Integrated foresight urban planning in Singapore

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How to optimise urban planning for sustainable development within finite land resources and growing urban population is an important global issue. This paper introduces a range of successful experiences of Singapore's integrated foresight urban planning to provide thought and guidance on urban planning. The whole planning framework follows three steps: concept plan, master plan and detailed plan. The core planning model is to divide the planning area into mass rapid transit-orientated new towns with a similar prototype. A multi-level transportation system forms Singapore's urban skeleton and enhances the connectivity among new towns. As a garden city, Singapore's green space planning methodology and white site concept are also advanced and worth learning.

1. Introduction

Singapore, with a population of more than 5.4 million in a land area of 716 km², of which over 40% is greenery, is ranked third in the world in population density. It is an equatorial country (1°17'N 103°50'E), lying off the southern tip of the Malay Peninsula. In <50 years after the founding of the Republic of Singapore, Singapore has become an economic and political centre of Asia, with the reputation of 'Garden City'. Singapore's urban planning has gone through a process from being disordered to well ordered. The great success is mainly accrued from the integrated foresight urban planning method and unswerving implementation, which enhances the country's healthy and continuous development.

Research into Singapore's planning process has been well documented in the literature, which generally falls into two main streams. One stream of research is focusing on residential and industrial planning, which forms the core content of Singapore. With limited land resources and a large population, Singapore has undertaken concerted planning for the high-rise, high-density residential system as well as for a sustainable industrial and business system. This planning stream basically focuses on the description of the planning parameters and innovative ideas (Song, 2008; Tuan Seik, 2001; Wang, 1987; Yang and Lay, 2004; Yuen and Nyuk Hien, 2005). The other planning research stream engenders transportation planning, green space planning and water planning, which forms the infrastructural skeleton of Singapore. This stream shows the planning method as well as a series of management policies (Fwa, 2005; Han, 2010; May, 2004; Savage and Kong, 1993; Tan, 2006; Tanuwidjaja, 2011).

Little is known about the translation of Singapore's comprehensive urban planning framework to overseas applications. Therefore, this paper is focused on giving a detailed introduction of Singapore's urban planning experience, including urban planning framework, new town prototype, transportation system, residential system, green space system and white site planning, in the Singapore context. Conclusions are summarised to provide guidance for the benefits of other cities.

2. Singapore's urban planning framework

Singapore has a scientific, rigorous three-tier architecture urban planning framework, as shown in Figure 1, including concept plan, master plan and detailed plan.

Singapore persists in following a long-term overall concept plan to support Singapore's development, usually for the next 40–50 years, which is subject to review every 10 years. This concept plan serves to ensure that land is sufficient to meet the requirement of population and economic growth in the future. In tandem with the concept plan, a medium-term master plan (or blue-print plan) is designed to form a land-use pattern and transportation network, which shall be revised every 5 years. Detailed construction shall conform to the detailed plan outlined in the near-term development, usually for 5–10 years. The concept plan and master plan are issued by the Urban Redevelopment Authority (URA), while the detailed plan is made by the agency overseeing the developments.

Due to historical reasons, Singapore's urban planning system was influenced by the English system of the past. English

Figure 1. Urban planning framework in Singapore

colonial administrators drew a first draft plan for Singapore in 1827, and subsequently formulated a series of plans for public buildings in 1887, 1896 and 1913 (Pearson, 1969). These regulations provided an insight and understanding to Singapore's post-independence ring concept plan formulated between 1963 and 1967 with UN aid (URA, 2012). With the aim to build a garden city, this ring concept plan envisaged the high- and low-density residential estates, industrial areas and commercial centres in a ring formation around the central water catchment area, as well as a network of expressways and a mass rapid transit (MRT) system to provide island-wide interconnectivity. The initial spatial layout for Changi Airport, port, expressway

network, rail network and other main infrastructure was designed into this plan.

The ring concept plan was subsequently reviewed between 1968 and 1971 under the Singapore's State and City Planning Project to keep pace with the changing demand, as shown in Figure 2, in which a detailed prospect of economic and social developments was highlighted. The concept plan with a planned population of 4 million divided the country into five regions (central, north, northeast, east and west), where four non-central regions were created to aim to reduce congestion in the central region (Chew, 2009). The focus in this concept plan was to build a central region at the international level, develop the rapid transportation system, promote the quantity of living environment and provide more residential houses and green land.

The 1971 concept plan has been reviewed several times, in 1991, 2001 and 2011. The 2011 revision places sustainable development as the top priority, with a target population range of 6.5–6.9 million by 2030 (URA, 2011b). The land-use nature has been carefully specified as shown in Figure 3, in which the reserve sites can provide options beyond 2030 to ensure use by future generations.

A distinct difference between Singapore's urban planning framework with other cities is the highly disciplined organisation

Figure 2. Concept plan 1971 (URA, 2011a)

Figure 3. Concept plan 2011 (URA, 2011b)

mode and context. Singapore is a city-state and island nation that practises strict organisation from planning to management. All the policies are designed carefully and launched without bias. Singapore's long-term urban planning practice, its public housing programme, its green space protection policies, its public transportation encouragement policies, its financial support policies and other policies are lauded internationally.

The current land-use and development policy is to create partially self-sufficient towns and districts that are served by four regional centres, namely the Woodlands Regional Centre in the north, the Jurong East Regional Centre in the west, the Paya Lebar Central in the northeastern and the Punggol Creative Cluster and Learning Corridor in the east. Each regional centre services one of the four different regions of Singapore besides the central area, and essentially replaces some of the commercial functions of the central area (Bishop *et al.*, 2004). It is found that this planning approach is working well and is well fitted with Singapore's development.

3. New town prototype

In accordance with the master plan, Singapore divides the planning area into new towns. To guide new town development, Singapore developed a simple but rigorous prototype

Figure 4. New town prototype (Liu, 2014)

in the late 1970s, as shown in Figure 4, in which all the infrastructure was deliberated according to the population number. It is a MRT-centric urban planning concept, with the surrounding land use constituting a certain fraction of different types; that is one-third for high-rise residential building and infrastructure, one-third for commercial, industrial, education infrastructure, and the rest is used for transportation infrastructure, green space, white site and so on. This prototype is

different from models in other countries, in which the high-rise apartments not only afford residents the opportunity to take advantage of cool sea breezes free from insects and mosquitoes (Tuan Seik, 2001), but meet the requirements of a high-density population.

Each new town is mutually self-contained, while adjacent new towns are connected by the MRT and expressway networks. Although it has not been updated since 1992, the latest standards published for various facilities are specified as indicated in Table 1. These standards have been well followed and applied into 23 new towns since the first test bed of Queenstown in the 1950s.

4. Transportation system

Singapore has determined a MRT-orientated new town development guideline at the beginning of overall planning, where MRT should be the main transport mode. All new towns are connected by MRT lines, as shown in Figure 5, as well as the light rapid transit network as feeder service to the MRT network. For now, MRT is the most popular mode in Singapore, with more than 2 million passengers a day. The Land Transport Authority (LTA, 2013a) aims to double the MRT mileage from 178 km today to 360 km by 2030, whence 80% of people will live within 10 min walking distance of a MRT station.

Every MRT line is routed through high-density housing estates, and most MRT stations are located in/nearby a commercial mall. The MRT system has smooth connection with the general public bus system. For a large residential area, a bus interchange station is planned above or near the MRT station. Take Boon Lay MRT station as an example, which services the west part of Singapore with a large volume of passenger traffic. It is an elevated platform station, where the nearby bus interchange station with 31 public bus lines is located within Jurong Point shopping mall, as shown in Figure 6. Residential houses, a medical centre and a community library are built within 200 m of the MRT station.

The public bus system has a good connection with the MRT system in Singapore. There have been 348 bus routes and 4608 bus stops since the end of 2012 (LTA, 2013c). Besides the close link with MRT stations, many initiatives have been made to promote public transport (PT) usage, such as bus lanes, 'B' signal (signal for bus which is displayed before the green lights to ensure the bus's priority), 'Give Way' signage, express/rapid bus services, intra-town services, night bus services, supplementary bus services, premier public bus services, niche public bus services and so on (Ibrahim, 2003). Although there are only two main bus operators, Singapore Bus Service Transit Limited and Singapore Mass Rapid Transit Trains Limited, Singapore delivers a world-class enhanced integrated fare

system for public service, not only regarding the ticket fare structure and network planning, but also regarding information sharing. Using a contactless smart EZ-link card, travellers can enjoy the joint discount in both MRT and public bus system across all operator companies, which is more convenient to travellers and more environmentally friendly for society.

There are three levels of road system in each new town, as shown in Figure 7. The outermost line is the expressway to connect the new town with outside towns (see Figure 8(a)). Major arterial roads link the town centres with outside towns (see Figure 8(b)), while minor arterial roads ensure the inside connections among the main residential buildings (see Figure 8(c)). There is an extensive network of footpaths built alongside major and minor arterials to link the residential blocks (see Figure 8(d)). This hierarchical road system is an effective method to ensure travel accessibility and traffic calming at the same time. The speed of vehicles decreases from the external network to the town in good progression. Within residential precincts, there are only minor arterials lined alongside the footpaths.

The transportation system's development and Singapore's urban development play complementary and coordinated roles. On the one hand, Singapore's urban development relies on the rapid development of the railway system. As the city's economy prospered and the population increased, urban residential space has expanded. Transportation development underpins the expansion framework linking the city centre with the many town centres located around the island, such that while the city anchors the central business district (CBD), many business functions are decentralised and devolved to the towns. On the other hand, the city's development leads to the improvement of the transportation systems. Hence, transportation planning is the necessary component in city and new town planning.

The development of the transportation system also affects travel behaviour significantly. From the analysis of the House Interview Survey from 1997 to 2008, the total trips in Singapore have experienced a growth rate of 20% (4.8% per annum), whereas the private transport trips grew even faster than the PT (25 against 16%) (Cheong and Toh, 2010). The imbalanced increases have resulted in the daily PT mode share dropping consistently from 63% in 1997 to 58% in 2008. To address the falling PT mode share, LTA recently implemented several policies, including managing travel demand through an electronic road pricing system, providing more effective and convenient PT, and reducing the car population through a vehicle quota system. These measures have contributed effectively, as the PT mode share has increased to 63% as of 2013. LTA aims to achieve a PT mode share of 70% during the morning peak hours by 2020, and 75% by 2030.

Facilities	Planning standards
(a) Commercial	
1. Shops (30–400 m ²)	One shop to 70 du 20% in TC, 50% NC and 30% within precincts
2. Kiosks (5–15 m ²)	One to 600 du 30% in TC and 70% in NC
3. Emporiums (4500–6500 m ²)	One to two per new town
4. Supermarkets (1200 m ²)	One to two per new town
5. Eating houses (450 m ²)	One eating house to 750 du 7% in TC, 23% in NC, 70% within precincts
6. Restaurants (90–2000 m ²)	One to 1000 du 30% in TC and 70% in NC. In addition, two or three fast food restaurants and one or two bigger restaurants in TC
7. Office space	60 m ² to 450 du 70% in TC and 30% in NC
8. Cinemas (1800 m ²)	Two per new town in TC
9. Mini-market (450 m ²)	One to 6000 du
10. Market produce shop (130 m ²)	One to 3000 du
11. Market produce lock-up shop (40 m ²)	One to 500 du
12. Wet market-cum-cooked food centre	One to 5000 du replaced by (9)–(11) since 1982
13. HDB area office	One 0.28 ha site to 15 000 du approximately
(b) Institutional	
1. Primary school site (1.8 ha)	2300 du to one Primary school
2. Secondary school site (2.7 ha)	4100 du to one Secondary school
3. Junior college site (6 ha)	One per new town
4. Vocational institute site (6 ha)	One per new town
5. Library (0.3–0.4 ha)	One per 30 000 du
6. Polyclinic (0.5 ha)	One site to 4000–5000 du to be sited in NC
7. Community centre (0.4 ha)	One per new town
8. Mosque (3000 m ²)	One per 9000 du
9. Chinese temple (0.2 ha)	One per 12 000 du
10. Church (0.3–0.4 ha)	One site for two new towns
11. Hindu temple (0.2 ha)	These non-profit communal uses are usually located at the ground floor void decks of the apartment blocks. For other institutional uses, there are six to seven reserve sites of 0.2–0.4 ha per neighbourhood
12. Others; for example, the residents' committee centre, community hall, neighbourhood police post, kindergarten, childcare centre, senior citizens' club and so on	
(c) Sports and recreational	
1. Swimming complex (1.5 ha)	One per new town
2. Sports complex (3 ha)	One per new town
3. Indoor stadium (1.2 ha)	One per new town
4. Football field (140 × 100 or 95 × 70 m ²)	Minimum one per neighbourhood
5. Hard courts for badminton, volley ball and so on (16.5 × 8.5 m ²)	One court to 1000–1200 du
6. Multi-purpose court (30 × 18 m ²)	One court to 2500–3000 du
7. One court to 2500–3000 du	One per neighbourhood
8. One per neighbourhood equipment	One to 700 du
9. Precinct garden (0.2 ha)	One to 3000 du
10. Neighbourhood park (1–1.5 ha)	One per neighbourhood
11. Town garden (5–10 ha)	One per new town

TC, town centre; NC, neighbourhood centre; du, dwelling unit; HDB, Housing and Development Board

Table 1. Planning standards for new facilities (Field, 1992)

Figure 5. Singapore MRT map (LTA, 2013b)

Figure 6. Map of Boon Lay MRT station (Jurong Medical Centre (JMC, 2012))

Figure 7. Road system

5. Residential system

Although the population density is quite high, Singapore's residential system is neat and comfortable and does not result in a tight condition. It is because urban planning has taken into consideration the attendant population growth. The amount of commercial infrastructure, as well as educational infrastructure and recreational infrastructure, is in accordance with the population number in each new town, which also provides certain local employment opportunities to minimise trips into the CBD.

There are three kinds of residential buildings, namely high-rise HDB flats (as built by Housing and Development Board), condominium and terraced houses (Singapore Department of Statistics (SDS, 2014). Singapore faced a serious housing issue when Singapore attained self-governance in 1959. Only 9% of residents lived in public housing. To solve this problem, Singapore passed the law of the Housing and Development Act in 1960 (Wong *et al.*, 2008) and established HDB to provide Singaporeans with quality homes and living environments. Within the first 5 years, HDB had built 54000 HDB public housing flats to provide housing to middle- and low-income families. By the end of 2012, approximately 82% of the population lives in HDB housing with a high standard of living condition and environment. The average living space per capital is about 30 m², which is much higher than other cities in Asia, such as 12.9 m² in Hong Kong, 15.8 m² in Tokyo and 17.3 m² in Shanghai.

HDB starts planning the residential town from the edge of the city, which is good for decentralising the population,

decreasing the demolition work and reducing the construction budget. With the development of the transportation network, including the MRT network, PT network and expressway, people are more willing to move out of the city belt to live in the new towns. As the housing requirement is being met, the government then focuses on reconstructing the city centre.

Although HDB flats cater primarily to the masses, they are built in a variety of quality and design. There are three types of HDB flats, including small units (<90 m²), medium units (90–110 m²) and large units (>110 m²). In the HDB estate, there is ample open space with facilities and greeneries around residential buildings for recreation (see Figure 9). Three-dimensional (3D) parking lots are located within the new town instead of ground parking lots to provide parking space for vehicles and avoid illegal parking along the roadside. Given Singapore's hot and rainy climate, adjacent residential buildings are linked by rain shelters, likewise the link-ways with transit stations.

Another typical characteristic of Singapore's residential system is the ground-floor void deck design as shown in Figure 10. This design ensures open horizontal space, good ventilation, upstairs' privacy, as well as space for community activities. Household rubbish can be directly disposed within home premises through the rubbish chute built into the kitchen. All community rubbish is collected together and send to the garbage disposal plant.

6. Green space system

Singapore pays great attention to environment protection and sustainable development. As an island nation, with scarce land, Singapore nevertheless designates a large area for nature reserves that are protected by law from development. Advocating nature conservation and minimising human intervention are the basic green development policies in Singapore. Singapore has become the 'greenest' city in Asia, as it has 66 m² of green space per person, above the average of 39 m² (Economist Intelligence Unit (EIU, 2011); Lim, 2011).

Singapore's green system follows the principle of all-round development of green points, green corridors and green parks. Every residential building is required to encompass some grass land, and rooftops are being decorated as outdoor gardens. Residents are also encouraged to decorate staircases with greenery. These small green points are dotted in Singapore everywhere as shown in Figure 11.

Singapore takes full advantage of different kinds of landscape to stretch limited green space. As shown in Table 2, different shapes will be designed according to the actual landform to maximise the green space.

Figure 8. Road infrastructure: (a) expressway, (b) major arterial road, (c) minor arterial road and (d) segregated dual footpath (Koh and Wong, 2012)

Figure 9. Facilities in new town (HDB, 2010)

Figure 10. Ground-floor void deck in Singapore

Figure 11. Green roofs in Singapore (HDB, 2014; OMA, 2009)

Besides these, Singapore has 44 national parks (each more than 20 ha) and 240 city street gardens (each more than 0.2 ha). The National Parks Board (NParks, 2012) is always seeking ways to sustain and grow Singapore's green spaces, which have resulted in a proliferation of innovative ideas and fruitful collaborations, and attest to the enduring value that is placed on enhancing and enriching Singapore's green landscape.

7. White site

In each new town, there are certain spaces, called 'white sites', used or intended to be used for commercial, hotel, residential, recreational and other compatible uses, or a combination of two or more of such uses as a mixed-use development (URA, 2014a). This kind of space provides flexible room for the

development to optimise the best potential future uses. A developer can decide the land-use nature, use purpose and percentage according to the local requirement, as long as URA's specifications are met. There is no differential premium if the developer changes the land-use nature of a white site during the lease term. For example, a developer can determine a small percentage of commercial area at the initial stage, while raising the percentage in future when demand increases without specific application and payment. In this way, urban construction can meet future requirements in time, and promotes dynamic and multi-functional development.

Take one white site in Marina Bay as an example, which is located near the CBD, as shown in Figure 12. The particulars of the land parcel are listed in Table 3. Meanwhile, the bid

Shape: ha	Periphery: m	Ratio
2	500	1:1
2	565	1:1.13
1	828	1:1.66
2/3 2/3 2/3	1012	1:2.02
1/5 1/5 1/5 1/5 1/5 1/5 1/5 1/5 1/5	1784	1:3.57

Table 2. Stretch limited green space (Liu, 2014)

document also sets specific rules for this site, such as a certain amount of parking plots to support the CBD parking system, and the district cooling system development (heating, ventilation and air conditioning).

The development concept of a white site reflects the flexibility of the urban plan, which caters for uncertainty of future urban developments. Meanwhile, the government sets planning

guidelines for every white site to ensure the plan's certainty. The combination of uncertainty and certainty shall promote efficient urban planning towards realising the greatest benefit along the right track, which is very helpful for the maintenance of overall land banking system of a nation.

8. Conclusion

With the improved quality of life, people tend to expect the city to be green and sustainable. Urban planning must make use of its existing characteristics, continue to innovate and look into the future. Besides the improvement of infrastructure, it is becoming more important to create a unique perception of affiliation and ownership among the inhabitants. Singapore's successful transition from a British colony to a world famous garden city is closely related to its series of integrated foresight planning methodologies with strict management, which becomes a model of metropolis urban planning.

This paper systematically summarises Singapore's urban planning history and current policies by introducing four main aspects; that is, urban planning framework, transportation system planning, residential system planning and the green

(a)

(b)

Figure 12. One white site in Marina Bay (URA, 2014b): (a) locality map of the example site and (b) 3D map of the example site

Location	Marina view/union street
Site area: m ²	Plot 1: 7817.5 (land parcel) Plot 2: 18.0 (cross-sectional area of subterranean lot)
Maximum permissible gross floor area: m ²	101 628
Allowable development	White site development with at least 71 140 m ² of the maximum permissible gross floor area (GFA) for office use, and the remainder for any one or more of the following uses <ul style="list-style-type: none"> ■ commercial (e.g. retail and entertainment) ■ hotel ■ residential
Maximum building height	200 m above mean sea level
Lease period	99 years
Project completion period	84 months

Table 3. Particulars of land parcel (URA, 2014b)

space planning. Two distinctive concepts are also discussed, namely new town prototype and white site.

As cities around the world develop, the challenges for Singapore's urban planners evolve around the imbalance between the increasing population and finite supply of resources. Coupled with the pressures brought about by climate change, these challenges make the way ahead a thought-provoking one: how to make long-term plan to accommodate the population with no degradation in the quality of life and how to develop Singapore in a sustainable way? With these challenges, URA released a long-term planning strategy in 2012, called 'Planning for a sustainable Singapore'. It states four planning objectives, which include sustaining a robust and vibrant economy, providing a good quality of living and a sense of well-being for all, developing in an environmentally responsible manner and optimising the limited land and sea space (URA, 2012). The Ministry of National Development (MND) has espoused a vision for future development as making Singapore a liveable and lively city state. Some key goals have been identified for 2030 in the Sustainable Singapore Blueprint 2015, including provide 0.8 ha of green park space for every 1000 persons, increase greenery in high-rise buildings to 50 ha, 80% of existing buildings to achieve at least green mark certification rating, 75% of journey to be made by public transportation during peak hours and 80% of households within 10 min walk of train stations (MND, 2012). To distil, create and share knowledge on liveable and sustainable cities, Singapore also established the Centre for Liveable Cities in 2008, which is aiming to design a liveability framework as a guide for developing liveable and sustainable cities. Although challenges of today's Singapore are different from earlier generations, the end goal remains the same, which is to keep Singapore's global

competitiveness while creating a comfortable and pleasant living environment.

Acknowledgements

This study is part of a research project, which is jointly led by Dr Y. D. Wong, Dr M. Meng and Dr P. H. Au, funded by the NTU Sustainable Earth Office (project title: Modelling multimodal travel behaviour linking non-motorised transport with public transport), and also supported by the Singapore National Research Foundation under its Campus for Research Excellence And Technological Enterprise (CREATE) programme.

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