and Extensive Systems.

Aligning the MRT route with high-density housing corridors also created a win-win situation. An established public transport network running close to Singaporeans' doorsteps would encourage them to use the system instead of cars. This would in turn generate demand for the system and increase its viability. The improved accessibility would also boost the attractiveness and value of properties in housing estates. MRT stations would be best located in areas surrounded by a mix of dense residential and commercial uses, and become transportation nodes that also helped to meet the daily needs of residents. Middle-to-low-density developments situated further away would be connected to MRT stations by buses.

The SCP acknowledged that the rail-based MRT might not be built immediately due to the heavy financial commitment, but urged that corridors of the basic system be safeguarded so that it could be constructed as soon as possible upon approval.[47]

CHAPTER 3

LAYING THE FOUNDATION FOR THE MRT

BEYOND THE STATE AND CITY PLANNING PROJECT: FURTHER STUDIES AND IMPLEMENTATION

Given the high cost of a heavy rail system—projected at $5 billion—construction of the proposed Mass Rapid Transit (MRT) system did not commence until a decade after the State and City Planning Project (SCP) submitted its 1971 report, known as the first Concept Plan (CP 1971). The government had further embarked on a three-phase Mass Transit Study (MTS), between 1972 and 1980, to confirm if such a sophisticated system was really needed. The MTS was a joint undertaking between the government and Wilbur Smith and Associates, a US transport planning firm. The firm noted that since Singapore's "pattern of development has succeeded in concentrating residences and jobs in well-defined locations", it was likely to avoid the problem of a sprawling urban landscape, "which, in so many other places, has frustrated public transport service". It added that, with the government and various statutory boards owning 60% of Singapore's land area, state action would continue to guide major urban developments.[48]

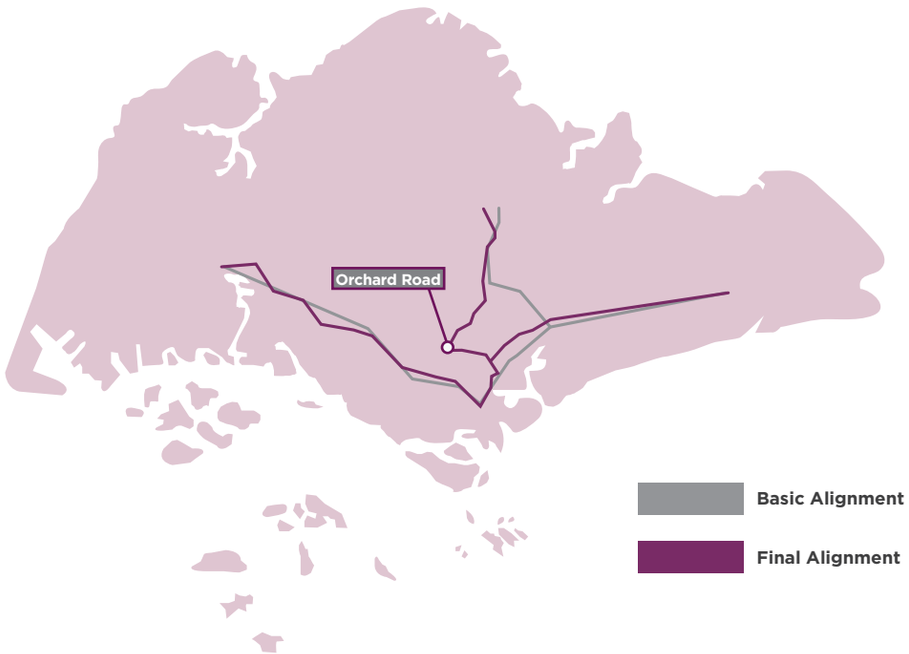
Phase one (1972–74) of the MTS revisited population forecasts up to 1992 and examined two possible categories of mass transit options: an all-bus system and a rail system combined with extensive bus services.[49] Phase two (1975–77) established that a bus-rail system was technically and economically the more viable option. For an all-bus system to meet future demand, multiple bus lanes per roadway would be necessary, along with boarding platforms in the middle of the road. This would practically rule out all other forms of road-based transport and create "bumper-to-bumper bus queues" given the sheer volume of buses required.[50] Phase three of the MTS (1979–80) involved preliminary engineering studies to better define the exact route alignment and potential locations of the stations.[51] The MTS eventually recommended a bus and train system, with the rail route adapted from the original SCP recommendation.[52]

Choosing the Alignment: High Density Principle

The SCP Transportation Plan recommended aligning the MRT lines with high-density housing and industrial corridors, and linking them to the Central Area. Thereafter, further detailed planning was needed. To maximise its reach and convenience, the rail system had to be able to carry people where they wanted to go. Bruno Wildermuth, a key person involved in development of the MRT—first as a consultant with Wilbur Smith and Associates and subsequently as part of the Mass Rapid Transit Corporation (MRTC)—recalled having a "really big fight" with the MTS engineers over the alignment of the North South Line (NSL) linking from Toa Payoh to the East West Line (EWL).[53] The engineers favoured the easier option of building it above ground and through the Kallang Basin, which was then a no-man's land.[54] Wildermuth, however, insisted that it run through Orchard Road because it was important to connect popular destinations like the shopping belt.

This complex proposition would involve higher costs arising from constructing the line through a built-up area and concealing the rail infrastructure underground to preserve the shopping belt's aesthetics. This led to at least 10 rounds of cost–benefit analyses before an inverted T-shaped alignment was agreed upon. It proved to be a worthwhile undertaking that turned Orchard Road into the star commercial destination[55] it is today.

Exhibit 2:
Proposed MRT Alignments Linking the North South Line to the East West Line



Safeguarding the MRT Alignment

A disciplined approach to long-term planning allowed Singapore to build a well-connected transport network by safeguarding key routes years in advance. By the time phase three of the MTS began, the government had already started preparations for a potential pro-rail decision, including safeguarding the inverted T-shaped alignment proposed in phase two. A Provisional Mass Rapid Transit Authority (PMRTA) was also formed in 1980 to prepare for the construction of an MRT system in the near future.[56]

No permanent building was allowed to be built on the land to protect the route and to avoid the cost and hassle of land acquisition and demolitions in the future. Such safeguarding allowed construction of the MRT to commence smoothly in 1984. A safeguarding system had been instituted in the mid-1970s in which the Public Works Department (PWD), in cooperation with the Urban Redevelopment Authority (URA), was involved in identifying the corridors to be protected.[57] The URA, which had oversight of land use plans, would identify proposed developments close to the MRT alignment and hand them to the PWD for review. The PWD would then evaluate and decide whether developments could be built without affecting the safeguarded corridor, or if modifications were required.[58]

Pok Sheung Foo, a PWD transport planner who had been involved in safeguarding the route, recounted a significant case in the Central Area. In the late 1970s, the Chartered Bank's pre-war premises had been acquired for demolition to make way for the Raffles Place MRT station. The bank had submitted plans for a new building at a site at Battery Road, which also lay over the underground MRT alignment.[59] Pok had rejected their plans since the foundations would obstruct the MRT tunnels and in turn, affect two lines because Raffles Place was to be an interchange for the NSL and EWL. The bank then submitted a revised proposal that provided for an MRT tunnel,[60] which was subsequently approved by Pok and his team in early 1980.[61] Thus, the new Chartered Bank Building was built with arching foundations to accommodate the MRT, with the bank bearing the $14 million cost.[62] This was done long before the station and tunnels were constructed so that no retrofitting would be needed to accommodate the future rail infrastructure.[63] As of 2017, the building (renamed 6 Battery Road) retains its direct entry point to the underground station, which was built later.

The strict safeguarding procedures meant that only three permanent buildings were eventually affected by the construction of the NSL and EWL. These were the Chartered Bank and Indian Overseas Bank buildings in the Central Area, and a block of Housing & Development Board (HDB) flats situated over an MRT tunnel in Braddell.

Breakthrough and Approval

The three-phase MTS was not the last of the additional feasibility studies carried out. In 1980, a team from Harvard University led by Professor Kenneth Hansen produced a report vouching for an all-bus system over the bus-rail option. The Hansen Report, as it had become known, attracted much public attention. The issue culminated in the Great MRT Debate, with several cabinet members and planning experts sparring on national television.[64] This sparked a final Comprehensive Traffic Study (CTS) between 1980 and 1982 to evaluate the two proposals.[65] Eventually, the all-bus option was debunked after it emerged that Hansen's team had failed to account for important ground conditions, such as the surge in peak-hour travel demand to and from the Central Area.[66]

The reclamation of Marina South, which began in the 1970s for development into a new downtown area, provided the turning point in the MRT debate and highlighted the need for transportation and urban development to go hand in hand.

> *The breakthrough came with the reclamation of Marina South. Well, as you know, Marina South is adjoining the city centre, Telok Ayer Basin, south of Shenton Way. And the only way you can get to Marina South is through a road by the side of Telok Ayer Basin. Only one road!*
>
> *So we said, "Alright, if large numbers of people want to get to Marina South, the only way is to have MRT. If there is no MRT, Marina South will remain predominantly an open space. Right? If you have MRT going to Marina South, then that open space can be developed. And all that you need is to sell only part of that developable land to pay for all your MRT costs. Now you have a big chunk of land here. Do you want to develop it or not? If you want to develop, have MRT."*
>
> Ong Teng Cheong, then Minister for Communications[67]

CONSTRUCTING THE COMPASS LINE

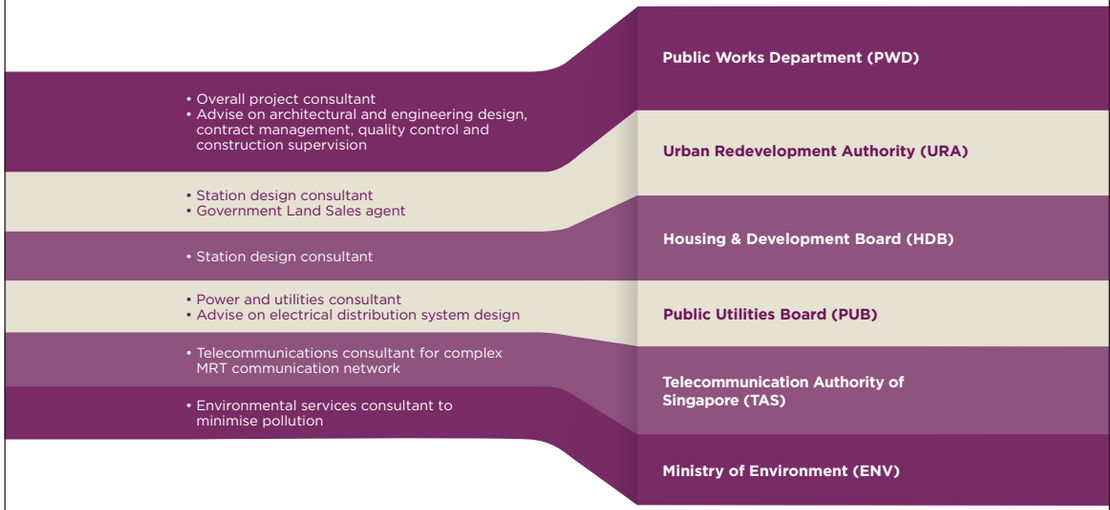
The government gave the go-ahead for the construction of the $5 billion MRT system in 1982. By then, many new HDB towns had sprouted and the Central Area had significantly transformed into a modern commercial hub through redevelopment.[68] The safeguarded MRT route no longer lay on barren land, but cut through developed zones surrounded by high-rise buildings. This posed new challenges and led to higher building costs compared to building on undeveloped land.

Building the original 42-station, 67-km Compass Line—made up of the NSL and EWL—was "a national project in the true sense of the word".[69] Construction was staggered to avoid overtaxing the building industry, with priority given to the NSL as well as a stretch of the EWL cutting through the Central Area. This was in view of high travel demand and the time-consuming nature of underground construction through most of these segments. It was a major undertaking from 1984–87, involving many government bodies and affecting the everyday lives of many Singaporeans. In order to coordinate island-wide infrastructural development beyond the transport system, strong governance in the form of sound institutions and inter-agency cooperation was essential.

While the PMRTA had been formed back in 1980 to conduct feasibility studies and planning for the proposed rail system, the actual construction involved functions beyond its authority. In 1982, six key governmental bodies were formally appointed to assist the PMRTA, and subsequently the Mass Rapid Transit Corporation (MRTC).

Alignment of the completed Compass Line.
Image courtesy of Calvin Teo, CC BY-SA 2.5, via Wikimedia Commons.

Exhibit 3:
Roles and Responsibilities of Government Agencies Involved in MRT Construction



Additionally, the Ministry of Finance and the Land Office continued to provide vital guidance on finance matters and land acquisition, respectively. These efforts ensured coordination and cooperation between the agencies and the MRT Authority. This also helped to reduce reliance on foreign consultants, enhancing local capabilities through the transfer of new railway construction technologies.[70]

The MRTC was formed in 1983 to replace the PMRTA as a full-fledged statutory board. The MRTC took on responsibility for the construction and operations of the MRT system and was tasked to get things up and running within 10 years. It was given significant powers, including the authority to take possession of private property to carry out railway construction or maintenance, remove obstructive entities from its path and call for the diversion of utility services to suit the MRT alignment.[71] The MRTC was thus able to execute its duties effectively, and the entire Compass Line, which commenced operations in 1987, was completed by 1990, two years ahead of schedule.[72]

FINANCING DEVELOPMENT INTEGRATED WITH TRANSPORT

Unlike many cities, major public infrastructure and development programmes in Singapore, including the MRT system, are funded from the government's operating revenues rather than other sources, such as land sales which are locked away as part of Singapore's reserves. At the same time, the Land Acquisition Act empowers the state to compulsorily acquire land from private owners for national infrastructure such as public transport, housing and industrial developments.[73] Part of the increase in land value created by public infrastructure is returned to the government through mechanisms like the Development Charge, and used for funding various public expenditures.

On the other hand, the implementation and financing of redevelopment programmes, including those around transit nodes such as MRT stations, often takes the public–private partnership route through the Government Land Sales (GLS) programme, where state land is released for development by the private sector, in line with the Master Plan and national development objectives.[74] For the MRT system, the government not only acquires land for the train lines, but, in some cases, also initiates comprehensive redevelopment and land use intensification of areas surrounding the stations.

The GLS programme has been a key instrument enabling and financing redevelopment in tandem with rail transit infrastructure. For example, under the 1989 GLS programme, the URA offered three prime sites near busy MRT stations in the Central Area—Bugis, Raffles Place, and Orchard—to be redeveloped into office and commercial spaces.[75] The sites became today's Bugis Junction, Chevron House and Wheelock Place, respectively. This approach was extended to mixed-use developments around other MRT stations, a recent example being the Tanjong Pagar Centre in the Central Business District (CBD). Through the GLS, the URA has also encouraged the private sector to take on new development concepts, such as Singapore's first purpose-built underground shopping mall, CityLink Mall, connected to the City Hall MRT station (see Chapter 6).

In some cases such as the Dhoby Ghaut station (see Chapter 4) on the North East Line (NEL), the public sector—particularly the LTA—took the lead in demonstrating the technical and commercial feasibility of building developments integrated with stations.

Wheelock Place, a GLS site adjoining the Orchard Road MRT.
Photo courtesy of William Cho @ https://flic.kr/p/7J57Mj

GOING UNDERGROUND IN THE CENTRAL AREA

Since the CP 1971, proposed transport infrastructure alignments have always been directed underground in the Central Area for various reasons, even though this almost doubles the construction costs.[76] This was seen as the only way to prevent environmental intrusion and preserve the aesthetics of the dense city centre, where rail viaducts and overhead transmission cables would have quickly become eyesores.[77] To keep all rail infrastructure neatly hidden away, the more expensive option of using the third rail—a steel electricity supply rail running alongside the tracks—to power the MRT was also adopted.[78]

Going underground also freed up terrestrial land for other uses, optimising Singapore's scarce land resources. The fact that developments could be built directly over MRT stations reinforced the need to integrate them with the MRT infrastructure by building connecting passageways. Such integration would bring mutually reinforcing benefits to commuters and businesses alike, regardless of whether the station or the development came first. The City Hall MRT station was completed a year after the Raffles City Shopping Mall was built. Located below the complex, it brought commuters directly to the development for a convenient shopping experience. The resulting increase in footfall led to rapid improvements in business.[79]

In the early 1980s, the URA announced a change in policy to synchronise its redevelopment projects in the Central Area with the construction of MRT stations, especially along the NSL. As one of the public sector consultants to the MRTC (see exhibit 3), the URA initially adopted a policy of keeping redevelopment projects away from the MRT sites. This was to avoid "cluttering them up" with construction works, but would also result in "the areas surrounding the stations (looking) barren" once the stations were completed.[80]

By 1984, the URA had drawn up preliminary plans for commercial developments, including offices, shopping centres, and hotels, to be developed around and above 12 underground MRT stations in and on the fringes of the Central Area. These included Raffles Place, City Hall, Orchard and Dhoby Ghaut, among others.[81] Commercial developments were to be located within a 200-m radius of the stations, and sites for these would be sold to private developers.

Seamless interface between Tanjong Pagar Centre and the MRT station.
Photo courtesy of GuocoLand Singapore.

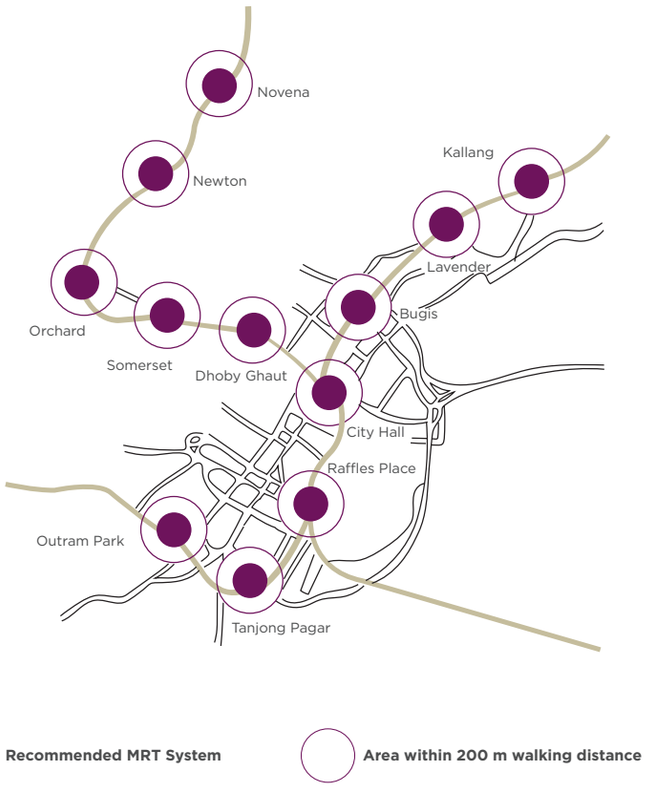
However, the simultaneous development of land by the private sector around key transit nodes was not always possible because the GLS programme was influenced by market conditions.[82] Therefore, the next best option was to provide for future integration with existing MRT infrastructure. Most underground station boxes were built to withstand the load of a building overhead, and these provisions were specified in site sale packages. At station level, removable wall panels were incorporated to provide seamless links for passageways leading to future adjacent developments.

This was exemplified by the Tanjong Pagar land parcel, which was sold for development in 2010, more than 20 years after the completion of the station. The Tanjong Pagar Centre opened in 2016 to high anticipation as a "truly 24/7 liveable place" in the business district. A key development condition called for it to be well connected to the underground MRT station as part of the government's goal to reduce the need to drive within the CBD. This necessitated the opening of at least two out of five knockout panels in the station walls that had been prepared in the 1980s, when the station was built as part of the EWL.

The developer, GuocoLand Limited, decided to take full advantage of this provision and opened all five knockout panels to "embrace the MRT station". Without these knockout panels, it would have been very difficult

to create a seamless connection to the station without compromising its structural integrity. As this went above and beyond requirements stipulated by the URA, GuocoLand entered direct negotiations with the train operator, SMRT, to optimise the interface between station and development. As a result, upon exiting the station turnstiles, commuters emerge directly onto a concourse towards Tanjong Pagar Centre and can move seamlessly between the station and the commercial zone. This shows how, in integrating complex developments with transit nodes, the abilities of private developers can be aligned with broader government planning objectives to achieve optimal outcomes.[83]

Exhibit 4:
Development Radius Around Central Area MRT Stations



An underground MRT system also called for innovative solutions to cope with Singapore's hot and humid climate. While there was air conditioning, incoming trains would regularly be pushing 40°C air from the tunnel onto the platform and dissipate the cool air.[84] This resulted in stations being fitted with the world's first underground platform screen doors.[85] The Compass Line also featured cross-platform interchanges, with the NSL and EWL meeting at Raffles Place and City Hall stations. Commuters were able to transfer between lines by simply walking across the platforms. This helped to optimise commuter traffic and reduce crowding at two extremely busy stations in the heart of the CBD.

CONNECTING HOUSING CORRIDORS

As Chief Executive Officer (CEO) of the HDB in the formative years of the MRT system, Dr Liu Thai Ker experienced first hand the integration of housing and transport planning, and the importance of strong governance as well as inter-agency cooperation under the CP 1971.

> *When I was the Head of HDB, I would keep referring to that plan. In other words, I would clarify the MRT alignments with the MRT authority. I provided them with HDB new towns' precise boundaries and worked together with them, but always using the Concept Plan as a guide. We're lucky that we had a very good Concept Plan. We were very lucky that cooperation of various government departments to try to do the best possible plan and best possible development in Singapore was there. The consciousness was there.*
>
> Dr Liu Thai Ker[86]

Dr Liu explained that while the CP 1971 was a broad strategic plan with few details to guide local planning, he stuck closely to its principles. The locations of upcoming HDB townships were selected according to the concept of urbanised corridors proposed in the CP 1971. This ensured that the towns would enjoy good access to the transport network, providing external connectivity in the form of roads and public transportation. Many new townships were therefore built precisely along the MRT route, with at least one station located at the town centre.[87] According to Dr Liu, meticulous attention was paid to ensure that "all the expressways and MRT lines fit in and [tie] in at both ends of the new town and through other communities smoothly".[88] Planners received support from political leaders, who understood what needed to be done in the best public interest. This gave planners the authority to acquire hundreds of hectares of land required for the developmental corridors.[89]

While aligning the MRT through corridors of high-density developments inevitably meant affecting many people during construction, disruptions were minimised as the MRT route had long been protected and sufficient land acquired for the purpose. Even then, Singaporeans could not avoid the dust and noise from MRT construction sites right in their backyards. Businesses near construction sites suffered heavily, with sales dropping as much as 50% because customers were diverted from their usual routes and recreational spots.[90] However, Singaporeans accepted this inconvenience as the "price of progress". Within a few years, the new MRT system would significantly improve connectivity and increase footfall.[91]

RATIONALISING AND REORGANISING THE PUBLIC TRANSPORT SYSTEM

The MRT system commenced operations in November 1987, six months ahead of schedule.[92] Singapore MRT Ltd (SMRT) was incorporated in the same year to operate the system along with the MRTC. To further improve connectivity, a train-bus system was implemented under the guidance of Lim Leong Geok, then Executive Director of the MRTC and Managing Director of the SMRT. He reasoned that trains served fixed routes at higher speeds, but could not cover every part of townships. Instead of covering costly long-haul routes, buses were given a new role of ferrying commuters to MRT stations. Bus routes were also rationalised to prevent duplication with the MRT.[93] Taking on a complementary rather than competing role allowed bus companies to improve their operational efficiency, and savings could be channelled towards improving fleets and services.[94]

The Public Transport Council (PTC)—formed in 1987 to protect the interests of commuters by regulating bus, taxi and MRT fares—took over the planning of bus routes from its predecessor, the Bus Services Licensing Authority.[95] Bus routes underwent constant scrutiny to ensure optimal services tailored to changes in population and ridership, especially with the advent of the MRT.[96] Changes to public transport fare structures were also addressed systemically. A common ticketing system and information integration for the bus-rail system was introduced in 1989 with the establishment of TransitLink.[97]

CHAPTER 4

A STRATEGY FOR DECENTRALISATION

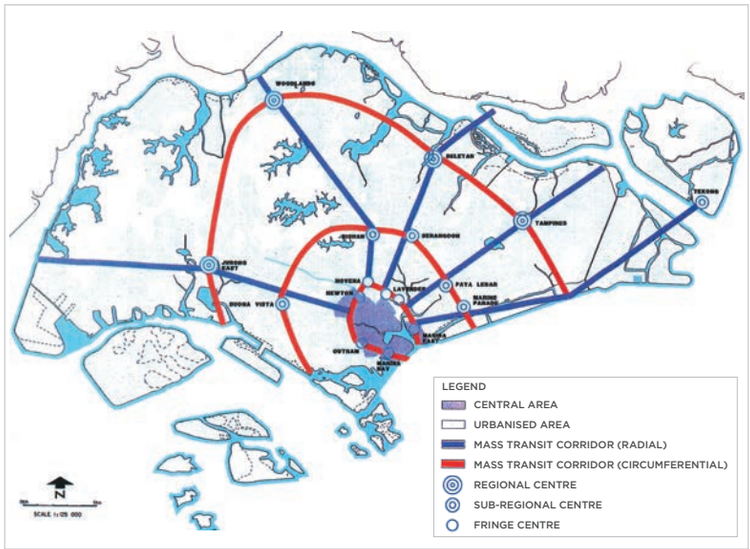
By the 1990s, the first Concept Plan (CP 1971) had transformed Singapore into a thriving metropolis and a "secure and healthy home" with greatly improved liveability.[98] However, as its authors noted, it was meant to be a "living document, kept constantly up-to-date and constantly under review, so that it continually expresses a development strategy and a development policy that is appropriate to the country's needs".[99] A review undertaken in 1991 led to a shift from problem solving to a more forward-looking approach aimed at making Singapore a "a tropical city of excellence". Known as the 1991 Concept Plan (CP 1991), it laid out the following broad objectives:

i. Safeguarding and providing land for development
ii. Encouraging sustained economic growth and coordinating infrastructure development
iii. Improving the quality of living and working environments
iv. Enhancing the quality of life[100]

THE CONSTELLATION CONCEPT

The planning principles of integrating land use and mobility laid out in the CP 1971 helped create a robust transport system comprising a comprehensive road network and a rail-based Mass Rapid Transit (MRT) system. This improved Singapore's liveability and aided its economic progress. While the CP 1991 preserved and strengthened these principles, it also sought ways to prevent urban congestion in the future.

The CP 1991 noted that, in their pursuit of economic growth, many cities ended up suffering from an over-developed city centre prone to paralysing traffic congestion. In this scenario, "millions of people crowd into a city centre at the same time, and then all leave at the same time", denying professionals a vibrant and stimulating environment to work and live in. The solution: decentralisation supported by a well-planned and comprehensive public transport system.[101]



The Constellation Concept and proposed rail connections.

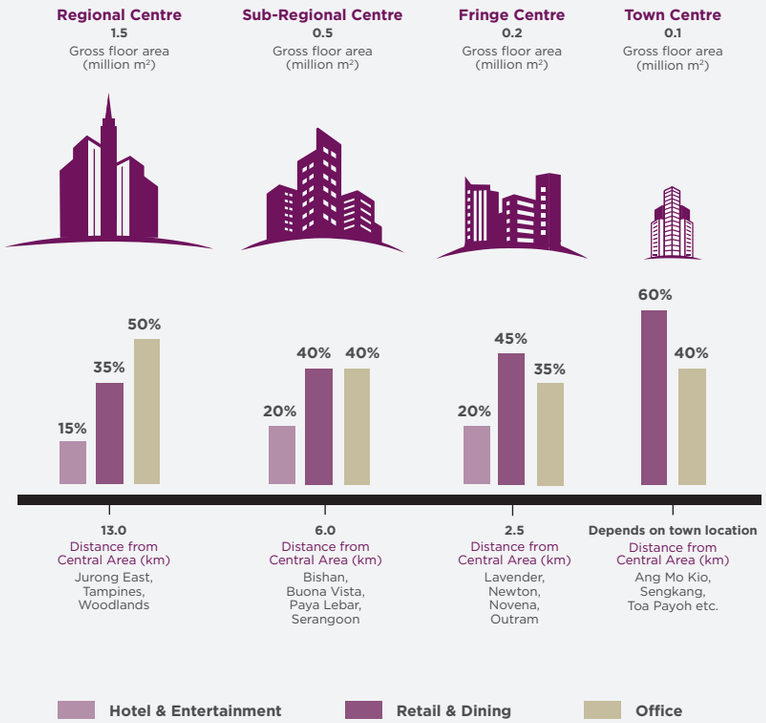
It proposed the Constellation Concept, which was built upon plans for decentralisation first proposed during the State and City Planning Project (SCP).[102] It envisioned bringing jobs and amenities closer to Singaporeans' homes, thereby reducing their daily travelling distances and time.

A detailed constellation of suburban commercial centres was conceptualised, with Fringe, Sub-Regional and Regional Centres "fanning out" from the Central Area. The Regional Centres would be the farthest from the Central Area and bring about the greatest change to Singapore's urban structure. With up to 50% of gross floor area (GFA) dedicated to office space, and the rest for entertainment, dining and retail, these centres would create diverse work opportunities and vibrant neighbourhoods for living.[103]

Public transit was the guiding planning concept in the 1991 Concept Plan, embedded in the constellation concept that the intersecting stations of the linear and radial MRT lines were made the key activity centres for commercial, residential uses and so on. In short, we are putting the most accessible locations in a public transit system for the most intensive use in terms of pedestrian flow, in terms of people movements. We are encouraging people to make good use of the public transit system through integrated land use and transport planning.

Dr John Keung[104]

Exhibit 5:
Commercial Centres Outside the Central Area



Dr John Keung, who was involved in drafting the CP 1991 as then Deputy Chief Planner and Deputy Chief Executive Officer of the Urban Redevelopment Authority (URA), explained the importance of having higher density and plot ratios for developments near major transit nodes. He noted that "with more people living very near these major public transit nodes, it [was] more natural for them to make use of public transport to go to work, to go shopping, to do all other things...[and] the tendency to use public transport is higher".[105]

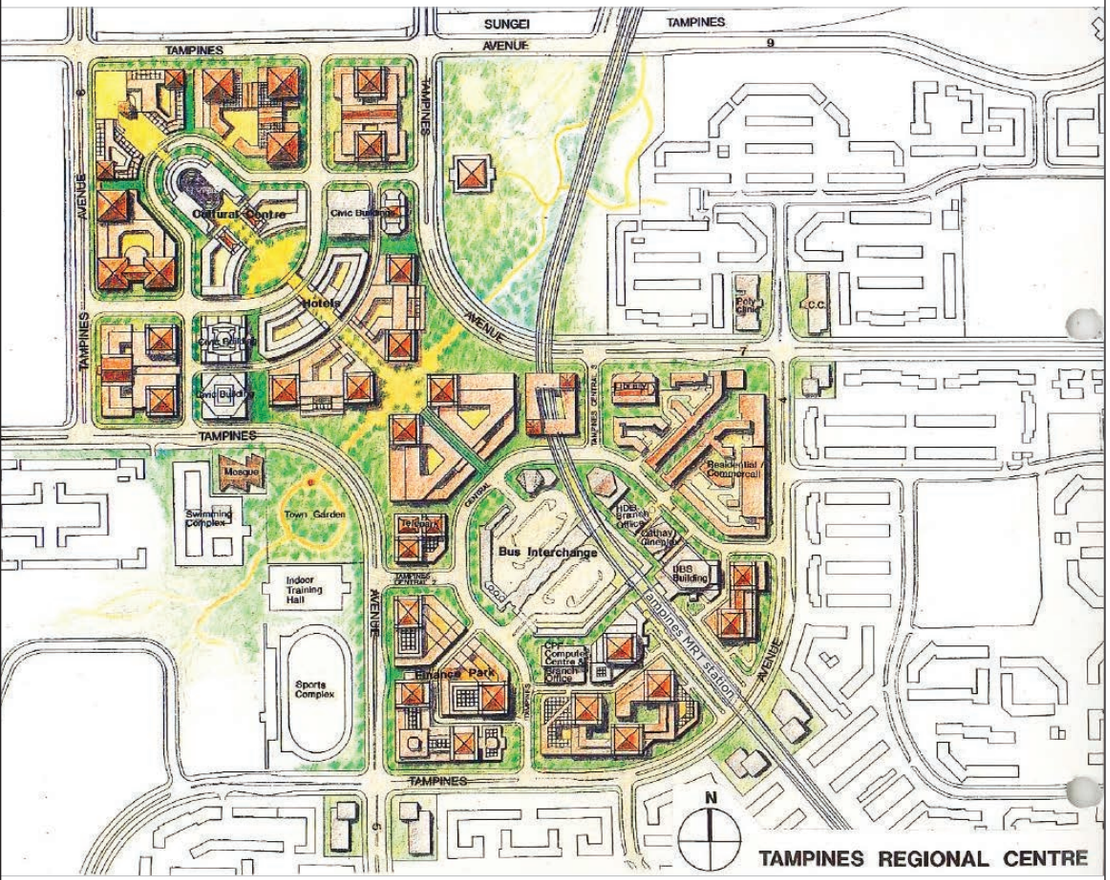
The public transport network would serve the Constellation, with each commercial centre having its own MRT station that would also act as a transport node. High-density clusters of residences, office blocks and attractions such as shopping malls would also generate heavy travel demand. Therefore, situating them near MRT stations would provide convenience and connectivity without heavy reliance on private transport. This would lead to better utilisation of the public transport system and increase its operational viability. The government also committed to two other developments: a brand-new North East Line (NEL) to connect the future townships of Punggol and Sengkang, and extending the North South Line (NSL) towards Woodlands to create a loop and connecting it to Jurong East (See Case Study: A Tale of Three Regional Centres).

CASE STUDY: A TALE OF THREE REGIONAL CENTRES

Four regional centres were identified in the CP 1991: Tampines in the east, Jurong East in the west, Woodlands in the north, and Seletar in the northeast. At 15 times the size of a typical town centre, each Regional Centre was expected to accommodate 1.5 million m² of commercial developments—half of which would be for offices, 35% for retail and dining, and 15% for hotels and entertainment—to serve 800,000 people by Year X, which would be when Singapore's population reached four million.[106] While the centres at Tampines, Woodlands and Jurong East materialised to varying extents, Seletar has since been earmarked for development of the aerospace industry and was thus not developed as a regional centre.

Tampines: The Natural

Tampines was the first Regional Centre to take shape in the early 1990s. Until then, it was a new Housing & Development Board (HDB) township dominated by public housing and anchored around the above-ground Tampines MRT station on the East West Line (EWL). Easy access to the comprehensive public transport system, three major expressways, and proximity to Changi Airport were key factors favouring a Regional Centre there. The timing was also apt—Tampines's public housing development had been recognised in 1991 with a World Habitat Award by the United Nations' Building and Social Housing Foundation.[107]



1991 master plan and urban design for Tampines Regional Centre.
Image courtesy of Housing & Development Board.

Tampines Regional Centre was envisaged as "a mini-downtown in your own backyard" that would contain most facilities found in the city centre. Residents could make fewer trips downtown, as the Regional Centre could provide the range and depth of amenities, jobs and services to meet most of their daily needs. The structure and urban form of Tampines Regional Centre took on a unique "hourglass" shape. Its southern end contains a transport-cum-commercial hub which has since been realised, while the northern end, originally earmarked as a cultural hub, has been developed for residential use.

Tampines Regional Centre was carefully designed to meet several aims, including pedestrian accessibility and creating a comfortable and unique street life. To facilitate the anticipated high level of traffic and pedestrian movements, a central "spine" road—Tampines Concourse—was built to connect developments in the southern and northern ends. "Doughnut" shaped buildings with large internal courtyards, coupled with covered walkways, also made it easy for people to move around.

Among the designated Regional Centres, Tampines was the first to take off very successfully, guided by its master plan and detailed urban design guidelines. The HDB also acted as the planning and land sales agent for the government, launching and shaping more than 10 plots of land in Tampines Regional Centre. The Central Provident Fund (CPF) Board, DBS Bank and cinema operator Cathay Organisation were among the early entrants to the Regional Centre,[108] and new shopping malls were constructed. To kick-start the relocation of businesses, the master plan included a "telepark" to house communication and computer systems of companies, and a "finance park" jointly promoted by the Monetary Authority of Singapore (MAS) and the Economic Development Board (EDB). Wong Kai Yeng, who was the URA's Director of Physical Planning in the 1990s, recalled that it initially took some convincing to get companies to come to Tampines, and that the availability of the MRT line helped make the case.

> *So, some of the companies will struggle [to stay] in the city centre instead of moving out. There was a lot of convincing...but some of them were convinced to put some of their backroom operations [in Tampines].... Then we assured them that even if they have to travel, you have the MRT, which is quite fast.*
>
> Wong Kai Yeng, former Director of Physical Planning, the URA[109]

Many companies relocated their data centres, administrative and training functions to Tampines where rents were lower, as these backend operations did not need to be located in the very expensive Central Business District (CBD). Some of the first movers included financial institutions like Citigroup and NTUC Income,[110] as well as multinationals like Hitachi and Abacus. At the same time, the Jurong Town Corporation (JTC) was busy developing new industrial and business parks nearby, such as the Changi Business Park and the Tampines Wafer Fab Park.

By the early 2000s, the decentralisation approach appeared to have worked in Tampines. Despite the limitation of building height restrictions due to its proximity to the airport, the Regional Centre had built up a critical mass of about 120,000 m^2 of office space spread over several buildings.[111] More than 40% of workers in Tampines and Changi Business Park lived in the east.[112] Today, Tampines Regional Centre functions like a complete mini-city in the eastern region of Singapore. Tampines received a further boost when phase three of the Downtown Line (DTL) opened in October 2017, linking it to Marina Bay.

Woodlands: Led by the MRT

In the late 1980s and early 1990s, the HDB was facing an excess stock of unsold flats in Woodlands. It was reported in 1991, that only about half of the flats there were occupied.[113] With the NSL then terminating at Yishun, Woodlands was perceived to be less well served by public transport and thus an unpopular choice of residence.

Despite the clamour for a new MRT line to serve the northeast region, the government decided instead to prioritise the extension of the NSL towards Woodlands, forming a loop to Choa Chu Kang in the northwest (the terminating station at a Branch Line connecting to Jurong East).[114] The HDB's public housing development programmes for Woodlands were at the time more advanced than for the northeast, ensuring economically viable ridership numbers. It was also cheaper to build the Woodlands extension first.[115] The Mass Rapid Transit Corporation (MRTC) had initially planned for four stations along the Woodlands extension, which were increased to six to cater to a larger catchment in the upcoming Regional Centre.[116] Built at a cost of $1.3 billion and completed in 1996, the MRT extension boosted the accessibility and attractiveness of the new township, and a brand new Seletar Expressway (SLE) was also built to link Woodlands to the Central Expressway (CTE).

Woodlands Regional Centre was envisaged to provide major services and amenities for the fast-growing population in the northern sector of Singapore. When completed, it was expected to yield about 1.5 million m^2 of commercial GFA[117] serving some 61,000 public and private housing units in Woodlands and neighbouring towns.[118] The southern half of the Woodlands Regional Centre would serve as the commercial and business centre, while the northern half was planned primarily as a cultural and entertainment hub. The HDB's development strategy was to first privatise a parcel of land on the southern side of the MRT station for commercial use, which was later developed into Causeway Point retail mall in the mid-1990s. It also built the Woodlands Civic Centre, housing various government services within a single building and providing contiguous development towards the MRT Station.

A major pedestrian spine was planned to run through the Regional Centre, perpendicular to the MRT track which cuts the centre in two. Two public plazas, which formed nodes along this pedestrian spine, would serve as focal points in the northern and southern sections of the Regional Centre. The HDB also required the developer of the first commercial site to provide 24-hour public access through the development at ground level along the pedestrian spine.

In the 2013 Master Plan, the Woodlands Regional Centre was expanded to 100 hectares (1 million m^2) of developable land. Two distinct precincts were identified: Woodlands North Coast, and Woodlands Central around the MRT station.[119] The revamped Regional Centre was to anchor the growth of the North Coast Innovation Corridor, with the Thomson–East Coast MRT line (TEL) scheduled to pass through Woodlands by 2019. A new North–South Corridor, featuring continuous bus lanes and cycling trunk routes is currently in the works, and will provide more connections between Woodlands and the city centre. The Singapore terminus for the future rapid transit system link to Johor Bahru is also slated to be at the Woodlands North station on the TEL.[120]

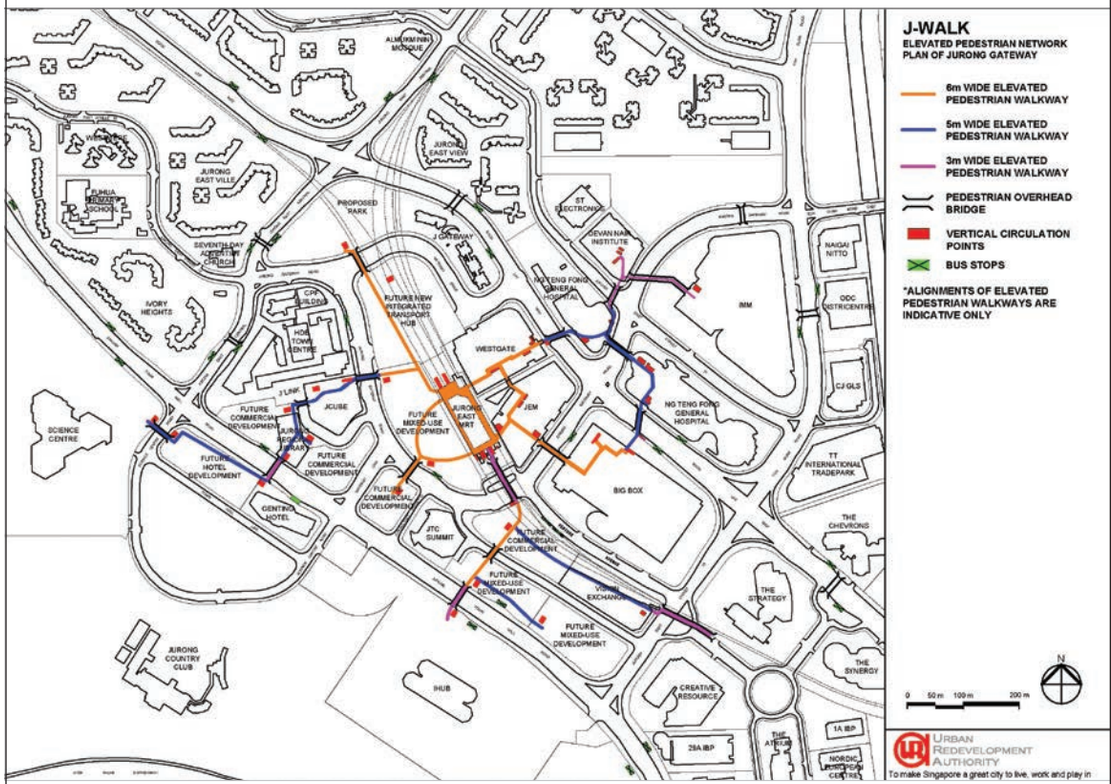
Jurong East: The Late Bloomer

In Jurong East, located in western Singapore, the MRT station served as the focal point for the Regional Centre. Completed in 1988, the Jurong East station went on to become an interchange between the EWL and the NSL when the latter's Woodlands extension opened in 1996. Although construction of public housing in Jurong East had started as early as the 1970s, much of the land surrounding the MRT station was left vacant in anticipation of future development. An early version of the Development Guide Plan (DGP) for the Jurong East Regional Centre, prepared in 1992, featured a bold proposal to create a traffic-free environment by building an underground road network and a massive subterranean carpark.[121] The subsequent 1995 Jurong East planning area report earmarked nine hectares (90,000 m^2) on either side of the station for high-rise commercial tower blocks, with medium-rise office blocks sited farther away.[122]

In the early 1990s, the public sector embarked on a number of developments to kickstart the Regional Centre. The JTC established Singapore's first business park there in 1992—the 37-hectare (370,000 m^2) International Business Park (IBP). Government offices were encouraged to free up space in the CBD for the private sector by shifting to suburban commercial hubs such as Jurong East. In 2000, the JTC moved its own headquarters to the new JTC Summit Building, which was close to the Jurong East town centre and its transport nodes.

However, the flurry of public-sector activity was not matched by the private sector. Only a handful of commercial and retail developments took root in Jurong East in the 1990s, such as the Jurong Entertainment Centre and the International Merchandising Mart (IMM) Mall, featuring a mix of retail and warehousing facilities. Jurong East's positioning as a gateway to the Jurong and Tuas industrial areas was both a boon and bane. While the proximity of Jurong East to the industrial areas made it a natural choice for a regional centre, the public perceived it as being overly industrial and too far from the city centre. The challenges of marketing the nearby IBP in the mid-1990s were telling.[123]

In the Master Plan 2003, four sites immediately adjacent to the station were zoned commercial or "white", allowing a wider mix of uses.[124] However, the convergence of several rail tracks at the above-ground Jurong East MRT station had increased the challenge of developing the immediate surroundings.[125] The master plan was tweaked further following reviews in 2008 and 2014. Expanded and rebranded as Jurong Lake District (JLD), it is currently being developed as Singapore's second CBD over an area as large as the new downtown at Marina Bay.



Schematic plan of the Elevated Pedestrian Network (J-Walk).
Image courtesy of Urban Redevelopment Authority.

Jurong has always been seen as industry, companies did not want to go there, no matter what you say...even though it's an MRT interchange and all that, we were not very sure at the time when we did [launch Jurong East], whether it would grow.... So, a couple of things happened. First thing is, I think, given [the URA] planners' ingenuity, they decided not to call it Jurong East Regional Centre, it's Jurong Lake District, because...[the URA] pulled in the greenery, Chinese Garden, Japanese Garden...and that's where the liveability comes in.... And then we did small things like environmental improvements...later on, when we did the master plan for the whole area, we parcelled the land and sold it.

Wong Kai Yeng[126]

Integration with transport facilities featured strongly in Jurong East.[127] Developers were required to construct various parts of an elevated pedestrian network known as "J-Walk" to seamlessly connect surrounding developments to the public transport node, enhancing the area's walkability. For sites nearest to the MRT station, the URA imposed land sales conditions mandating that developers provide street-level and elevated pedestrian networks. To further incentivise private developers and building owners to connect to the elevated pedestrian network, the URA introduced a GFA exemption scheme in 2010. Under the scheme, space within buildings that constituted part of the elevated pedestrian network—previously treated as internal circulation space—could be exempt from the permitted GFA.[128]

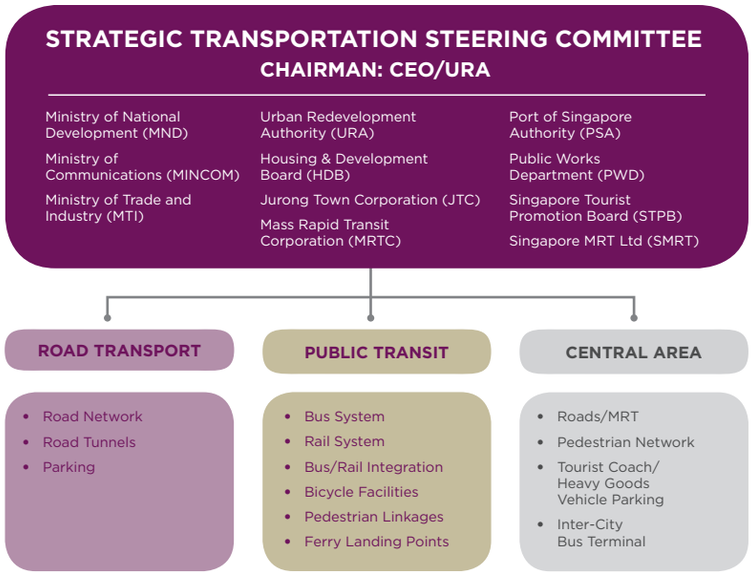
Nearby, a new precinct has been designated as a mixed-use business district containing the proposed terminus for Singapore–Kuala Lumpur High Speed Rail. The traffic-free environment envisioned decades earlier in 1992 may be partially realised in the new precinct, which has been planned as a "car-lite" district. With an ambitious target of more than 80% of trips within the precinct to be made by public transport, it would feature consolidated underground car parks, an extensive network of cycling paths as well as a 45-hectare area served only by public transit.[129]

SUPPORTING THE 1991 CONCEPT PLAN

The Strategic Transportation Plan

In 1995, a Strategic Transportation Plan (STP 1995) was developed to support the CP 1991. It was a multi-agency effort aimed at evaluating traffic implications of the land use proposals and recommend safeguarding key transport corridors. In the early 1990s, land transport responsibilities were split among various agencies. Roads, rail infrastructure and assets fell under the purview of the Public Works Department (PWD) and the MRTC respectively, while the Ministry of Communications oversaw bus operations. The URA initiated the formation of a planning group comprising representatives from departments and statutory boards under the ministries of national development, communications, and trade and industry.

Exhibit 6:
Working Structure of the Strategic Transportation Plan



With a common platform in place, the STP 1995 was put together with an emphasis on building road and rail networks. It was developed in two phases: phase one involved setting out basic policy directions and formulating a draft plan, which was tested in phase two using a computer-based forecasting model to simulate traffic flows under various policy scenarios. The STP 1995 also touched on finer elements of integration, such as pedestrian linkages, bus-rail integration and bicycle facilities (see Chapter 7). It stressed that public transport journeys should be direct, with sufficient network coverage for 95% of trips to be completed within one transfer, whether intra- or inter-mode. Additionally, these trips should be no more than 30% longer than similar journeys taken by car.[130]

Setting up the Land Transport Authority

In 1995, the Land Transport Authority (LTA) was formed to take on transport responsibilities initially divided among agencies such as the Registry of Vehicles (ROV), MRTC, the Roads and Transportation Division of the PWD and the Land Transport Division of the Ministry of Communications. The LTA was given oversight over both public and private vehicle matters and its responsibilities included policymaking, regulatory functions, systems servicing and land transport planning.[131] In 1996, the LTA published a white paper titled "A World Class Land Transport System", detailing its vision to improve Singapore's transport system and incorporating the goals of the CP 1991 and STP 1995. It outlined the following key challenges:

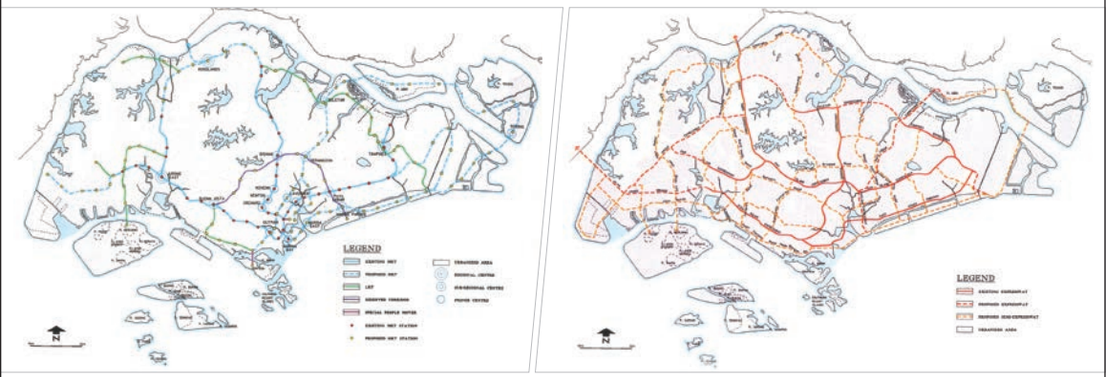
i. Integrating transport and land use planning
ii. Expanding the road network, maximising its capacity
iii. Managing road usage and demand
iv. Providing quality public transport choices[132]

The white paper envisioned a "value for money" world-class transportation system comprising air-conditioned buses serving light corridors, and trains serving heavier ones with high travel speeds and predictable timings.[133] The recommendations of the STP 1995 were also adapted into an internal document that formed the basis for the LTA's Land Transport Master Plans of the 2000s, and which contained alignments of MRT lines to be built up to 2030.[134] It helped to set the stage for the next phase of integrated transport and land use development.

CHAPTER 5

CONNECTING THE DEVELOPMENTAL CORRIDORS

Beyond proposing the creation of key commercial centres, the 1991 Concept Plan (CP 1991) also presented plans for expansion along new developmental corridors. These included the accelerated development of Woodlands in the north as well as another area in the northeast, opening up the new townships of Punggol and Kangkar (now known as Sengkang) by the late 1990s. The transport network would expand accordingly, branching out to serve the needs of the residents and the working population in these previously underdeveloped areas. This required comprehensive planning and well-coordinated development efforts among many different public agencies.



Proposed MRT and major road network for Year X in the 1991 Concept Plan.

CONNECTING NEW TOWNS

While about 80% of the expressway network proposed under the State and City Planning Project (SCP) had been completed by 1990,[135] further road expansion was needed to cope with continuous economic and population growth. The 1995 Strategic Transportation Plan (STP 1995) emphasised connecting major arterial roads to activity centres, and a new category of road, namely semi-expressways, was added to the road hierarchy. Major arterial roads slated for upgrading to semi-expressways did not require widening. Instead, grade-separated junctions such as flyovers and underpasses were added along with extra time for green traffic signals, increasing the capacity of these roads by as much as 60%. A conceptual island-wide road grid was also drawn up to achieve an optimal traffic network. It comprised a "lattice" of three expressways running east to west and five flowing north to south, supported by semi-expressways within each "box"[136].

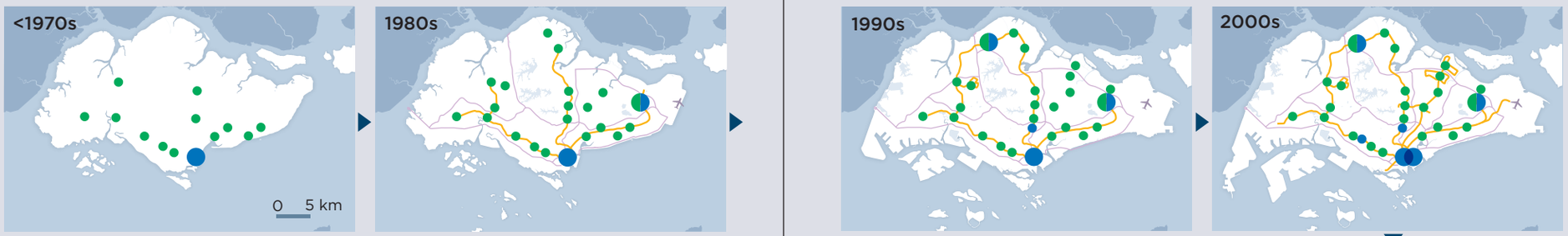
The Kallang–Paya Lebar Expressway (KPE) first proposed in the 1971 Transportation Plan faced a particularly rocky process from conceptualisation to construction. Initially, only a 2.8 km-long stretch, called the Kallang Expressway (KLE), had been planned as one of the original nine expressways. Since its alignment through the Paya Lebar Air Base posed security concerns, construction of the KLE did not commence as planned until much later.

In 1985, following a government study, the development of the northeastern corridor commenced. To serve the upcoming townships of Sengkang and Punggol, a 9.2 km long continuation was added to the KLE—essentially the southern leg of the KPE—linking it to the Tampines Expressway (TPE). After reviewing various options, the KPE's original alignment was preserved, save for a shift to the west of the air base to allay security concerns.[137] To minimise land usage, three quarters of the KPE was built underground and the tunnel snaked past built-up areas and waterways. The KPE fully opened in 2008, reducing pressure on the parallel Central Expressway (CTE) and improving connectivity to the northeast.[138]

The STP 1995 also recognised the need to control road usage, despite expansions in road capacity, as demand for cars would increase with affluence. Road pricing was bolstered—with the new Electronic Road Pricing (ERP) system replacing the old Area Licensing Scheme—to increase awareness of the cost of congestion and curb road usage. This also provided an incentive to consider using public transport,[139] which would have to be enhanced to meet the travel needs of Singaporeans.

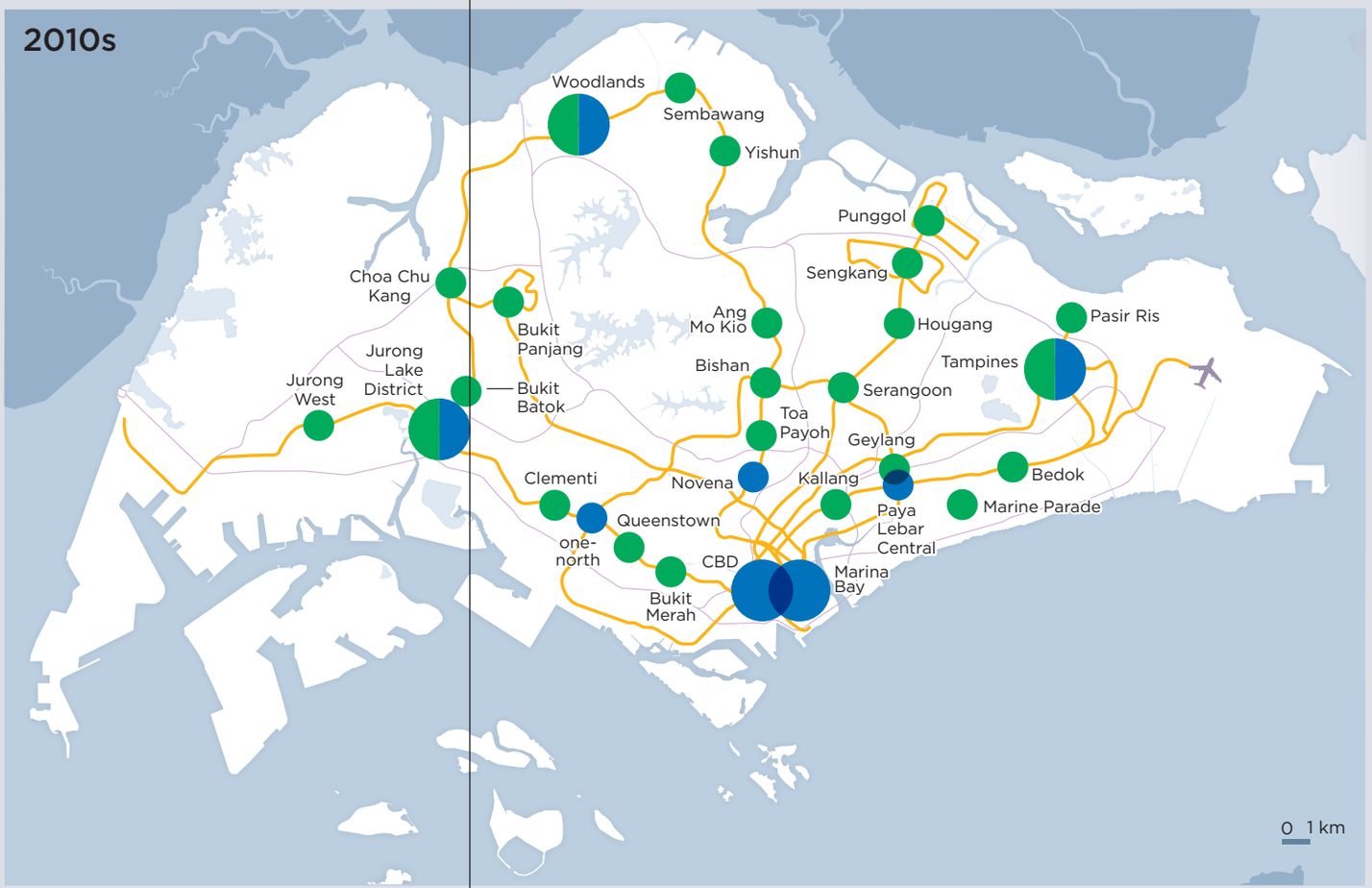
The Mass Rapid Transit (MRT) rail network underwent simultaneous expansion with road building to ensure that the newly developed corridors would be well-served by public transport. In the 1990s, the government committed to extending the North South Line (NSL) in a loop towards Jurong East, as well as a brand new line towards the northeast—the North East Line (NEL)—to support the rapid development of new towns there (see Chapter 4).

EXHIBIT 7



INTEGRATING LAND USE AND MOBILITY: IN RETROSPECT

Integration is achieved when the transport network is planned in tandem with key areas of development. This is necessary to optimise the utility and value of Singapore's scarce land and to ensure that new housing towns, commercial centres and employment hubs are well served by the transport network, and in particular, public transit.



Transport Network
- MRT Lines
- Expressways

Areas of Development
- Housing Towns
- Commercial Centres

BUANGKOK'S WHITE ELEPHANT: CHALLENGES OF PHASING HOUSING AND TRANSPORT DEVELOPMENT

Singapore got its third MRT line when the $4.6 billion high-capacity NEL opened to much fanfare in 2003. The underground line took seven years to build and traverses a 20 km route with 16 stations linking housing estates such as Hougang, Sengkang and Punggol to the city centre. However, hopes of some residents were dashed when the operator, Singapore Bus Services (SBS) Transit, announced just three days before the NEL's inauguration that Buangkok station would not be opened immediately. With the start of the NEL already delayed by seven months, the unexpected announcement prompted some to label the $80 million station a "white elephant".[140] Despite lobbying by local Members of Parliament (MPs) and grassroots leaders, the station only opened in January 2006.

Located between Hougang and Sengkang stations, the Buangkok station was then surrounded by open fields and lacked residential developments in its immediate vicinity. The Land Transport Authority (LTA) had assessed that 2,000–3,000 housing units were needed within 400 m of the new station for operations to be financially viable. With only about 500 housing units within this radius at the time,[141] the prospective ridership for Buangkok was deemed too low. In fact, the SBS Transit would save an estimated $1 million in annual operating costs by not opening the station.[142]

While the government had in-principle approved building the NEL as early as in 1988, its development timeline and financial viability had depended on the public housing programme in the northeast. The fully underground NEL would also cost more to operate than a surface line, and the government was prepared to develop such new lines provided they could at least recoup operating costs. In the mid 1990s, when plans for the NEL were being studied, demand projections for rail services were buoyant, with daily ridership projected at between 200,000 and 250,000.[143] At the same time, the Housing & Development Board (HDB) was running a high-volume building programme to service the strong housing demand. Mohinder Singh, former LTA Director of Planning, explained the process of estimating potential rail ridership:

> *[The] HDB projected so much, and based on that, the transport modellers in [the] LTA also ran the figures to say that by the opening year [for the NEL], there should be a certain amount of ridership, which will increase with the take-up of houses... therefore, if you look at it over the appraisal period of the line, it would be viable.*[144]

Construction of the NEL began in 1997, when the resident populations of Sengkang and Punggol had started growing. However, housing demand slumped soon after the 1997 Asian Financial Crisis, and the economic downturn triggered by the 11 September 2001 terror attacks in the United States (US). The HDB found itself scaling back housing developments in Sengkang and Punggol. However, the government pressed ahead with the development of the NEL as delays would have increased costs. When the NEL started service in 2003, it carried fewer than 150,000 passengers a day, far lower than the 200,000–250,000 projected earlier.[145] The SBS Transit's annual losses were projected at up to $40 million in the short-term.[146] Then Minister for Transport, Yeo Cheow Tong, told Parliament in 2003:

> *[The NEL was] running a deficit because the developments in the northeastern part [had] been a lot slower than originally projected when the decision was made to proceed with [the] NEL...because of the slowdown in demand for flats, the building programmes for Sengkang and Punggol have had to be scaled back quite significantly.... So, if the demand had taken place, or had developed as originally anticipated in the early 1990s, then the NEL would have been viable fairly quickly.*[147]

BUANGKOK'S WHITE ELEPHANT: CHALLENGES OF PHASING HOUSING AND TRANSPORT DEVELOPMENT

Continued...

Despite the economic downturn and drop in housing demand, by early 2005, the HDB had completed 960 housing units in the area, which was still short of the required critical mass.[148] However, following vigorous lobbying by MPs and grassroots leaders, Yeo announced that the station would open by mid-January 2006, despite studies predicting that it would incur losses until 2008.[149]

This episode illustrated the challenges of phasing housing and transport developments to meet the expectations of the public, especially given that Singapore's open economy is buffeted by external economic conditions. It also highlighted the difficulties of balancing public benefits and private costs.

Although mismatches like this do happen from time to time, this does not negate the need for close coordination among stakeholder agencies. In fact, greater efforts have been put into coordinating the planning of rail stations and new developments. For example, agencies have worked together to plan for a new MRT station, Punggol Coast Station, along the NEL extension to serve future developments in Punggol North.

LOCALISED INTEGRATION: LINKING DEVELOPMENTS TO MRT STATIONS

Large fields surrounding MRT stations were a common sight in the 1990s. The 1996 white paper by the LTA noted that far closer cooperation between transport and land use planners was needed to achieve fully integrated usage of such areas. The objective was two-fold: maximise development potential around the stations and improve the convenience of travel.

The lack of integrated development had been highlighted by an Inter-Ministry Committee on MRT/Bus Integration set up in the wake of STP 1995. It found that such sub-optimal land use stemmed from a lack of synchronised development as the stations were sometimes built before new townships. There was also a prevailing view among public sector agencies that land around stations was primarily for commercial use, hence too valuable to be utilised for bus interchanges and housing, even when market demand was weak. The land adjoining MRT viaducts was "sterilised" to provide a buffer against track noise in keeping with Pollution Control Department guidelines.[150]

The Committee urged "a total approach towards the planning and development of land use around MRT stations...For the proposed NEL, the Urban Redevelopment Authority (URA), HDB and/or LTA would be responsible for the integrated planning of land use around the stations. A single agency should then be appointed as the overall developer for the integrated development of land around the stations."[151] It also recommended that future developments be built atop underground stations, or astride the viaducts for those above ground. The land could be opened up to high-density uses beyond purely commercial developments, such as residential or mixed uses. Instead of using setbacks as a noise buffer, sound barriers and use of noise-attenuating materials in trains could be employed. It was also recommended that all future MRT lines be built underground to allow development of land above the stations.[152]

Such sites were progressively released for high-density, mixed-use developments with high plot ratios and accessibility to public transport. However, the pace of release of the sites is usually carefully considered, to balance supply with actual demand for development quantum. At the

same time, there is a need to safeguard reserve sites for future needs. The LTA worked with the URA and the HDB to ensure its vision was properly articulated in their development plans. Planning provisions for high-rise integrated developments near MRT stations were included in the URA's Development Guide Plans (DGP), which were detailed master plans at the local planning level.

During the development of the NEL, the government strongly pushed for integrating and intensifying the use of land around stations. A large amount of private land was acquired with the objective of re-distributing the benefits of the increase in land values expected around the new MRT stations. While many low-density developments in areas such as Little India and Kovan were acquired, some religious and conservation buildings were left untouched.

CASE STUDY: DHOBY GHAUT—A NEW DEVELOPMENTAL APPROACH

By the mid-1990s, while new developments had emerged around and above MRT stations in the Central Area such as Raffles Place, land around Dhoby Ghaut on the NSL remained largely undeveloped despite the URA's push for intensification.[153] The LTA's formation in 1995 provided the government an opportunity to try a different approach to integrate transport and land development.

Around that time the URA was also finalising its DGP for the 83-hectare (830,000 m^2) Museum Planning Area, which included the vicinity of Dhoby Ghaut. It was envisaged as a commercial hub for the Museum precinct, which was otherwise characterised by historic buildings, institutions, arts and cultural facilities. The redevelopment around the station would expand the commercial floor space by about 250% to 625,200 m^2. The most intensive use—up to plot ratios of 4.9—was earmarked for the sites next to and above the existing MRT station and the planned NEL interchange.[154] Developers of these parcels would be required to provide underground pedestrian linkages to the MRT station and adjacent buildings.

Then Minister for Communications, Mah Bow Tan, announced in 1996 that the LTA would take the lead in developing the land above a new interchange at Dhoby Ghaut for the NEL. Dhoby Ghaut was also expected to serve as the interchange for the Circle Line (CCL), Singapore's first medium-capacity orbital route to be opened in 2010. The CCL would connect all existing radial MRT lines with interchanges in suburban commercial centres, providing inter-line transfer options outside the busy city centre.[155] Once all three lines intersecting at Dhoby Ghaut were operational, some 20,000 commuters would pass through the station every hour during peak periods.[156] Mah explained the rationale for the LTA's involvement:

> *Transport facilities will be fully integrated as far as possible with building developments around the MRT stations. In this way, it will give commuters maximum accessibility to housing, commercial and recreational facilities. For the North East Line, the LTA will develop the two interchange stations, i.e., the one at Dhoby Ghaut, which interchanges with the North South [Line], and Outram Park which interchanges with the East West Line. The reason why the LTA is getting involved is to demonstrate the feasibility and the benefits of such an approach.*[157]

The 9,575 m^2 site above the proposed interchange station—wedged between Plaza Singapura shopping centre and the historic MacDonald House—would be the first integrated commercial development to be built concurrently with a station beneath it. Local property developers were reluctant to construct above MRT stations due to concerns about the additional risks.[158] The project was intended to demonstrate that, despite the technical challenges, such integration could be achieved. However, the government was clear that the LTA was not expected to be the developer of all sites adjoining stations, which would remain the role of the private sector through Government Land Sales, or developing agencies like the HDB.

The Dhoby Ghaut NEL station was envisaged as a five-level interchange connected to the existing NSL station and adjacent properties, including the one to be developed by the LTA. At 28 m below ground, the station

The Atrium@Orchard built above the Dhoby Ghaut NEL station.
Photo courtesy of Terence Ong, CC-BY-SA-3.0, via Wikimedia Commons.

was the deepest and largest at the time. The surrounding road network was realigned to improve traffic flow and create a larger plot of land for redevelopment. Loading provisions for future developments above the station had to be carefully designed in consideration of the complex network of service and MRT tunnels running underneath. The Stamford Canal would run through the first basement of the NEL station, requiring the commercial development to be built over the canal in two blocks. The government also updated the legal definition of land under the Land Titles Act in 2001 to address issues with land titles for such integrated mixed-use projects involving airspace and underground space.[159]

The commercial development, named The Atrium@Orchard, and the NEL station were completed in 2002.[160] The commercial development was then handed over to the Singapore Land Authority (SLA) and sold in January 2008 to the CapitaMall Trust (CMT) with a fresh 99-year lease.[161] Capitalising on its ownership of Plaza Singapura next door, the CMT further integrated the two properties and improved connections via linkways.

Though more of such integrated developments were planned at NEL stations, private sector appetite remained supressed following the Asian Financial Crisis.[162] However, by 2001 a few stations such as Clarke Quay, HarbourFront and Sengkang (see Case Study in this chapter) had been tendered out for integrated developments featuring mixed-use or residential projects.

NURTURING A MULTI-MODAL TRANSPORT SYSTEM

By 1996, 51% of daily trips were made by public transport—3 million by bus and 700,000 by MRT. To increase this proportion, it was important to understand commuters' woes and implement targeted solutions. For buses, the long, unpredictable waiting times and lengthy journeys were the main concerns, while MRT users complained about overcrowding during peak periods and the inaccessibility of stations. Alongside efforts to develop the areas surrounding transport nodes, the systems themselves would need upgrading to provide a higher level of service.[163]

Integrating Rail and Bus Infrastructure

The advent of the MRT and its subsequent expansions necessitated the rationalisation of existing bus services to prevent overlapping and duplication of routes, resulting in under-utilisation of many bus interchanges built before rail network. At Toa Payoh interchange—completed in 1983—occupancy of bus bays averaged as low as 38% in 1994.[164] Existing interchanges in town centres also took up large swaths of prime land that had increased in value after MRT stations were built nearby. The Inter-Ministry Committee on MRT/Bus Integration recommended that the LTA work with bus operators to right-size these interchanges by rationalising bus bays along with bus services. The prime land reclaimed in the process could be redeveloped and intensified, increasing demand for the rail system.[165]

The HDB was responsible for building bus interchanges in new towns. For the convenience of commuters transiting from the MRT station to the bus interchange, the HDB created retail corridors to provide shopping facilities[166] though some commuters preferred to take short cuts through the open fields, risking potential hazards along unsheltered and unpaved tracks.[167]

Intensifying developments around MRT stations alone is not sufficient to ensure good accessibility. Planners must fully integrate MRT stations with building developments and other transport modes. For example, at the new Woodlands MRT station, other transport facilities like bus interchange and taxi and car drop-off points are well integrated with the station. Commuters can interchange easily, in comfort, even in inclement weather.

The Land Transport Authority[168]

Vertical integration of bus interchanges and MRT stations would also be explored.[169] In 1992, Singapore's first underground bus interchange was commissioned by the Mass Rapid Transit Corporation (MRTC). Taking advantage of the undulating terrain, the interchange would be developed below the Woodlands MRT station, which would open in 1996 as part of the NSL extension.[170] The HDB remained closely involved in the process to ensure that the interchange would be well integrated with the rest of the town. Deputy CEO (Building) of the HDB, Fong Chun Wah, recalled that the HDB and the MRTC worked closely to sketch out access points and ensure that buses did not circle excessively around the town centre, and could "quickly dive down underground".[171] These efforts amounted to savings in land cost and enhanced development potential of the surrounding land, which was valued at $308 million.[172]

Woodlands MRT station above the bus interchange (left) and Toa Payoh Integrated Transport Hub (right).
Photo from the Ministry of Information and the Arts Collection, courtesy of National Archives of Singapore (left) and courtesy of Centre for Liveable Cities (right).

Vertical integration greatly improved commuter experience by enabling transfers via a short and sheltered passenger concourse. Unlike older stations, no retrofitting was required at Woodlands since integration had been earlier planned for.[173] Accessibility by the NSL and the convenience of intermodal transfers helped to turn Woodlands from a "barren country" to a more attractive place to live.[174]

The concept of Integrated Transport Hubs (ITH) was introduced with the opening of the first air-conditioned bus interchange at Toa Payoh in 2002. This stemmed from a need to redevelop bus interchange sites in town centres as part of larger integrated developments to allow for "better and more intensive land use".[175] The Toa Payoh ITH replaced the existing bus interchange and was integrated with the town's MRT station, retail uses and the HDB Hub. Subsequently, plans for many of these integrated developments were undertaken by private developers through Government Land Sales (GLS). In these cases, the HDB or the URA, as the land sales agent, worked closely with the LTA to develop the land sales brief for tenderers.[176]

With about 65% of all MRT users walking 800 m or less to the nearest station,[177] the STP 1995 identified the need to provide pleasant and safe pedestrian access to transport nodes and proposed planning and design criteria for walkways. Activity zones were to be created within 400 m of transport nodes, and, where possible, climate modifiers—covered malls, air-conditioned gallerias and greenery—incorporated to help mitigate Singapore's hot and wet climate. The Public Works Department (PWD) also had an ongoing programme to provide sheltered pedestrian access to transport nodes.[178] To support an increasingly multi-modal transportation system, the STP 1995 also looked at integrating networks, fares and facilities. These measures would come together to make access and transfers seamless and convenient, with minimal operating inefficiencies.[179]

Light Rail Transit

In the late 1990s, the Light Rail Transit (LRT) system made its debut as a new feeder service in selected townships, extending the reach of the rail network. Unlike the MRT, the LRT catered to relatively low demand from within individual townships and also required lower capital expenditure. The LRT could run at higher frequencies than buses, and accessibility and convenience could be factored into the system design and location of its stations. For example, LRT alignments were made to hug the road reserve instead of sitting astride road dividers like MRT lines. This allowed stations to be located closer to housing developments.[180]

Bukit Panjang LRT station.
Photo courtesy of Land Transport Authority.

Singapore's first LRT system opened in Bukit Panjang in 1999, following years of lobbying by residents for better connectivity. Extending the NSL to Bukit Panjang was not operationally and financially viable because it was a low-density area outside the MRT alignment. Hence the Bukit Panjang LRT (BPLRT) was introduced as a feeder system with small driverless trains operating in a loop, with one point of connection to the NSL.[181] However, the pre-existing infrastructure posed constraints. As a result, the tracks were squeezed between HDB blocks, running on average 8 to 10 m from residents' windows.[182] Not all stations could be optimally sited and the rail alignment was restricted to an elevated path above existing roads, creating kinks and undulations. To generate sufficient demand for the LRT and prevent duplication of routes, bus services were rationalised, effectively eliminating the only public transport alternative in the event of breakdowns—a trade-off between efficiency and resilience. Even with its flaws, the LRT proved beneficial to Bukit Panjang as buses alone could not have coped with demand.[183]

The lessons from the BPLRT were taken into account in planning the new towns of Sengkang and Punggol, where LRT systems were incorporated from the outset rather than retrofitted. LRT stations in these new towns are carefully sited in relation to the nearby housing developments, providing seamless connectivity to the nearest MRT station.[184]

Multi-Modal Operators

Integration was also pushed beyond physical infrastructure, and the government wanted multi-modal operators to helm Singapore's public transport systems. With the expansion of the rail network, bus operators who failed to diversify would continue losing market share due to route rationalisation. Multi-modal operators running both bus and rail services would be able to achieve operational and cost efficiencies, and synchronise services to provide easy transfers between the two modes.[185] In 2001, both the Singapore Bus Service (SBS) and the Trans-Island Bus Services (TIBS) underwent corporate changes to become multi-modal operators— the SBS became SBS Transit Pte Ltd and the TIBS became the SMRT Buses Ltd, a subsidiary of the SMRT Corporation. The ability to operate a multi-modal transport system was a key criterion in the selection of the operator of the NEL and the Sengkang and Punggol LRTs.[186] The SBS Transit was selected in 2001, as it provided a better integration plan than the SMRT.

CASE STUDY: SENGKANG—INTEGRATION FROM SCRATCH

Sengkang was conceived as a bustling housing township with unprecedented levels of intensification and integrated planning. In 1997, this largely undeveloped area in Singapore's northeast region provided planners with a clean slate to develop a truly integrated town. Sengkang featured an easily navigable internal road network and was served by three major expressways. It was also well-connected by public transport, with a station on the new NEL, a bus interchange and an intra-town LRT system.

Sengkang LRT.
Photo courtesy of Calvin Teo, CC-BY-SA-3.0, via Wikimedia Commons.

Unlike in Bukit Panjang, in Sengkang it was possible to optimise land use by siting stations to provide good coverage to most residential areas, encouraging residents to use the system and make it viable. The LRT weaved smoothly through the town, and residents needed to walk no more than 400 m to the nearest station.[187] Sufficient setback was provided between the tracks and the nearest blocks—15 m on average—to minimise noise pollution and also to ensure commuters did not infringe upon the privacy of households by being able to peer into their windows.[188] The 14-station Sengkang LRT was built in tandem with the NEL and completed in 2003.[189]

Similar to Sengkang, the rail systems in Punggol were planned from the outset to serve both the inter-town and intra-town transportation needs. Most residents in Punggol live within 200-400 m walking distance from an LRT station.

All-in-One Town Centre

The Sengkang MRT station was sited in the heart of the township. The transport node was envisioned as part of an "integrated town centre" with the MRT and LRT stations as well as a bus interchange linked to a commercial development in the midst of a residential district.[190]

The vision was translated into a developer's package, and in 1998 the HDB called a tender for the 2.7-hectare (27,000 m^2) plot despite a weak property market. The Sengkang site was a rare exception to the decision to halt the GLS programme in 1998 and 1999, in an attempt to safeguard the opportunity of building a fully integrated development in the town centre. The HDB worked closely with the LTA to formulate the developer's package, including conditions to ensure a high degree of integration, such as specifying air rights and integration interfaces between transport facilities and surrounding developments. Given its prime location, the site could be developed to a maximum gross plot ratio of 4.2, with at least 40% of gross floor area (GFA) to be used for commercial facilities including retail, dining, office and entertainment. The winning tenderer would also build the bus interchange, and its completion was timed to coincide with the opening of the Sengkang MRT station.[191]

Building an Integrated Hub

Designing an integrated transport, commercial and residential development came with technical challenges such as facilitating circulation of rail and bus commuters to the shopping levels, while ensuring the privacy of residents.[192] Beyond land sales conditions, the developer was given the freedom to decide on the layout and number of levels within the development.[193] The winning tenderer, Centrepoint Properties, decided to concentrate the commercial complex on one side with residential blocks on the other. This would ensure sufficient traffic flow to the retail area without spreading it out in a manner that would cause it to lose vibrancy.[194]

The integrated hub opened in 2003, with the Compass Heights condominium on one side and the Compass Point mall on the other (later renamed Compass One).[195] This was timely considering that Sengkang's population had grown more than ten-fold since its conception. In anticipation of the high-level accessibility to public transportation, the mall's retail space had been fully taken up a year before it opened. The integrated approach created a compact development with significantly improved connectivity to the Central Area.[196] The bus interchange and rail stations were built no more than 20 m apart, while taxi stands and drop-off points were connected by sheltered walkways.[197]

Big-name tenants such as Cold Storage and the National Library Board (NLB) set up shop in the mall, even attracting shoppers and visitors from neighbouring townships on the NEL, such as Hougang and Punggol. As Jeffrey Heng, then-CEO of Centrepoint Properties, noted, "Sengkang's selling point is that everything is literally at your feet." [198]

With a well-planned intra- and inter-town transport system and a vibrant central hub, Sengkang demonstrated the exemplary appeal of integrated developments.

CHAPTER 6

A PEDESTRIAN-FRIENDLY CENTRAL AREA

By the time the 1991 Concept Plan (CP 1991) was due for review, the development of three of the four Regional Centres—Tampines, Woodlands and Jurong East—proposed under it was well underway.[199] The 2001 Concept Plan (CP 2001) brought planners' attention back to the Central Area, with the goal of making it vibrant, with a critical mass of a live-in population and round-the-clock activity. Just as decentralisation helped to bring jobs and recreation facilities closer to suburban townships, the business-oriented area—comprising the Central Business District (CBD), the Civic District, Orchard Road, Bras Basah and Bugis—would be transformed into a place to live, work and play. This entailed injecting more homes, attractions and amenities into the existing CBD, as well as the new downtown at Marina Bay.[200]

The Land Transport Authority (LTA) and the Urban Redevelopment Authority (URA) joined forces to plan and design a pedestrian-friendly and public transport-oriented Central Area. With many Mass Rapid Transit (MRT) lines converging there in the near future, commuters would be able to move around the city centre easily without the need to drive. By 2025, with commencement of new lines such as the Downtown Line (DTL) and Thomson–East Coast Line (TEL), more than 90% of developments in the Central Area would be within 400 m, or a 5-minute walk, of an MRT station.[201] Integration would go beyond locating transport infrastructure close to activity hubs and involve detailed planning to link it to surrounding developments. According to Fun Siew Leng, the URA's Chief Urban Designer, this approach could help reap significant benefits, because "when developments are integrated with underground MRT stations, it makes it much more convenient for commuters to get to these developments; and land above the station is optimised and in fact the value of the land is enhanced."[202] Planning discipline and the cooperation of the private sector were essential to achieve this in a complex and densely built-up area.

PLANNING FOR WALKABILITY

In planning a pedestrian-friendly district, the URA had to first consider the broad land use strategy for Singapore and take into account the MRT alignments proposed by the LTA. The two agencies then worked together to plan the locations of the underground MRT stations before the URA drew up detailed urban design guidelines. These included defining the number and locations of entrance and exit interfaces, the development typology of station surroundings and provisions for the stations to withstand the load of buildings overhead.

ION Orchard and entrance to the underground Orchard MRT station.
Photo courtesy of William Cho @ https://flic.kr/p/6GLX8o

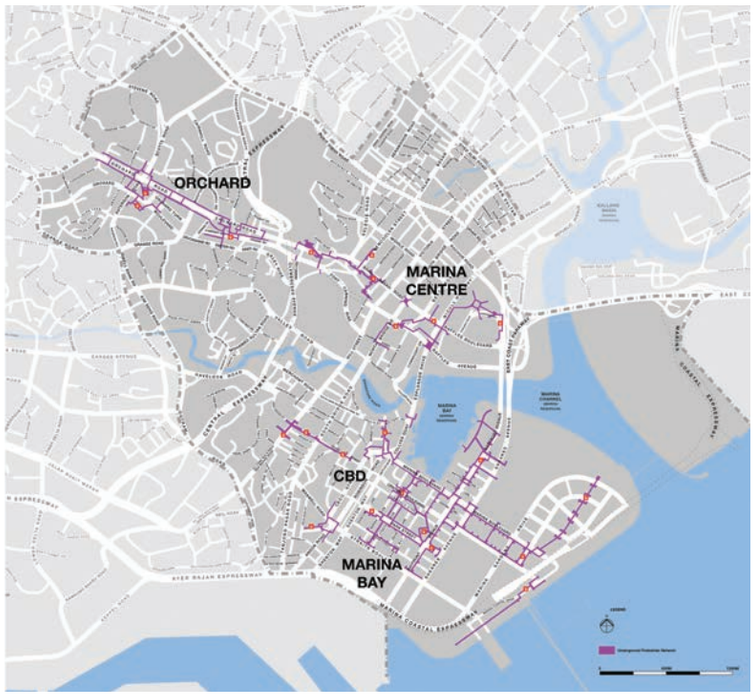
A cost-effective way to reduce loading requirements is to locate high-rise buildings away from the underground structures or locate roads, pedestrian malls or lower-rise buildings over them. Loading requirements are reflected in detailed plans that guide LTA engineers and planners overseeing the construction of stations. The provision of structural loading, or pre-loading, of underground station structures is crucial since the surrounding land may not be developed simultaneously for a variety of reasons. These include the need to optimise the value and returns from land—a scarce resource in Singapore—through comprehensive planning and integration with transport nodes before selling it. For example, the site at Orchard Turn—directly above Orchard MRT station—was sold in 2005, almost two decades after the station opened in 1987. The sale was timed to coincide with plans for rejuvenating the area, resulting in the iconic ION Orchard mixed-use development that opened in 2009.

Pre-loading also facilitates the construction of overhead developments with minimum disruption to station operations. The installation of knockout panels—wall segments that can be easily removed compared to stronger diaphragm walls used in permanent structures—allows stations to be safely integrated with future developments.

AN ENGAGING WALKING EXPERIENCE

Efforts were also made to connect developments further from MRT stations using specific urban design (UD) guidelines. In the Central Area, UD guidelines covered a variety of pedestrian walkway typologies across basements, as well as first and second storeys of buildings, collectively forming a comprehensive pedestrian network. This facilitated seamless connectivity between developments, MRT stations and key attractions, providing all-weather walking comfort for pedestrians and customer footfall for retailers. Provisions for activity-generating uses were also stipulated to create vibrant streets that, according to the URA's Fun Siew Leng, ensured that "as you walk, you don't feel that the distance is far, because it's not boring." [203]

Hence, first storeys of developments facing streets or public spaces were to be fronted by shops, restaurants and services rather than blank walls. Similar requirements applied to underground and elevated pedestrian links between developments, making it convenient for pedestrians to shop or grab a bite along the way.[204]



Underground Pedestrian Network across the Central Area.

The URA spearheaded the development of a comprehensive Underground Pedestrian Network (UPN) to promote overall walkability. Air-conditioned Underground Pedestrian Links (UPLs) were implemented between MRT stations and areas of high pedestrian traffic, with either escalators or elevators leading to the street level at key circulation points. A Central Area Underground Master Plan was drawn up to map out existing and proposed UPLs around MRT stations, and building owners and developers were incentivised to facilitate the construction of this extensive network. GFA exemptions were extended to pedestrian walkways in existing adjacent buildings, on condition that the most direct connection be provided from the basement to street level. The URA also introduced a Cash Grant Incentive Scheme in 2004 to reimburse the cost of constructing selected UPLs around Orchard Road, the CBD and the new downtown. Eligible owners and developers would be required to provide detailed UPL proposals complying with the technical requirements of agencies such as the LTA, the Singapore Land Authority (SLA), the Public Utilities Board (PUB) and the fire safety department of the Singapore Civil Defence Force (SCDF).[205]

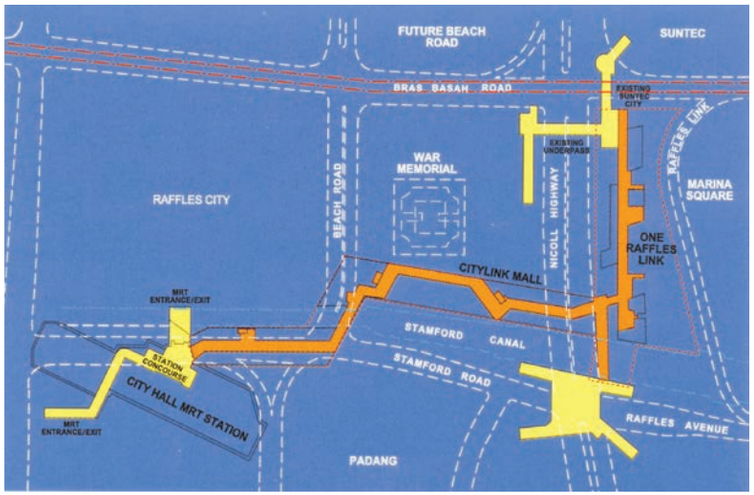
In newly planned areas such as Marina Bay, the UPN was designed as an essential aspect of the area. However, its implementation was opportunistic in existing built-up areas. Developers needed to be convinced to provide access points from their basements. For an existing development, this meant making changes to its floor plan, and disruptions to business as a result of having to close off the affected area for construction. The rise of e-commerce and concerns about customer footfall "leaking" to adjacent developments further complicated the issue. UPLs that have been successfully built tended to be undertaken by building owners who were redeveloping their buildings or by successful tenderers of Government Land Sales (GLS) sites where UPLs were designated a sale of site condition.[206]

CASE STUDY: CITYLINK MALL—SINGAPORE'S FIRST PURPOSE-BUILT UNDERGROUND SHOPPING CENTRE

Straddling City Hall MRT interchange station and the Marina Centre area, the CityLink Mall officially opened in 2000. With more than 50 shops along a 350-m stretch, it was Singapore's first purpose-built underground shopping mall. The underground linkway was connected to the office building at One Raffles Link and the mixed-use Suntec City complex. It would later be connected to Esplanade Theatres by the Bay, a performing arts centre under construction at the time.

While the idea of developing underground linkways connecting MRT stations to nearby buildings was not new, they were often developed on an ad hoc basis and sometimes delayed by lengthy negotiations between the authorities and private building owners. Moreover, such underpasses were primarily intended as utilitarian passageways for commuters to get in and out of train stations.

While new developments such as Raffles City and Suntec City had sprouted in the area, they lacked sheltered interlinks. The City Hall station, which served as an interchange between the North South and East West MRT lines, was already seeing heavy commuter traffic. The nearby Marina Centre area—an up-and-coming commercial precinct with a mix of office, retail and entertainment—was expected to receive three million visitors each month.[207] The URA's 1995 Development Guide Plan (DGP) highlighted, among other things, the need to improve pedestrian linkages in the vicinity of Beach Road, City Hall station and new developments at Marina Centre. The objectives were "to provide direct, convenient connections to public transportation", and "to encourage pedestrian activities."[208]



Alignment of CityLink Mall and One Raffles Link.

The URA unveiled detailed plans at the launch of the land sales site in April 1996. Initially named the Esplanade Mall, the land parcel comprised of two sites—an underground L-shaped mall that would run below the War Memorial Park, and an aboveground plot at Raffles Link that would serve as the gateway to Marina Centre. The subterranean site designated for the shopping mall was expected to create a retail floor space with an expected catchment of over 2,400 persons per hour.[209] For the Raffles Link site, the developer was given the flexibility of a "white" site to build either a purely commercial development, a mixed commercial-cum-residential development, or a hotel, without attracting differential premium for the change in land use.

Touted as the "jewel" of the URA's commercial GLS sites that year, its unique positioning as Singapore's first underground shopping mall coupled with a commercial development attracted interest from both local and foreign developers.[210] The URA imposed technical conditions on the sale site to ensure that the development was aligned with the broader

planning intention for the area.[211] For example, the conditions specified locations of the various entry and exit points along the underground mall, as well as alignments of current and future connections, such as one to an underground plaza that would link up with Esplanade Theatres. The walkways could be excluded from GFA computations if they were for public use and made accessible to the public during the MRT operating hours.

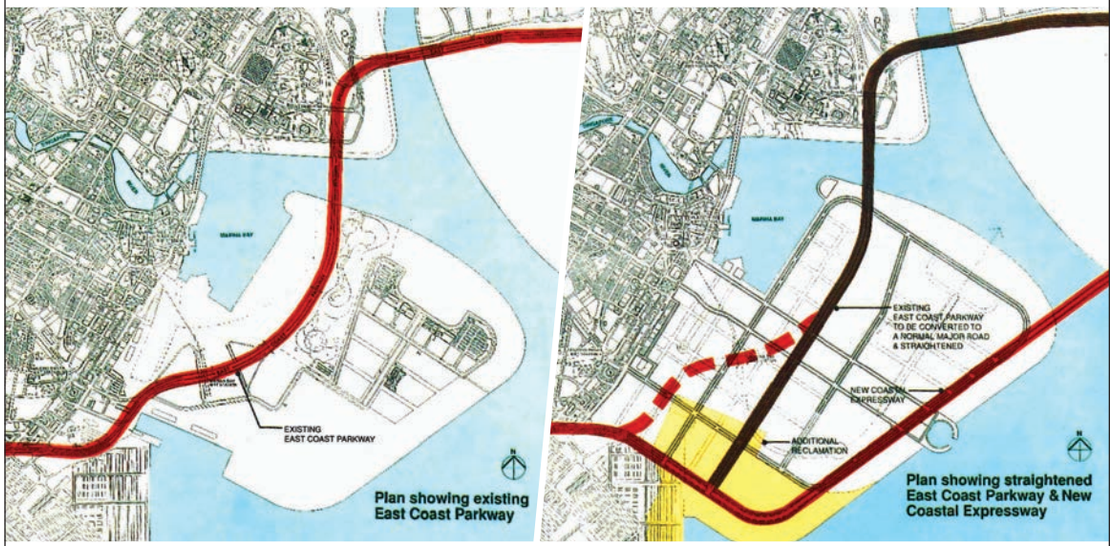
However, the site also had major drawbacks. Mainly, the cost of building underground was projected to be up to five times that of a similar development above ground.[212] The construction challenges included having to build close to and across the existing underground Stamford Canal (at two points), and complying with stringent requirements for building underground and near MRT lines. Moreover, doubts were cast on its commercial viability as the retail sector was in a slump at the time, and it was feared that an underground mall would largely serve as a thoroughfare, with few pedestrians stopping to shop. This appeared to deter some developers, with the representative of a local company commenting, "If it is just the above-ground building, we would definitely bid. But there is the [underground] shopping mall involved; that may cause some problems."[213]

By the close of the tender in August 1996, the winning bid was placed by the Hongkong Land, a leading Hong Kong-based developer. While some major local developers stayed away, the project marked the Hongkong Land's entry into Singapore's commercial property market and was its largest project in the city at the time.[214] According to the developer, the urban design of Hong Kong's Central district—where sheltered footbridges and underground linkways interconnect buildings and shield pedestrians from the elements—inspired the CityLink Mall.[215] To dispel the impression of dark and narrow spaces associated with underground tunnels, the mall featured high ceilings and skylights, with coloured lighting incorporated along one wall. The entire project, comprising CityLink Mall and One Raffles Link office building, was completed in 2000 at a cost of more than $600 million.[216] Retail space in CityLink Mall was much in demand when it opened in 2000. The shops were fully tenanted, and up to 40,000 people a day passed through on weekends.[217]

CASE STUDY: MARINA BAY—PLANNING FOR PEOPLE-CENTRED ACCESSIBILITY

Envisioning a Sustainable New Downtown

Situated near the mouth of the Singapore River, the Marina Bay district emerged from reclamation carried out in the 1970s and 1980s to prepare for future expansion of the city centre towards Marina South. The reclamation at Marina South also heavily influenced the decision in favour of a rail-based MRT system, concluding the decade-long debate on the preferred public transit system (see Chapter 3).[218] Since the opening of the first phase of the Downtown Line in 2013, Marina Bay has been served by four MRT lines, making it one of the most accessible areas by public transport.



Realignment of the East Coast Parkway.
Image courtesy of the Urban Redevelopment Authority.

We wanted to plan Marina Bay to be a sustainable district, and one aspect of sustainability refers to having good public transport. So, Marina Bay is planned to be well served by a network of MRT stations such that at any point in Marina Bay, an MRT station is no more than a 5-minute walk away. Eventually, when the district is fully developed, one can walk from one development to another and also to other stations through these developments.

Fun Siew Leng, Chief Urban Designer of the Urban Redevelopment Authority

Alterations to existing roads were also necessary to improve Marina Bay's accessibility. A portion of the East Coast Parkway (ECP)—completed in 1981 as one of the original nine expressways proposed in the 1971 Concept Plan—was truncated and downgraded to a major arterial road. This was necessary as the ECP bisected the reclaimed Marina South, making it difficult to cross from one side to the other, disrupting the continuity of the landscape.[219] The road was also realigned to fit into the grid pattern planned for Marina Bay, optimising the parcellation and development potential of the surrounding land. To support the strategic land use plan for Marina Bay and replace the ECP as a transport link to the city, the 5-km long Marina Coastal Expressway (MCE) opened in 2013 as Singapore's first undersea road.

A Vibrant Place to Live, Work and Play

Street-level pedestrian walkway.
Photo courtesy of Jacklee, CC BY-SA 3.0, via Wikimedia Commons.

Schematic of Underground Pedestrian Network and areas for mandatory activity-generating uses at Marina Bay.

The waterfront district at Marina Bay was primed to become the centrepiece of the Downtown Core, Singapore's business and commercial district of the 21st century. A natural extension from the existing CBD, the Marina Bay area opened up 3.6 km^2 of prime land for development. It was envisioned as more than a traditional business-oriented area and would be an attractive place to live, work and play, remaining lively around the clock. This shaped the planning principles that guided Marina Bay's development into a well-connected and vibrant district.

To achieve a vibrant mixed-use development, the URA zoned most sites in Marina Bay as "white", giving developers flexibility in incorporating retail, recreational and residential elements provided they fulfilled the minimum provision of quality office space. The area's grid pattern also provided flexibility for combination or subdivision of parcels, and phasing of development according to market conditions.[220]

A comprehensive walking network was included in the Marina Bay master plan and realised through the construction of gallerias, covered walkways and pavements shaded by dense greenery. Underpasses and elevated walkways were incorporated to increase accessibility between developments and MRT stations. While it would be best to prioritise level pedestrian tunnels, compromises were made occasionally for practical reasons. For instance, the underground walkway linking the One Raffles Quay office building to the Raffles Place MRT station was directed under the existing tunnels to avoid the expensive diversion of existing service pipes, necessitating the installation of escalators. Additionally, land sales conditions commonly stipulate that underground walkways must have a minimum width of six to seven metres, with a clear height of four metres to help maintain a comfortable, non-claustrophobic underground walking experience. Lining walkways with shops on one or both sides would also enhance the experience.[221]

Accessibility and Amenities

The Marina Bay Financial Centre (MBFC), opened in 2013, successfully incorporated comprehensive walking and transit connections into its mixed-use environment. Built by a consortium comprising the Hongkong Land, Keppel Land and Cheung Kong Limited/Hutchison Whampoa on a 35,500 m^2 land parcel awarded by the URA in 2005,[222] it was touted as a crucial link to connect Marina Bay and the existing CBD. The development comprised three office towers, two luxury residential towers and the underground Marina Bay Link Mall (MBLM).[223]

To align with the purpose of the Downtown Core as the heart of business and finance in Singapore, 60% of the MBFC's GFA was dedicated to office space. The rest of the white site could be developed with residential, retail, hotel or recreational components, with its composition "largely determined by market conditions".[224] Land sales conditions for the site were defined to play a part in the larger plan for a comprehensive UPN around the Downtown Core. The UPN at the MBFC comprised basement-level walkways linking adjacent buildings, MRT stations and other key activity centres. The development was required to be connected to two MRT stations—the existing Raffles Place station and the new Downtown station.[225] Part of this would form a subterranean pedestrian mall, which would go on to become the MBLM, the retail and dining component of the MBFC.

The mall was designed to be widely accessible, with fully air-conditioned UPN connections to Downtown station and adjacent developments, including The Sail and One Raffles Quay. It also extended further underneath Marina Boulevard towards the Raffles Place station in the existing CBD.[226] Knockout panels of 7 to 10 m were also safeguarded to support the phased development around the waterfront and promote connectivity around the area.

Underground Marina Bay Link Mall.

Street level and elevated connections also featured strongly in the MBFC's development conditions. Pedestrians walking along the UPN would surface at specific access points, facilitated by escalators and lifts, and conveniently move along street-level covered walkways towards buildings. Covered linkways and through-block links within individual buildings were encouraged as part of the street-level network to allow occupants to take the most direct route to their destinations. Additionally, a wide building setback of a minimum of 7.5 m was imposed along Central and Marina Boulevards to create a dedicated pedestrian walkway, with attractive landscaping and a distinctive tree-lined boulevard.[227]

Accessibility was of utmost priority to banks in selecting a new office location, and premises in close proximity of transport nodes, dining and retail outlets proved the most attractive. The MBFC's mixed-use concept, equipped with an integrated pedestrian network, attracted global institutions including the Standard Chartered Bank, Deutsche Bank and American Express. The development was much anticipated, with Tower 1 being fully leased three years before its completion.[228]

CHAPTER 7

GOING CAR-LITE

Modern transport planning for a built-up city called for a more aggressive push away from private vehicles in response to ever-increasing land use constraints, and other considerations such as environmental sustainability and social inclusiveness. Under its 2013 Land Transport Master Plan (LTMP 2013), the Land Transport Authority (LTA) envisioned a "People-Centred Transport System" with three key areas of focus: more connections, better service, and a liveable and inclusive community.

Singapore's growing population and affluence demanded a comprehensive transport system that connected ever more destinations in the most efficient and comfortable manner. With 12% of Singapore's land space already dedicated to roads—a hefty proportion compared with 14% for housing—subsequent increases in road space needed to be made in a controlled and sustainable manner, with viable alternatives to driving being provided.[229]

DOUBLING THE MRT NETWORK

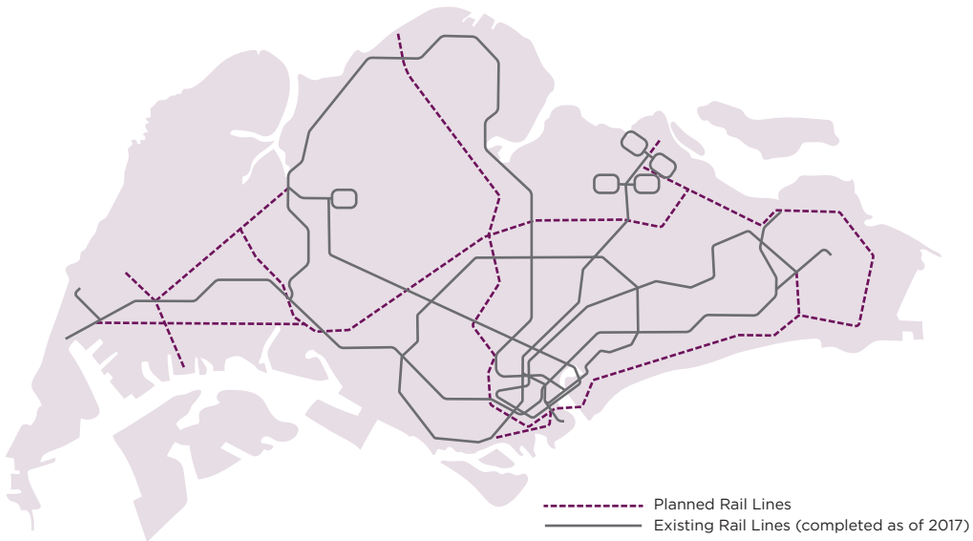
First and foremost, there was a need to ramp up the Mass Rapid Transit (MRT) network as the backbone of Singapore's public transport system. This entailed a sustained expansion of the railway to cater to growing demand for travelling longer distances. However, such expansions were to be implemented in a more densely built-up environment than ever before. With underground lines planned in closer proximity to developed areas, safety and environmental concerns assumed increased significance. In order to avoid unnecessary delays and costs, a balanced approach was needed to find the best way for integration amid land use constraints. Various agencies needed to work closely together, and with community stakeholders, to devise the best solution for commuters while balancing environmental concerns.[230]

The LTMP 2013 unveiled new MRT lines and extensions to be built by 2030, bringing the total network length to 360 km. A new MRT line, or extension, would be opened almost every year between 2013 and 2021. These include the Cross Island Line (CRL), Jurong Region Line (JRL) and extensions to the existing Circle Line (CCL), Downtown Line (DTL) and North East Line (NEL). Beyond enhancing connectivity and convenience, the new lines would also increase the resilience of the overall MRT network by making alternative routes available in the event of disruptions.

In December 2011, the North South Line (NSL) was hit by severe breakdowns that affected thousands of commuters, especially during peak hours. In the following years, MRT disruptions continued to occur across the network, highlighting the need for higher levels of maintenance. This was especially so for the ageing infrastructure on the older lines built in the 1980s, the East West Line (EWL) and NSL. Having alternative MRT routes would relieve some pressure on existing lines, allowing them to cope with increased ridership as Singapore's population increases. Many existing stations would also be transformed into interchanges, enhancing the network's interconnectivity and reach.[231]

In 2010, bus-rail integration was further galvanised through the implementation of distance-based fares. With the new integrated fare system, commuters would not be charged additional boarding fees when transferring from bus to train or bus to bus. In fact, average fares decreased after the introduction of the distance-based system, allowing commuters to seek the most efficient journey using the public transport system as a whole with improved affordability.[232]

Exhibit 8:
Rail Network Expansion Plan up to 2030



LEARNING FROM DISRUPTIONS: PLAYING CATCH-UP ON UPGRADING RAIL INFRASTRUCTURE

It emerged in the mid-2000s that Singapore's structured long-term planning approach was unable to respond effectively to short-term fluctuations in the economy, resulting in significant impact on its infrastructure. The 2001 Concept Plan had projected a gradual increase in population towards 5.5 million over the next 40–50 years, and transport infrastructure development was planned accordingly. However, the population had approached 5.1 million by 2010, significantly higher and quicker than planned.[233]

The government had adopted liberal immigration policies from 2005 to boost economic growth by allowing the non-resident workforce to grow. Coupled with other measures, this led to Singapore's quick economic recovery from the 2008 United States sub-prime mortgage crisis. However, the short-term population surge placed great strain on Singapore's transport infrastructure, especially the MRT system. This culminated in severe MRT breakdowns in December 2011 and shed light on key areas for immediate improvement.

It was not possible to respond immediately due to the high costs and long lead-time of rail infrastructure implementation (14 to 15 years including planning and feasibility studies). Additionally, the LTA had experienced difficulty in obtaining and justifying funding for rail network expansion following the tightening of financial controls after the construction of the NEL in the 1990s. This was due to the 1997 Asian Financial Crisis impeding the housing market in the late 1990s, leading to fewer-than-expected developments along the NEL corridor. This resulted in low NEL ridership in the initial years after its opening, and the Buangkok "White Elephant" incident (see Chapter 5).

To prevent the recurrence of such a situation, the government took a financially conservative stance. However, this tightening of controls would eventually cause the rail network to become overloaded for want of timely expansions to cope with increased demand. After the NEL opened in 2003, barring extensions to existing lines, no new rail lines were opened until the medium-capacity CCL commenced in 2010. While construction of Phase 1 of the DTL had begun in 2008, it was slated to open only in 2013.[234] This proved too late to serve the rapidly increasing population. On top of that, there was limited scope to inject more capacity into the existing lines. Much of the existing MRT network was covered by the NSL and EWL, which operated on an older signalling system that restricted the number of trains the system could handle. Inadequate projections and planning provisions left the system unable to cope with the sudden population surge.[235]

Arriving at a satisfactory solution was difficult amid the dilemma between supporting rapid economic growth and encumbering the existing transport system. The volatile economic situation made it difficult for timely projections of demand to justify building new MRT lines, and fiscal prudence remained a priority for the government.

LEARNING FROM DISRUPTIONS: PLAYING CATCH-UP ON UPGRADING RAIL INFRASTRUCTURE

Continued...

The population grew faster than we expected, and our infrastructure did not keep up. Should we have given ourselves a bigger buffer and said, "Let's build and be ready"? I think in retrospect, clearly yes, we could have done more. Could we have predicted that we would have five years where the economy would grow brilliantly and our population would increase so rapidly? You could not easily have said that. Should we then have said, "I didn't plan for this infrastructure; let's tell the business to go away and let's forget about growth; we don't need these extra jobs; we just stay where we are?" I think that would be very risky. So we went ahead, and the strains showed up.

Prime Minister Lee Hsien Loong[236]

The experience highlighted a need for the need for closer coordination of policies affecting economic growth, population changes and infrastructure planning. A more comprehensive and balanced assessment of the trade-offs between financial and non-financial, short-term and long-term considerations would be necessary to ensure a more coordinated decision-making process.

EVOLVING CHALLENGES: INTEGRATING NEW LINES IN A BUILT-UP CITY

To promote public transport usage, the LTA announced in the LTMP 2013 that 80% of Singapore's households would be within a 10-minute walk to the nearest MRT station by 2030. This would be supported by plans to locate more residential developments, especially public housing, near MRT stations. Under the new plans, residents living in Housing & Development Board (HDB) neighbourhoods further from town centres could look forward to having a station closer to home. This was evident in the DTL Phase 3, which opened in 2017, featuring multiple stations within large townships such as Tampines and Bedok. For many residents, this made walking to the nearest station a viable alternative to a feeder bus connection.[237]

Construction of Tampines West Downtown Line MRT Station close to an HDB estate.
Photo courtesy of Land Transport Authority.

However, it had also become more difficult to create smooth, integrated transfers between lines in an increasingly complex network. With many new lines passing through developed areas than before, existing land uses imposed constraints on MRT route alignments and the locations of stations. In some cases, safeguarding of station locations had been done at a very early stage, helping to smoothen the actual construction years later. The Chinatown station, for example, forms an interchange between the NEL and the more recent DTL. While 10 years separated the opening of the two lines, provisions had already been made during the construction of the NEL for both to connect seamlessly.[238]

Finding the Next Best Solution

In other cases, especially in building interchanges between new and existing lines, difficulties in creating seamless and compact transfers resulted in a longer walk for commuters.[239] The Newton and Tampines stations on the DTL were constructed further from their counterparts on the NSL and EWL, respectively, resulting in longer transfer distances between lines. Unlike most interchanges, where convenient transfers are possible via air-conditioned passages, commuters changing lines at these stations need to exit and re-enter the system through fare gantries.

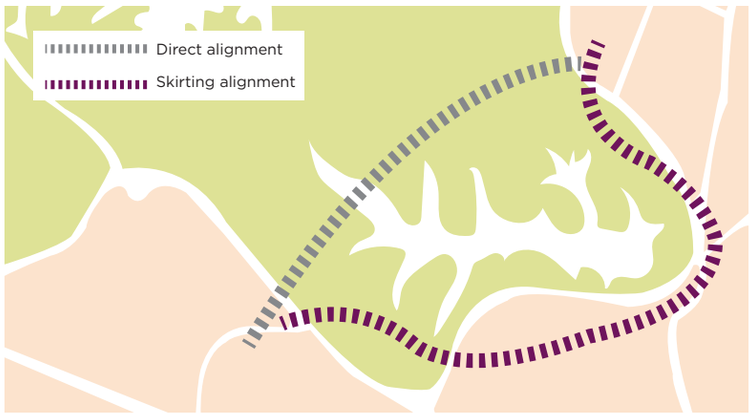
At Tampines, the LTA faced a challenge in accommodating the new DTL station within the densely built-up HDB estate around the existing EWL station. Locating the DTL station any closer would have meant tunnelling under HDB blocks, potentially affecting residents if reinforcement works were needed. Therefore, the next best solution was to build the DTL station 300 m away from its EWL counterpart and give commuters a 15-minute grace period to complete the transfer while paying for a single journey. The transfer was routed alongside the Eastlink Mall, which provided retail and food options for the convenience of passing commuters. The LTA also improved the existing public walkway by removing pushcarts and creating a barrier-free 8-m wide footpath that could channel a larger stream of commuters at the busy interchange.[240]

A Balanced Approach

The MRT expansion plan also considered the impact of rail projects on important non-urbanised areas. In the case of the proposed underground CRL an area of contention was with its potential alignment, which runs in close proximity of the Central Catchment Nature Reserve (CCNR), Singapore's largest nature reserve. The CRL was proposed as an important addition to the rail network and would provide a strategic east-west link as well as an outer orbital route. When completed, it would stretch more than 50 km from Changi to the Jurong Industrial Estate.[241] By intersecting with all existing radial lines, it would significantly cut journey times and give commuters a wider choice of routes.

Two potential underground alignments were identified. One was a direct route, passing 40 m below ground through the CCNR with no physical structures at surface level, and the other, a skirting alignment passing beneath homes and businesses lining the edge of the reserve.[242] The latter would be five km longer, and, besides increasing the commuting time, would significantly increase the amount of physical infrastructure needed as well as construction costs. Land acquisitions along with additional works would inflate the CRL's bill by $2 billion.

Planners had to consider the multi-faceted impacts, including transport connectivity and engineering feasibility of both alignments, the interests of stakeholders such as businesses and homeowners, as well as the need to protect the nature reserve that could be adversely affected by rail engineering works. In line with Singapore's vision of becoming a City in a Garden, it is important to protect the CCNR and its rich biodiversity. At the same time, the ultimate goal of rail projects is to serve and optimise the travel experience of commuters. These constraints required close collaboration between the LTA, the National Parks Board (NParks), engineers and nature experts to identify the best way forward.[243]



Two possible alignments under consideration for the Cross Island Line.
Image courtesy of Land Transport Authority.

Therefore, in a first for rail projects in Singapore, an Environmental Impact Assessment (EIA) was carried out and the results publicly released. The LTA consulted nature groups extensively during the course of the EIA, taking into consideration past studies pertaining to the area. Residents living around the CCNR—who would potentially be affected by the alignments—were also informed. In 2016, the LTA released the first phase of the EIA report and invited public feedback. This episode illustrated the increasing complexity of projects that would require the engagement of a wider range of stakeholders to achieve optimal outcomes.[244]

ACTIVE MOBILITY: COVERING THE LAST MILE

Launched in 2016, the LTA's "Walk Cycle Ride SG" campaign articulated the government's vision of a highly connected and inclusive city, with a marked de-prioritisation of cars in the transport network. Singaporeans of all backgrounds would be greatly facilitated and encouraged to walk, cycle and utilise public transport.[245] While buses and the MRT have been the prevalent modes of commuting, with sustained expansion and improvement programmes led by the LTA, there has been a growing interest in using active, personal forms of mobility to cover the last mile. Active mobility, such as walking and cycling, improves the reach of the transport network by effectively extending it to commuters' doorsteps. It also promotes a healthy lifestyle by combining exercise with commuting. To facilitate this, the LTA's Walk2Ride programme had been underway since 2013, pledging a four-fold increase in the reach of nationwide sheltered walkways by 2018. This entailed constructing more than 200 km of shelters, connecting developments within 400 m of MRT stations and 200 m of LRT stations and bus interchanges.

To facilitate and encourage walking, covered linkways were also provided within HDB townships to connect blocks of flats to key amenities, including neighbourhood bus stops. These have proven especially helpful during rainy weather, and for the elderly and less mobile.[246] Pedestrian-friendly features have been embedded in the design of new HDB developments such as in Bidadari and Punggol North, where residents can look forward to landscaped walking routes lined with retail shops and amenities. Similar facilities would also be incorporated in existing townships through estate rejuvenation programmes such as the HDB's Neighbourhood Renewal Programme and Remaking Our Heartland programme.[247] The creation of an expansive, sheltered walking network is key to enhancing the coverage of the public transport network and facilitating sheltered door-to-door journeys keeping in view Singapore's tropical climate.[248]

However, somewhat longer distances could still pose a challenge for the elderly and disabled, given the need to navigate existing infrastructure such as overhead pedestrian crossings. As part of the LTA's vision for an inclusive transport system, especially in light of an ageing population, measures were taken to aid the less mobile. These included barrier-free access to MRT and LRT stations, and equipping overhead bridges with lifts at transport nodes.[249]

Covered walkways and cycling path in Tampines HDB town.
Photo courtesy of Land Transport Authority.

LAYING THE PATH FOR CYCLING

While the popularity of cycling is seemingly a recent trend in Singapore, the government had already begun considering cycling as a potential form of transport back in the 1990s. It identified cycling as being inexpensive, efficient and incorporative of exercise, and laid out plans for it as part of the 1995 Strategic Transportation Plan (STP 1995). However, it also acknowledged that it would not be enticing to cycle long distances under Singapore's hot and humid conditions. A household survey initiated by the Public Works Department (PWD) in 1988-89 revealed that bicycles accounted for only about 1% share of transport modes in Singapore. Besides the climate, the scope for cycling was also restricted by the limited infrastructure. In the 1990s, bicycle paths were limited to parks or recreational routes, with scant parking facilities. Unregulated cycling on the roads also posed danger to both cyclists and motorists. The STP 1995, therefore, envisioned cycling playing a complementary role to the MRT, providing commuters an active option to cover the short distance between home and train stations during the mornings and evenings, when the weather is cooler.

A Strategic Beginning

The STP 1995 proposed a plan to "promote safe, efficient and comfortable travel for cyclists", and for a system of cycling routes as well as facilities such as signage and storage. It considered three possible classes of bikeways to be implemented in Singapore: segregated bicycle paths, demarcated cycling lanes on existing roads, and shared routes on existing roads.

These would be designed specifically to support short local trips of two to three km, enough to cover HDB town areas, and more feasible for implementation than an island-wide network. An incremental, cost-effective implementation process would be followed. This included converting existing infrastructure where possible, such as wide pedestrian paths or low-volume local-access roads, and ensuring that cycling paths were strategically located to link to essential destinations. The infrastructure was also carefully designed with safe and level routes and attractive scenery, plus amenities such as shelters along the way.[250] However, the PWD had prioritised its road-building programmes at the time, and there was also not enough public interest in cycling to justify building a dedicated cycling network. It was not until the late 2000s that interest in cycling increased rapidly.[251]

Widespread Implementation

After the formation of the LTA in 1995, these cycling provisions were brought under its purview and were reflected in its 1996 white paper as well as subsequent LTMPs in 2008 and 2013. The LTA built better bicycle parking facilities at MRT stations and bus interchanges to facilitate the coverage to and from transport nodes. It also began catering to cyclists willing to travel longer distances. As a dedicated island-wide cycling network was not feasible given the scarcity of land in Singapore, the LTA decided to leverage the NParks' island-wide Park Connector Network (PCN) for long-distance routes. This involved working with agencies such as the Urban Redevelopment Authority (URA) and the HDB to close the gaps between the PCN, neighbourhood and commercial centres, and transport nodes.[252]

Bicycle parking at an MRT station.
Photo courtesy of Land Transport Authority.

The LTMP 2013 expanded on these initiatives, announcing that coverage would be extended to all HDB townships, tying in with the multi-agency National Cycling Plan—involving the LTA, URA, NParks, HDB, Public Utilities Board (PUB) and Sport Singapore (SportSG)—and the HDB's Remaking Our Heartland programme. For example, in line with the Punggol Eco-Town vision, a comprehensive cycling network has been planned for Punggol to encourage residents to adopt cleaner modes of transportation. The cycling paths were built in tandem with new roads, and where feasible, existing roads were also retrofitted with cycling paths. In Yishun, a dedicated cycling track was implemented in two

phases along Yishun Ring Road. Phase 1 was completed by the HDB and connected Yishun and Khatib MRT stations, while Phase 2, covering the rest of Yishun Ring Road, was funded and completed by the LTA by 2015. Dedicated cycling paths would be built in all 26 HDB townships by 2030. The intra-town cycling networks, together with the PCN, would form a comprehensive island-wide cycling network of over 700 km in length.[253]

Ang Mo Kio Linear Park under the viaduct of the North South Line.
Photo courtesy of Land Transport Authority.

Ang Mo Kio, a mature HDB township developed in 1973, was retrofitted in 2016 to become Singapore's first model walking and cycling town. Its new pedestrian and cyclist-friendly features included a 4-km cycling path connecting key destinations such as the Ang Mo Kio MRT station and AMK Hub. Staircases leading to uphill HDB blocks were also fitted with ramps for cyclists to wheel their bicycles instead of having to carry them.

Included in the cycling path was a 1-km Linear Park—a walking and cycling track under the MRT viaduct, making good use of the incidental sheltered space. Greenery as well as art installations were added along the walkway to beautify the environment. This creative implementation was possible due to the close collaboration between the LTA, the URA and the NParks, and with significant community involvement. The first phase of the Ang Mo Kio Cycling Network was completed in 2016 and is to be expanded to 20 km by 2020—the longest in any housing township. It would also be linked up with the future North–South Corridor (NSC), creating a direct path to the city.[254]

The LTA and the HDB also stepped up efforts to provide more bicycle parking spaces at MRT stations and HDB blocks. The HDB started providing bicycle parking for new public housing at Punggol Eco-Town in 2011 with a ratio of one lot to 10 dwelling units, and increasing norms to the current standard of one lot for every six dwelling units across Singapore.[255] To optimise the use of valuable land, the HDB also developed dual-tier bicycle racks. The private sector has also leveraged these trends, leading to an upsurge in mobility-sharing services—effectively allowing anyone to travel by bicycle without having to own one.

Supporting Policies

Besides infrastructural improvements, supporting policies also played a major role in encouraging active mobility and creating a safe environment for different transport modes to co-exist. The Active Mobility Bill was passed in 2016, recognising cycling and personal mobility devices (PMDs) such as e-scooters as regulated modes of transport. The regulations included a code of conduct and the right to ride on public paths, with stiff penalties for those who flout the rules.[256] Also, after a successful six-month trial in 2017, commuters were allowed to bring foldable bicycles and PMDs aboard buses and trains provided they conformed to specified size limits.[257]

From 2016, selected developers were required to submit a Walking and Cycling Plan (WCP) for joint scrutiny by the LTA and the URA.[258] Under these guidelines, some commercial, retail and business park developers and schools would be required to provide barrier-free and sheltered access for pedestrians and cyclists. The provision of conveniently located parking facilities and connectivity to adjacent developments was also stipulated.

TENGAH: A CAR-LITE FOREST TOWN

Tengah will be Singapore's 24th HDB township. Planned as a "Forest Town", with about 42,000 new homes surrounded by lush greenery and biodiversity in western Singapore, Tengah conforms to the HDB's goal of creating townships that are well designed, sustainable and community-centric. With apartments due to be offered for sale from 2018 onwards, the new township will offer its future residents quality living and easy access to a wide range of amenities in a greener, car-lite and pedestrian-friendly environment. Tengah's design will also facilitate a range of convenient options for travelling within and beyond the township.

Car-Free Town Centre

Tengah will have the first "car-free" HDB town centre in Singapore, with roads, parking facilities and services plying below ground. Named the "Market Place", the town centre will be nestled in a large "Central Park"—integrated with water bodies and a 100-m wide and 5-km long "Forest Corridor" that would be safe for walking, cycling and recreational activities. In addition to offering a wide variety of facilities, the Market Place will also offer convenient access to mixed commercial and residential developments, transportation, an integrated community hub, and a sports hub.

Artist's impression of the Tengah Town Centre.
Image courtesy of Housing & Development Board.

Moving Around With Ease

Transit and mobility corridors have been safeguarded throughout the township. Bus services will be planned comprehensively to facilitate intra-town connections to key amenities, and inter-town connections to nearby MRT stations and key destinations. With most bus stops located within 300 m of homes, residents will have convenient access to public buses that will ply on dedicated lanes, offering a smoother and faster commuting experience. Tengah will also be served by the Jurong Region Line, and housing developments will be located within walking distance of MRT stations.

Walking and Cycling Everywhere

Tengah's extensive park network has been planned with features conducive to walking and cycling, which will also be facilitated throughout the township. Neighbourhood Centres will be located along the park network and be conveniently accessible from nearby housing blocks, transport nodes and other amenities such as hawker centres and community centres, serving as one-stop destinations for residents to meet their daily needs.

TENGAH: A CAR-LITE FOREST TOWN

Continued...

Tengah has also been designed to facilitate new and future modes of travel, such as personal mobility devices and autonomous, or self-driving vehicles. The HDB is also working with the Jurong Town Corporation to plan a mobility corridor connecting the town centre to the Jurong Innovation District—a next-generation industrial district for learning, research, innovation and manufacturing—to provide residents direct access to employment opportunities.

Tengah's comprehensive commuting networks.
Image courtesy of Housing & Development Board.

SHARING THE ROAD

Considering Singapore's limited land availability and an increasingly built-up environment, it was crucial to recognise that roads could no longer be the domains of cars alone. Where possible, the option of re-apportioning road space to suit other modes of transportation would be explored, encouraging people to choose from a wider range of mobility options, including cycling.[259] In 2015, the government announced its intentions for a car-lite city under its newly unveiled Sustainable Singapore Blueprint. The Ministry of Transport (MOT) adopted a three-pronged strategy to fulfil this vision:

i. Enhance public transport coverage and service levels so that 75% of all trips are by rail or bus
ii. Provide infrastructure for alternative transport modes such as cycling and PMDs
iii. Further restrict growth of private car population

To streamline developments with car-lite intentions, the LTA announced two "conversion" projects involving the future NSC and the existing Bencoolen Street in the city centre.[260] In 2018, construction would begin for the NSC, Singapore's first integrated transport corridor. The NSC was originally conceptualised in the LTMP 2008 as the North–South Expressway, Singapore's 11th expressway, to connect northern housing townships to the city centre and alleviate pressure on the parallel Central Expressway (CTE).[261] The concept underwent a redesign in 2016 to better cater to public buses, cyclists and pedestrians. It included physical features such as dedicated bus lanes for express services, which would potentially shorten city-bound journeys by up to 30 minutes and facilitate inter-town bus transfers. Pedestrian walkways and cycling paths would also be built, spanning the entire length of the NSC and become part of an island-wide cycling network.[262]

Bencoolen Street was partially "reclaimed" for pedestrians and cyclists. The original four-lane street was closed off for building the Bencoolen MRT station on the DTL, and reopened in 2017 with a host of car-lite features. The roadway was shrunk to two lanes, with one dedicated for buses. The rest of the former street area was converted into a wider pedestrian walkway and cycling path, with bicycle parking lots along the way to facilitate the use of environmentally friendly modes of travel.[263]

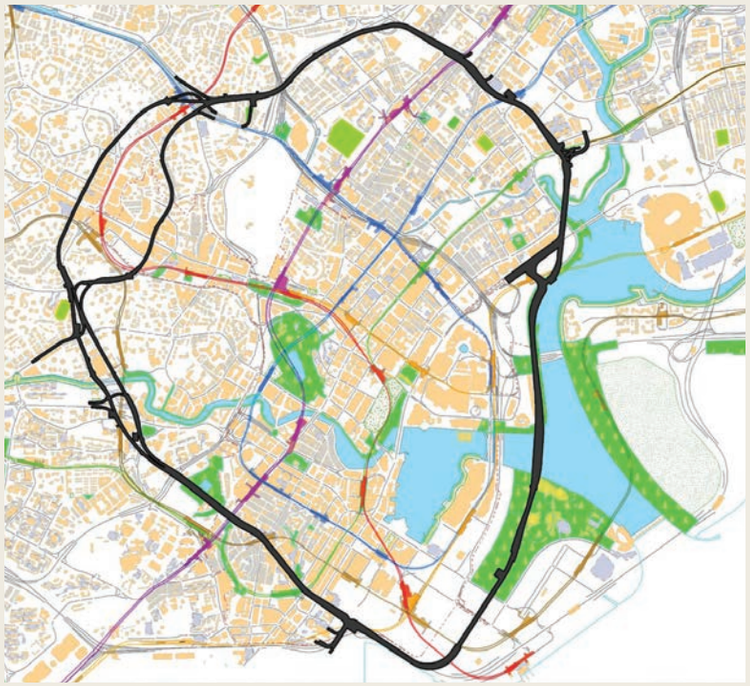
ABANDONING SURS: TOWARDS A CAR-LITE FUTURE

When the MRT system first opened in 1987, the government's focus was still on road expansion instead of the creation of an extensive rail network due to the significant costs involved. The Ministry of National Development (MND) had tasked the PWD to conduct a study on an underground road system "to increase road capacity in the city area, reduce traffic on the surface roads and also provide environmental benefits". The PWD team travelled to study similar systems overseas and identified the most optimal tunnel configuration to increase road capacity in the Central Area by 40%.[264]

The proposed Singapore Underground Road System (SURS)—an arterial ring road—comprised two continuous 15-km-long tunnels of two lanes each, running in both directions around the periphery of the Central Area. It was supposed to increase road capacity not just for access to the Central Area and the upcoming Marina areas, but also to create an alternative route for those wishing to bypass them completely.[265] At the time, planners at the URA had voiced concern that a large amount of land would end up being sterilised due to the SURS safeguarding. However, the government deemed that the enhanced transport capacity was necessary to make the land attractive for development.[266] Hence, the SURS alignment was eventually safeguarded in 1993 for future implementation.

In more than two decades since SURS was conceptualised, the Central Business District (CBD) had been transformed into a walkable area and was highly connected by public transport. At the same time, consistent decentralisation efforts had ensured the availability of jobs closer to Singaporeans' homes outside of the Central Area. These developments reduced the need for people to drive within the city centre, or even go there at all on a daily basis, eliminating the need for the augmented road capacity promised by SURS.[267]

No longer deemed essential to Singapore's transport ecosystem, the SURS alignment was de-safeguarded in 2017. Land originally affected by the safeguarding can now be released for development. This marked a key milestone in the government's push towards a car-lite society.



Singapore Underground Road System (SURS) alignment.
Image courtesy of Land Transport Authority.

CHAPTER 8

CONCLUSION: GUIDING PRINCIPLES OF INTEGRATED PLANNING FOR LAND USE AND MOBILITY

An integrated approach to planning for land use and mobility is crucial for creating a highly liveable environment in a small and densely built city like Singapore. The challenge of providing a comprehensive transport system amidst many competing uses for scarce land necessitates a long-term planning framework that considers the system as a whole. This needs to be backed by strong institutions to see plans through to implementation. While Singapore's transport system has evolved with the times, incorporating new modes of travel with greater coverage, the fundamental principles of integrated planning have endured.

The 1971 Concept Plan (CP 1971) and its accompanying Transportation Plan, both outcomes of the State and City Planning Project (SCP), are widely considered the first milestone in long-term planning in Singapore. A key recommendation of the SCP was that Singapore build an extensive and reliable public transport system to avoid the malaise of congestion that plagues most developed cities. This was only possible through the construction of a rail-based system with a separate right-of-way from road-based transport. However, due to the heavy financial commitment, it was only in 1982—a decade after the conclusion of the SCP—that the government finally gave the green light for the Mass Rapid Transit (MRT) system. This extensive undertaking was greatly facilitated by the presence of unobstructed corridors resulting from years of strict land safeguarding by government agencies. As a result, the first MRT lines—the East West and North South lines—opened in 1987.

Long-term plans, however, are not set in stone and must evolve in keeping with changing needs and environments. The strategic principles introduced in the CP 1971 were built upon and expanded in subsequent revisions. For example, the principle of decentralisation gave rise to the detailed Constellation Concept in the CP 1991, whereby commercial centres were built outside the Central Area and connected to it via the public transport network. This cut the average distances that Singaporeans travelled on a daily basis, reducing the load on the transport system and helping decongest the Central Area.

These commercial centres, the largest of which are Regional Centres intended to serve multiple housing townships, provide key employment zones anchored around MRT stations. High-density residential, commercial and retail developments built around these transport nodes help to create convenient and highly accessible activity zones. Seamless connectivity, via sheltered or underground linkways lined with retail outlets, facilitate the flow of human traffic between areas of activity and transport infrastructure—illustrating how integration at the local level can complement broader land use plans.

Over the years, the government has increasingly prioritised public transportation as the choice mode of travel. In the 2010s, this led to the vision for a car-lite Singapore. The public transport system was aggressively expanded to enhance its convenience and connectivity, and to make it a preferred alternative to driving. This included expanding the MRT network, bringing even more locations within its catchment and increasing the overall resilience of the system. At the same time, recognition of a rising interest in active mobility, especially cycling, to cover the last mile to and from transport nodes resulted in infrastructural improvements to improve the safety and convenience of these alternative modes of transport. The creation of a 700 km island-wide cycling network is in the works—calling for close collaboration between agencies such as the Land Transport Authority, the Urban Redevelopment Authority, the Housing & Development Board and the National Parks Board—to facilitate the integration of the network with townships, parks and other areas of development.

Looking ahead, the integration of transport and land use planning will only increase in importance and difficulty given Singapore's land scarcity and growing population. Expansions to transport infrastructure, especially public transportation, will need to be carefully planned amid increasing urban density to serve the current and future travel needs of Singaporeans. Only a high level of convenience, comfort and reliability will ensure that it remains an attractive choice for commuters.

TIMELINE: INTEGRATING LAND USE AND MOBILITY

1964
- Development began for Toa Payoh New Town, the first self-sufficient satellite town.

1966
- Land Acquisition Act enacted.

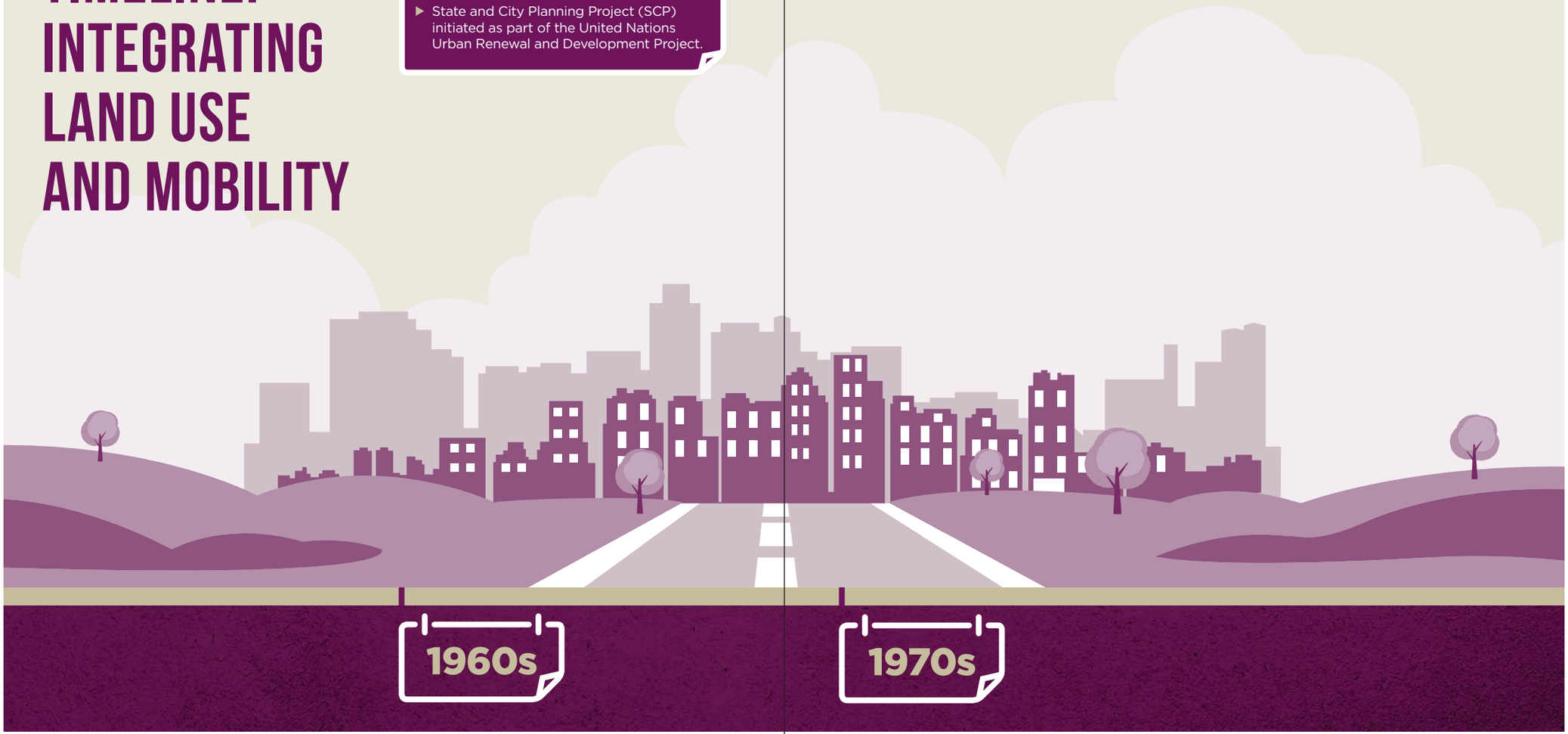
1967
- State and City Planning Project (SCP) initiated as part of the United Nations Urban Renewal and Development Project.

1971
- Concept Plan 1971 (CP 1971) and associated Transport Plan produced as outcome of the SCP.
- Land reclamation began at the Marina Bay area.

1972
- Three-phase Mass Transit Study began (concluded in 1980).

1974
- Central Area Expressway Study (CAES) launched.

1975
- Area Licensing Scheme (ALS) launched, Central Area designated as a Restricted Zone.



1960s

1970s

1980

- Provisional Mass Rapid Transit Authority (PMRTA) formed.

1981

- Singapore's first two expressways opened: the Pan-Island Expressway (PIE) and the East Coast Parkway (ECP).

1982

- Government reached decision to build the Mass Rapid Transit (MRT) system.

1982

- The PMRTA replaced by MRT Corporation (MRTC), a full-fledged statutory board.

1984

- Construction of the MRT system began.

1987

- North South Line (NSL) and East West Line (EWL) (collectively known as the Compass Line) opened.
- Public Transport Council (PTC) set up to regulate bus services and public transport fares.

1989

- Transitlink set up by the Singapore Bus Services (SBS), SMRT and Trans-Island Buses (TIBS) to develop an integrated bus-rail network and fare system.

1980s

1991

- Concept Plan reviewed (CP 1991), introducing the Constellation Concept.

1993

- Development Guide Plans (DGPs) prepared for 55 planning areas across Singapore.

1992

- Singapore's first underground bus interchange built below upcoming Woodlands MRT station.

1995

- Strategic Transportation Plan (STP 1995) produced.
- Land Transport Authority (LTA) formed through merger of the Registry of Vehicles (ROV), the MRTC, the Roads and Transportation Division of the Public Works Department (PWD) and the Land Transport Division of the Ministry of Communications.

1996

- White paper on "A World Class Land Transport System" produced by the LTA.
- Woodlands extension on NSL completed.

1998

- ALS replaced by Electronic Road Pricing (ERP), a fully automated system.
- All 55 DGP completed, forming the Master Plan 1998.

1999

- First Light Rail Transit (LRT) system opened in Bukit Panjang, retrofitted in existing township.

1990s

2000

- CityLink Mall opened as the first purpose-built underground shopping mall in Singapore, linking extensively from City Hall MRT station to various developments around the Marina Centre area.

2001

- SBS Transit Limited and SMRT Corporation underwent corporate changes to reflect their new roles as multi-modal transport operators.
- SBS Transit won the right to operate the North East Line (NEL) and Sengkang and Punggol LRT systems.
- Land Titles Act updated to allow for single titles to be issued for continuous stretches of airspace and underground space, and applied to Dhoby Ghaut NEL station.

2002

- Dhoby Ghaut NEL station (part of a three-way interchange with the NSL and upcoming Circle Line (CCL)) was completed, together with commercial development, The Atrium@Orchard, developed by the LTA.

2003

- NEL opened to public.
- Sengkang LRT opened to complement the NEL as the first intra-town transport system to be planned with the town itself.

2005

- Punggol LRT opened.

2006

- Buangkok Station opened, almost three years after the start of the NEL.

2008

- LTA released the first Land Transport Master Plan (LTMP 2008), focusing on a "People-Centred Land Transport System".
- Kallang-Paya Lebar Expressway (KPE) opened, last of original nine expressways proposed in the CP 1971.

2009

- CCL opened as Singapore's first medium-capacity orbital line.

2000s

2013

- LTA released the LTMP 2013, focusing on providing more connections, better service and a liveable and inclusive community.
- Marina Coastal Expressway (MCE) opened as Singapore's first undersea road, diverting major traffic flows into the city from the ECP.
- Downtown Line (DTL) Phase 1 opened.
- LTA commissioned Walk2Ride Programme to create barrier-free, sheltered walking networks around transport nodes.

2016

- Phase 1 of Ang Mo Kio Model Walking and Cycling Town completed.
- Active Mobility Bill passed, recognising cycling and personal mobility devices as regulated modes of transport.
- Walking and Cycling Plan effected by the LTA and the URA.

2017

- Land for Singapore Underground Road System (SURS) de-safeguarded.

2010s

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