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How Much Development Can a Rail Station Lead? A Case Study of Hong Kong

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Abstract

Since the concept was first introduced in the 1970s, transit-oriented-development (TOD) has greatly expanded in East Asian cities such as Hong Kong. Rail stations are built together with clusters of residential–commercial towers and government services to form a new style of living – a "rail village." This paper examines the composition, scale, spatial form, organization and operation of several typical rail villages in Hong Kong. The cases range across those planned from the mid-1990s to 2015. Based on the analysis of the rail village composition, the paper derives a development ratio to indicate the density, effectiveness and efficiency of a rail village catchment area. The ratio provides a useful and direct figure for the comparison of different stations, cities and development modes.

Keywords: Transit-oriented development (TOD), Hong Kong, Rail village, Catchment area, Development ratio

1. Introduction

The theory and practice of transit-oriented-development (TOD) originated in the 1970s (Bernick and Cervero, 1997; Cervero, 1998; Dittmar and Ohland, 2004). Together with the theory of New Urbanism, TOD has been shown to revitalize cities and solve many of the problems associated with city living, working and mass transportation. In parallel with North American practice, Hong Kong initiated the development of the mass transit railway (MTR) in the 1970s (Freeman Fox and Partners, 1970). The first MTR line, the Kwun Tong Line, opened in 1979 and the second, the Tsuen Wan Line, in 1982. In 1985, the Island Line was built in an east-west direction along the north side of Hong Kong Island. With a total length of 183 km (not including the Airport Express and light rail), the MTR lines spread through the region like veins, and most of the 86 train stations are surrounded by clusters of offices and residential buildings. About 42% of the region's households, 43% of the employed population and 75% of the commercial and office floor areas are located within a 500-meter radius of a train station (Yin, 2014). This area centered around a rail station is called "rail + property" or "rail village" (Tang et al., 2004; Bernick and Cervero, 1997).

In the 1990s, the cost of railway construction was HK$ 500,000 per meter, whereas the construction of the Shatin-Central Line in 2012 cost HK$5 million (US$645,160) per meter (Wenwai Pao, 2012). Building 1 km of railway today costs HK$5 billion (US$645 million), equivalent to eight times the cost of the Olympic stadium in London in 2012. Only by serving more people can such an expensive railway produce economic revenue and social value. The densely-built residential towers, offices and commercial buildings bring large numbers of passengers, consumers and high revenues, while the train station in turn brings great convenience for nearby residents (Fig. 1).

The Hong Kong MTRC is a listed corporation with a large percentage of government-held stock. The infrastructure and public buildings were built with public funds, while the offices and residential towers were built by private companies. Therefore, all rail villages are the result of public-private partnerships. The rail villages have had a profound influence on the city planning of the region. Once the MTRC acquires land from the government to build a station, the rail company becomes the landlord. The land above (rooftop) or adjacent to the station is subdivided and leased to interested developers through public auction. The MTRC derives 50% of its income from land development and property rentals (MTRC, 2016). This makes the MTRC a profitable public transportation operator and manager of rail villages - a phenomenon that is rarely seen in other cities. In this paper, we discuss the density and design of Hong Kong's rail villages, with the aim to share the practice and inspire further innovations in high-density environmental design and encourage more pedestrian-oriented public transportation.

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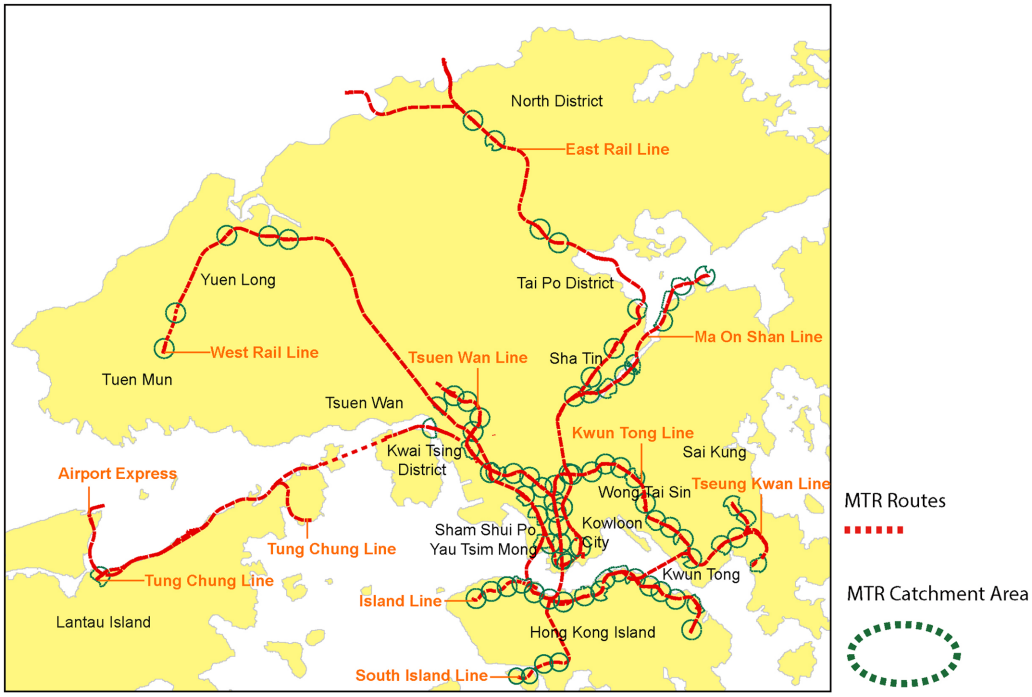


Figure 1. Clusters of development around rail stations in Hong Kong. The green line represents the 500-m catchment area. Courtesy of Prof. Ziyuan Yin.

2. Literature Review

A rail village is different from a conventional rural village, but presents a high-density and mixed-use living mode (Shelton et al., 2011; Xue, 2016). In 1993, Calthorpe systematically discussed the definition, type and design points of TOD, and formulated a set of detailed and specific guidelines for TOD (Calthorpe, 1993). In 1997, Cervero and Kockelman proposed the "3D" principle: "Density, Diversity, Design," and found that high-density, mixed use of land, and pedestrian-oriented design could reduce the demand for motor vehicle travel (Cervero and Kockelman, 1997). During this period, the TOD concept received widespread attention. At the beginning of the 21st century, the concept of TOD gradually expanded and linked with the strategy of urban development (Transportation Research Board, 2001). After the "3D" planning principle was widely accepted, in order to measure the effectiveness of TOD projects, Cervero and Murakami (2009) proposed the "5D" principles: "Density, Diversity, Design, Distance to transit and Destination accessibility." The expansion of this connotation fully reflects the interrelationship between transportation and land use.

It is clear that the five Ds should be mutually cooperative and considered in total. The government and transit agencies are placing more attention on TOD (Renne, 2009). Because they recognize that a particularly important solution is to change land-use patterns through transit-oriented development, (Ratner et al., 2013). Knaap (1997) pointed out that the superior accessibility of a rail station can increase the value of regional land, and the construction of infrastructure can lead to new regional development; thus, high-density development is worthy of encouragement.

The ideal station catchment range refers to a (circular) area centered on the rail stations and taking a certain distance as a radius. The radius is the acceptable distance traveled by community residents or office workers within a reasonable walking time. Due to differences in walking habits, walking speed and built environment among different regions, the selection of spatial scale based on the influence of rail transit varies. Japanese scholars basically take a 2-km radius zone around the rail station as the range of influence of the development benefits of urban transit (Yi, 2015). In the North American literature, Calthorpe (1993) set the walking distance of 2,000 feet (about 630 m); Porter defined the TOD development at the surrounding area of the rail station within half a mile (800 m) of the station (Transportation Research Board, 1997); Cervero (1997) considered the most suitable walking distance to be a 5-minute walk (about 400 m).

In short, North American scholars generally agree the ideal station catchment is within a radius of a quarter to half a mile, or around 400-800 m (Bernick and Cervero, 1997). For a healthy adult, this represents a walk of around 5-10 minutes. The range of influence was assumed to be half a mile in a study of the time effect of the western extension of the Max rail transit line in Tokyo (Knaap et

al., 2001). Moreover, 1 km served as the range in a study of the London Jubilee Line (Chesterlton et al., 2003). As mentioned, most residential and office towers and shopping malls in Hong Kong are within a 500-meter radius of the station. A walking distance of 10 minutes from home to rail station or bus stop for commuting is acceptable to most people, and a longer distance is acceptable when returning home after work (Yin, 2014). The rail villages in the following cases have a catchment radius ranging from 300 to 1,200 m, which is generally acceptable to the local residents and workers.

Planning at the regional scale sets the spatial structure of TODs (Kamruzzaman et al., 2014). The improvement of the city center, the development of the urban sub-center, the planning of regional transport nodes, the small-scale expansion and upgrading plan, the renewal of old built-up areas, and the development of new towns in the suburbs all indicated that the concept of TOD is now well-developed in Hong Kong, with a wide range of applications. However, few studies have empirically analyzed and compared the development spurred by different types of TOD.

In Hong Kong, the building clusters around the rail stations are generated by commercial interests and end-users' behavior and acceptance. Based on the preceding literature review and the situations in other countries, we examine the practice and built environment in Hong Kong to answer the following questions, which few studies have yet sought to answer. How large can a rail village be? How does a rail village work internally and externally? How long does it take to develop a rail village? In general, how much development can a rail station generate?

The authors aim to answer these questions through their own investigation. The paper is structured as follows. First, the background and a literature review of TOD and its practice in various areas including Hong Kong are introduced. Second, in the methodology section, the approach to analysing a catchment area is analyzed. The results for the five targeted stations and the villages under their influence are displayed in the third section. The fourth section discusses the results and offers some proposals for the development of rail villages.

3. Targeted Stations

In the early period of the MTR in the 1980s, the rail line penetrated the old and dense city area of Hong Kong Island and the Kowloon Peninsula. As mentioned previously, these areas are located on the most accessible roads and serve high numbers of residents and office workers. However, rail construction was not associated with land development alongside the railway, and new communities were not built to depend on the rail transit to optimize the urban spatial structure during this period. It was not until the MTR reached into the New Territories that a new town was constructed around a railway station, which became a good model for the organic integration of rail transit and new regional development.

In 1992, the Hong Kong government launched 10 "core infrastructure projects" for the new international airport, including Chek Lap Kok International Airport, Tung Chung new town, North Lantau Highway, Lantau Link, Route 3, the West Kowloon Highway, the West Kowloon reclamation area, the West Cross-Harbor Tunnel and the Central reclamation plan.

The Tung Chung Line and Airport Express use the same right-of-way, but with different entrances to the stations. The 31.3-km line runs from western Hong Kong Island, up the Kowloon Peninsula and the west part of the New Territories - Tsing Yi, Lantau, Sunny Bay, Tung Chung and Chek Lap Kok airport. The Tung Chung Line was the first project in which the MTRC integrated the concept of "rail + property (village)" into the station development. A trial for coordinated development between rail transit and urban



Figure 2. Targeted stations along the Tung Chung Line.

land utilization was carried out, so that the well-organized evolution and development of urban spatial form and structure could be guided by the construction of the metro. The Tung Chung Line has been in use since 1998, and the rail villages have gradually formed and grown over the years. The other lines, constructed later, use a similar concept, but with a less diverse sample of typologies than the Tung Chung Line. Therefore, five stations on the Tung Chung Line are analysed here (Fig. 2).

4. Factors in Rail Village

Based on literature review and investigation, we have identified the following factors determining the formation and effectiveness of rail villages.

4.1. Building Type

Building type relates to the "diversity" and "design" components of the five "Ds" (Cervero and Murakami, 2009). The mixture of various building types brings convenience to the people who work and live in the rail village. The permitted building types are prescribed in the Outline Zoning Plan and lease conditions of land auctioned by the government. Modification of such a lease involves lengthy legal procedures and huge fees paid to the government and a consultant land surveyor.

There is plenty of evidence that the pedestrian environmental quality affects how far people walk in their daily lives. Studies of the built environment and behavior have explored the design content of the pedestrian environment and provide clues for how to encourage walking (Appleyard et al., 1981; Bosselmann et al., 1999). Gehl pointed out that straight and wide streets are tedious and seem longer than interesting streets (Gehl, 2011). All targeted stations have a big shopping mall as the center of activity (Xue et al., 2012). In fact, over 100 shopping malls are either above or adjacent to a train station in Hong Kong (Al, 2016). In Hong Kong's strong consumerist culture, a shopping mall is an indispensable part of people's lives and pedestrian activities (Tan and Xue, 2014). These shopping malls are both the connection space and the consumer space involved in people's daily activities. Most rail villages have residential estates and towers. Both are profitable sources of land premiums for the government and MTRC, and provide convenient homes for millions of people. Property prices are positively correlated with the distance to the station (Chau and Ng, 1998).

Hong Kong Station is located in the central business district, which is not zoned for residential use. Only luxurious hotels and serviced apartments are provided near the station. There are office buildings at Hong Kong, Kowloon and Olympic stations, located in the inner city. There are hotels in both the inner-city and New Territories stations. On weekdays, most of the people in the Hong Kong Station shopping mall are workers and tourists.

4.2. Rail Village Area

The size of a rail village depends on the design and layout of its nearby environment. The connection between destination buildings and the rail station determines how convenient and fast it is for people to access the station. A radius of 500, 800 or 1,200 m is acceptable. In the following case studies, some of the areas within a given radius extend into the water. Generally, the area of a rail village with a certain radius is fixed. However, in real situation, the area varies according to the physical environment and topography.

4.3. Catchment Radius

Studies of TOD in Hong Kong and overseas frequently discuss the catchment radius. Similar to the rail village area, the real radius and pedestrian route depend on the urban design and degree of convenience of the pedestrian environment. The convenience of the pedestrian route determines how many people will walk to and from the station. This study only counts pedestrian-only routes (bridges, gardens, shopping arcades) that are free from the city's vehicular traffic. If pedestrian routes are well designed with gardens and shopping arcades, walking the first and last mile becomes a pleasant journey.

On some pedestrian bridge sections (3-4 m wide), there are 3,000-4,000 pedestrians every 30 minutes during peak hours (Kwok, 2017). These are vital connections, as they allow pedestrians to cross complicated road networks in order to reach the station (The situation at Olympic station is particularly pronounced, as the station building is between two major roads and connects to numerous buildings on the far side of both).

4.4. Floor Area of Train Stations

The floor area of a train station is oriented toward train and station operations. Shops take up some of the area inside the station lobby for passengers' convenience. Some stations have more rail functions such as depots that are naturally bigger.

4.5. Floor Area of Buildings in the Catchment Area

The floor area of buildings within the catchment area decides how many people and activities it can accommodate. Not all buildings within the area are counted. The study only includes developments constructed after the train stations were built. Kowloon Station represents a typical planning method in high-density Hong Kong, with trains underground, buses and minibuses above ground and a two-story shopping mall filling the podium. Towers of residential flats and hotels soar from the podium roof.

4.6. Building Users and Ridership

How many people are living and working in the rail village? How many people are using the metro? This is a question directly related to the effectiveness of metro system and rail village. Citing issues of commercial competi-

tiveness, the MTRC in Hong Kong does not disclose the ridership numbers at each station.

4.7. Development Ratio

To measure "how much development can a station generate?", we introduce a floor-area ***ratio*** between a station and its influenced development, measured by the relevant gross floor area in square meters. The ratio directly states the relationship between a train station and the scale of development resulting from the construction of the station. As few studies have addressed this, we provisionally name it the ***development ratio (R)***. R is simply calculated by the following formula:

$$R = \frac{\textit{the total floor area of the rail village}}{\textit{the floor area of the station}}$$

The value of R indicates the efficiency and density of land use; in general, the larger the value, the more efficient the rail village.

The floor area of the station was measured from the building floor plan. The authors visited the targeted stations and their surrounding areas. Through observation and investigation, the scope of a rail village was defined as having a radius of 300 to 1,200 m. The floor area of the buildings in the rail village was measured and calculated from the building floor plans of the Buildings Department of the Hong Kong government, and the data from property sales agents such as Centaline and Midland Realty.

The development ratio proposed in this paper indicates the land use density and efficiency of a rail village. Land and property prices in Hong Kong are astronomically high and beyond most people's means. The question of how to effectively use the buildable land, especially around a metro station, is a central concern of government, developers and general public (Calimente, 2012). In this sense, the higher the R value, the more efficient the land use. For example, the catchment of Kyoto Station in Japan has an R value of 20 (Hui, 2011). Most Hong Kong stations have a value of over 20 as described below.

5. Description of the Targeted Cases

To illustrate why the development ratio is high in some districts and low in others, we record the diversity of

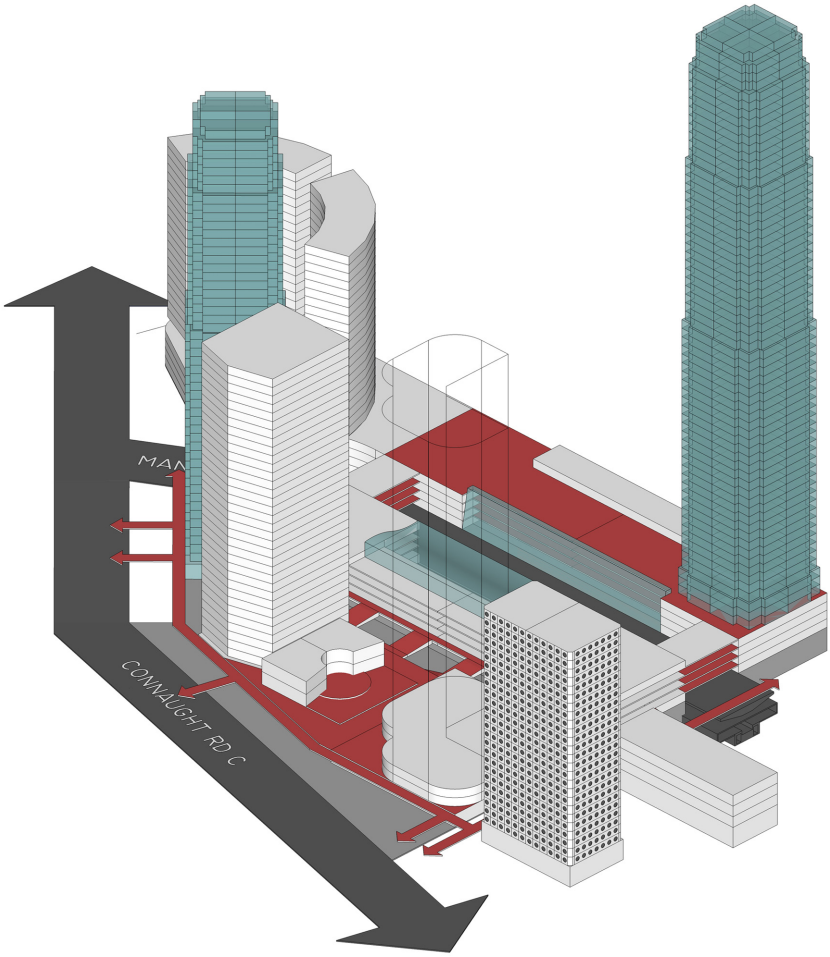


Figure 3. Composition of IFC complex in Central. Drawn by Dr. Tan Zheng.

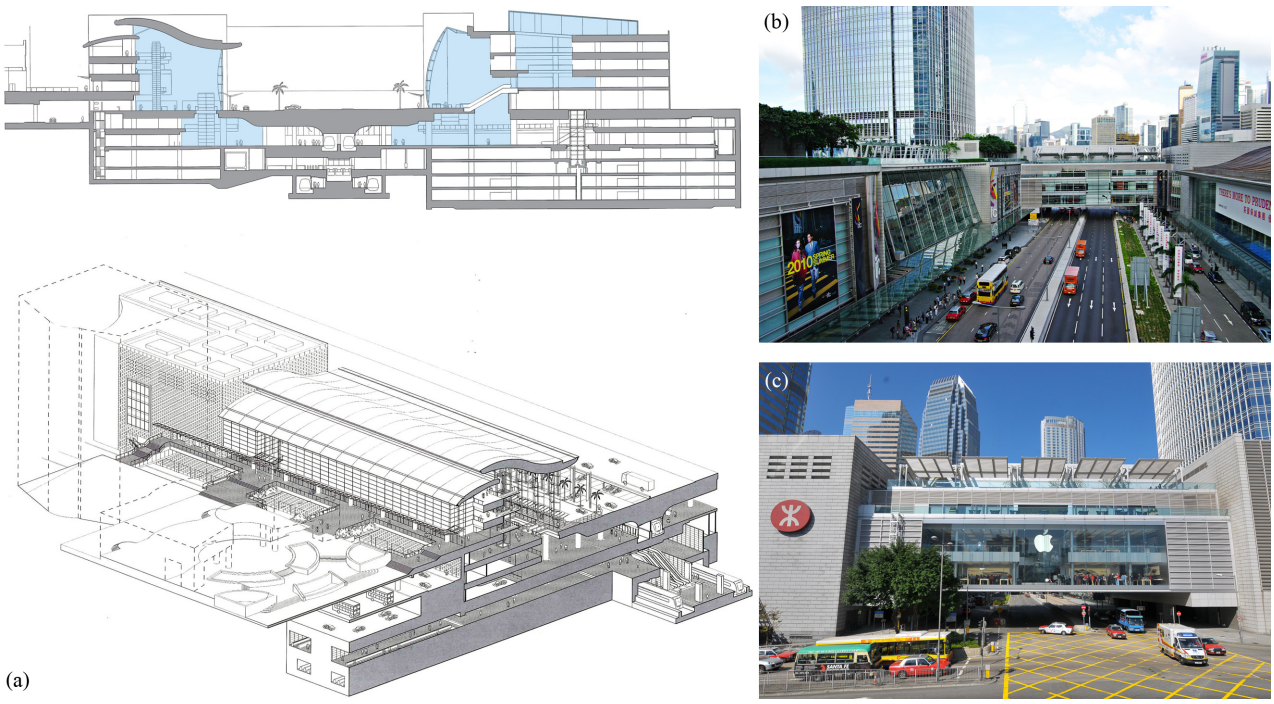


Figure 4. IFC and Hong Kong Station. (a) Section showing station, road and superstructure. Courtesy of Rocco Design, (b) Traffic transition in the central part of the IFC complex, (c) The opening allows vehicles to enter the complex.

building types at each station, the actual topography and the land use context.The figures with the views of pedestrian behavior and urban design factors are explained below, using the narrative method. The targeted stations are briefly described as follows:

5.1. Hong Kong Station

When the airport plan was confirmed, the government filled 20 ha of sea near Exchange Square in Central. The coastline was pushed outward by 350 m. The reclaimed land was used as the terminal for the Tung Chung Line. Above the station is the International Financial Centre (IFC) complex, with a shopping mall, office towers, hotel and serviced apartments on a 5.71-ha plot of land. In the Airport Express station, passengers can check in their bags and travel to the airport terminal in 30 minutes, "bringing the airport back to the city." This Tung Chung Line terminal is several hundred meters away from the old Central metro station. It took 6-7 years to build the train station and its skeleton. Several landmark skyscrapers were built over the next 6-7 years, and the development was completed in 2004. (Fig. 3)

5.2. Kowloon Station

Yau Ma Tei, Mong Kok and Tsim Sha Tsui were the earliest developed areas on Kowloon Peninsula, and as such they have been the most crowded areas in Hong Kong since the early 20th century. As one of the core projects of Hong Kong Airport, the West Kowloon reclamation project had the direct objective of providing land for the expansion of the Yau Tsim Mong quarter. Kowloon Station was planned as an important local node, with a certain density and mixture of program.

Although the developments surrounding the station are connected to each other by roads and metro lines, these developments are mainly accessed through the metro stations as there are few pedestrian routes between them. The well-organized elevated pedestrian bridges, which connect the train station to the nearby housing and commercial arcades, also encourage users to travel by metro. The traditional street block has been replaced by a megastructure of towers on a 13-ha plot with a 1.7-million-m^2 floor area (Fig. 5).

The development includes 14 residential skyscrapers and two hotel and office buildings. The ICC tower (2011) is 484 m high, designed by KPF from the U.S. The floor area of the station is around 20,000 m^2 (Xue et al., 2010; Terry Farrell & Partnership, 1998). The train station was put into operation in 1998. The shopping mall and the residential and office towers were completed in the following years (Fig. 6).

5.3. Olympic Station

Olympic Station's 16-ha plot was mainly constructed from the reclamation of West Kowloon. In this area, traffic accounts for 34%, a higher percentage than in the other projects. The plan, created in the early 1990s, set up the station location, with six pedestrian bridges connect-

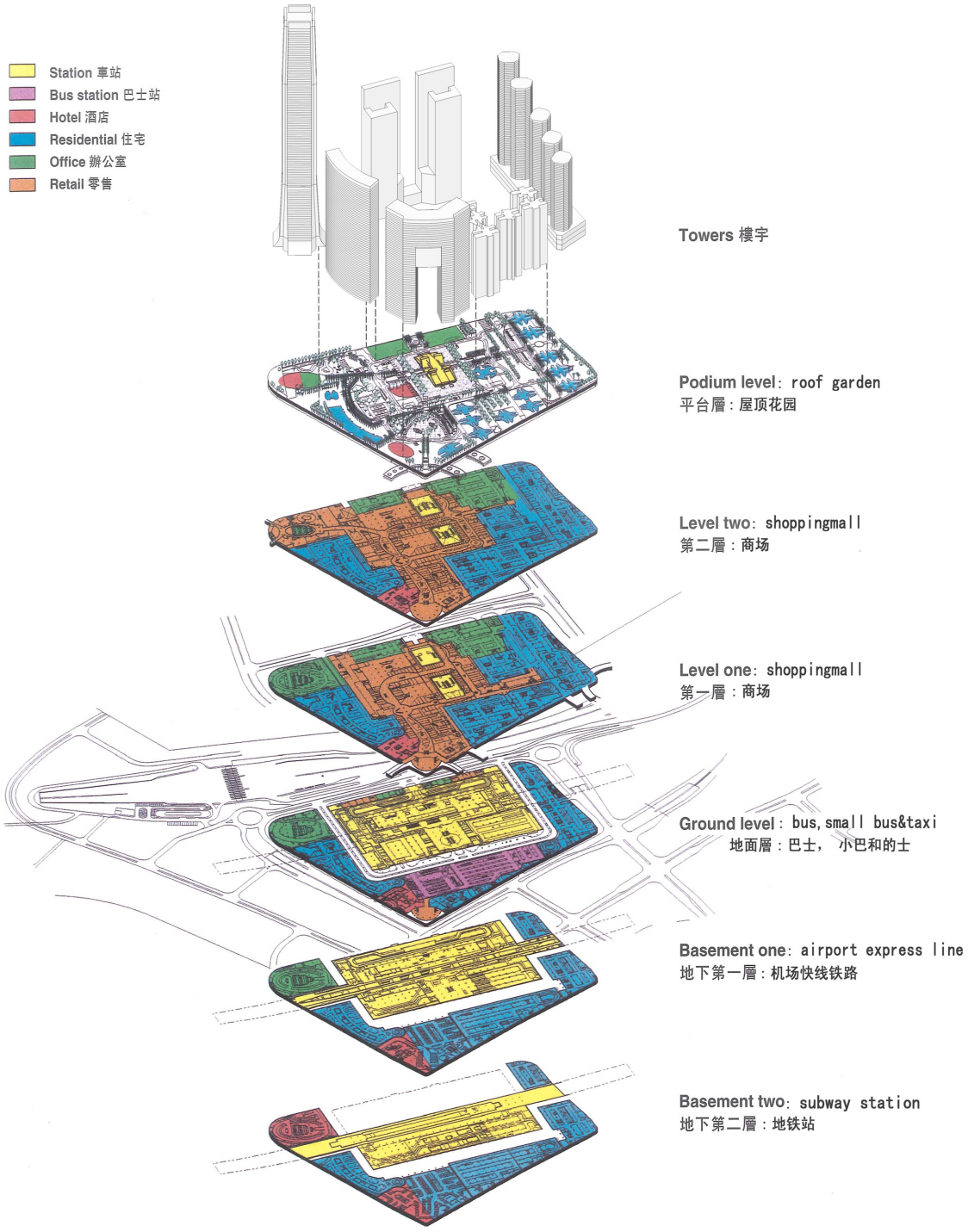


Figure 5. Relationship of various floors in the Kowloon Station development; master plan created in 1992. Courtesy of Terry Farrell & Partners.

ing the station to the neighborhood across West Kowloon Highway and other busy streets. Within a radius of 600-800 m, old buildings and new estates all enjoy the proximity of Olympic Station. In the other four cases, almost all estate development was preceded by the transit station. However, the Olympic Station rail village consists of old buildings that existed long before the construction of the railway. The Olympic Station was planned in the mid-1990s, and the station was completed in 2001. The nearby residential properties were gradually constructed over the next decade or so. Within the 500- to 800-m radius area, more of the older 1960s residential buildings are giving

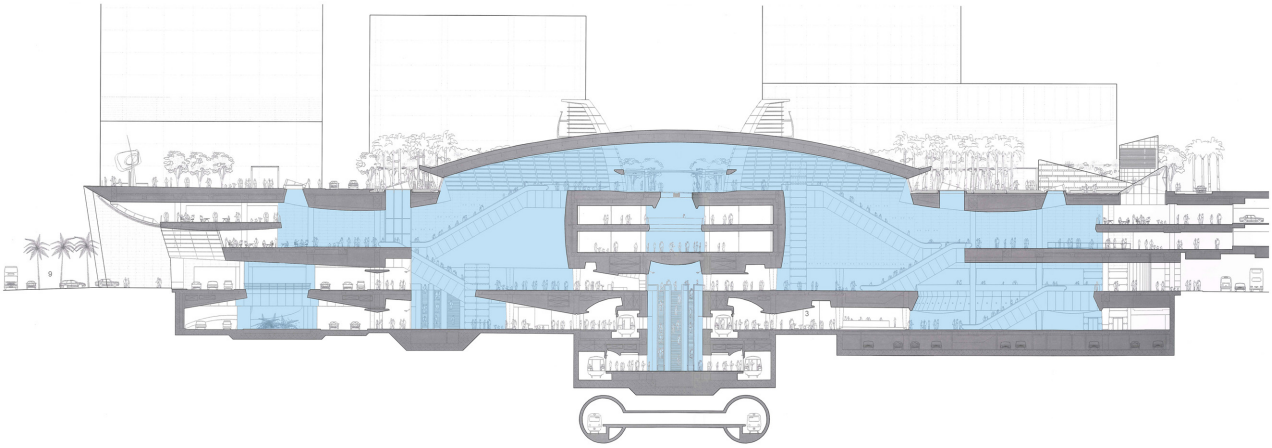


Figure 6. Section of Kowloon Station and shopping mall.

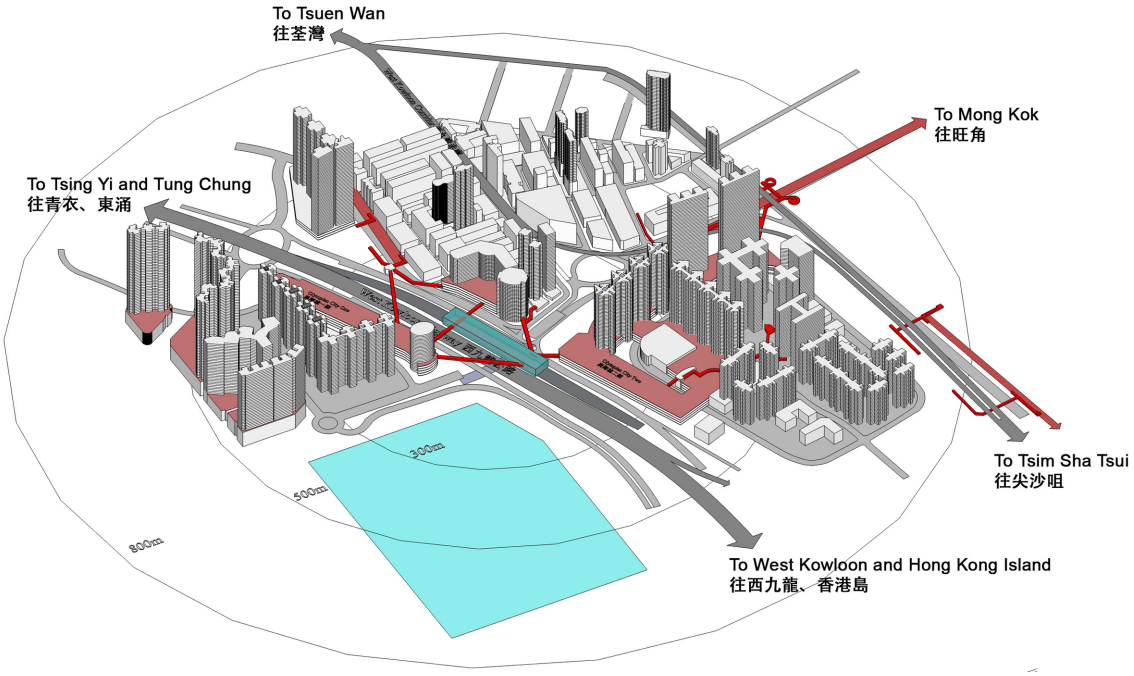


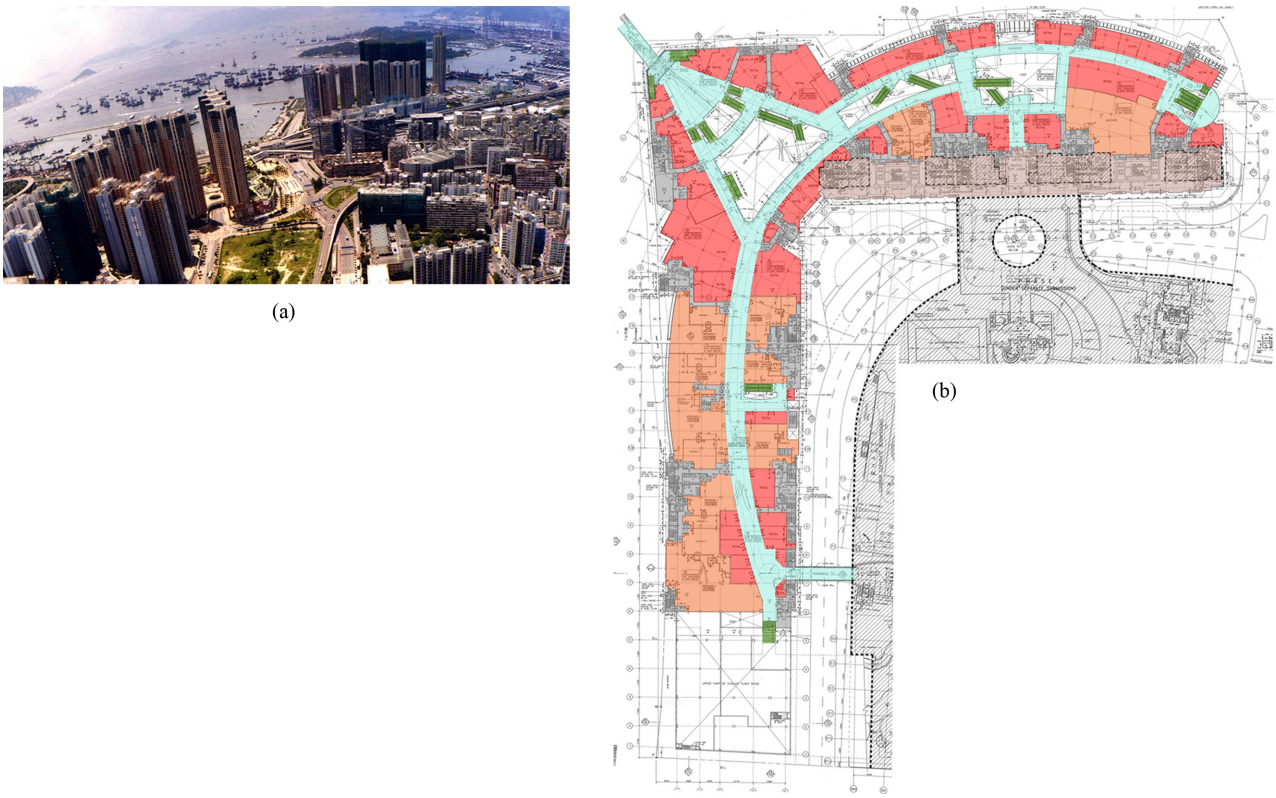
Figure 7. Catchment area of the Olympic Station. Drawn by Yang Ke and Sun Cong.

way to the new towers of 50 or more stories. The developers are more active in renewing the old districts because of the attractiveness of living near the metro (Figs. 7-8).

5.4. Tsing Yi Station

The first station in the New Territories is Tsing Yi, after which the Airport Express heads straight for the airport. The Tsing Yi complex contains the station and the Maritime Square shopping mall. The bus, shuttle and minibus stations are on the ground floor. The first floor is connected to the park and the open bus terminal by several pedestrian bridges. The east- and west-bound Tung Chung Line platforms are on the second and third floors, and the Airport Express is on the fourth. All of these station facilities link to the Maritime Square shopping mall, with a gross floor area of 46,000 m^2. Every day, 200,000 people pass through the building complex, and Maritime Square is constantly crowded. Above the shopping mall are residential towers.

The ground floor of Tsing Yi Station has a closer relationship with the nearby streets. The shopping mall opens onto the seashore park and promenade. The Tsing Yi complex only houses a shopping mall and residential buildings, and does not provide office space. Residents of nearby public and private housing estates take the MTR to com-



(a) (b)

Figure 8. The Olympic Station. (a) Residential estates and commercial buildings surrounding the Olympic Station. People mainly use the bridge instead of the ground to get around, (b) Plan of Olympian City shopping mall. One circular route threads through the shopping mall.

mute to Kowloon and Hong Kong Island, consistent with the "destination accessibility." The station and its resulting development were finished in 5-6 years.

5.5. Tung Chung Station

Tung Chung is a new town that emerged from the new airport construction in the 1990s. There are four phases of development; it is eventually planned to accommodate 250,000 people. The population was 19,000 by 2000, 34,000 by 2006 and 100,000 by 2010 (Fig. 10).

Tung Chung Station is the terminal of the Tung Chung Line. The North Lantau Highway and railway run along the seashore from Tung Chung Station, turning toward the airport. Tung Chung Station is located on a curve of the road and railway. The station and cross-highway Citygate shopping mall surround the residential estates on two sides.

Tung Chung Station was the catalyst for Tung Chung new town. The government subsidized home ownership and public housing prospered as a result of the railway's presence. To reach the goal of 250,000 residents, the government has continued land formation and public housing construction along the seafront and at the foot of the mountain; 110 ha of land have been claimed from the sea (Fig. 11).

The rail village in Tung Chung is mainly residential, with a small portion of office space. The shopping mall serves the residents. The central public space is surrounded by the shopping mall and the bus and train stations. The Tung Chung plan was augmented in response to the appeal for more housing land, doubling its current size. The new master plan stretches the development along the seafront, with high- and low-rise buildings around the subcenter and parks. Tung Chung town was formed in 1998 when the railway first opened. New developments are continuously added to the various private and public housing estates (Fig. 12).

6. Discussion and Comparison

To compare the functions and efficiency of MTR stations, we calculate and summarize the data for the above stations along the Tung Chung Line, as listed in Table 1.

In Table 1, Olympic Station has the highest R value, because it comprises a shopping mall of three phases, several new large-scale estates, and many upcoming urban renewal projects. The urban fabric of the old city allows for denser development. Most residential estates and office blocks are within 300-500 m radius. Moreover, residents in the rail village are attracted by several metro stations within the catchment area, including Olympic, Mong Kok

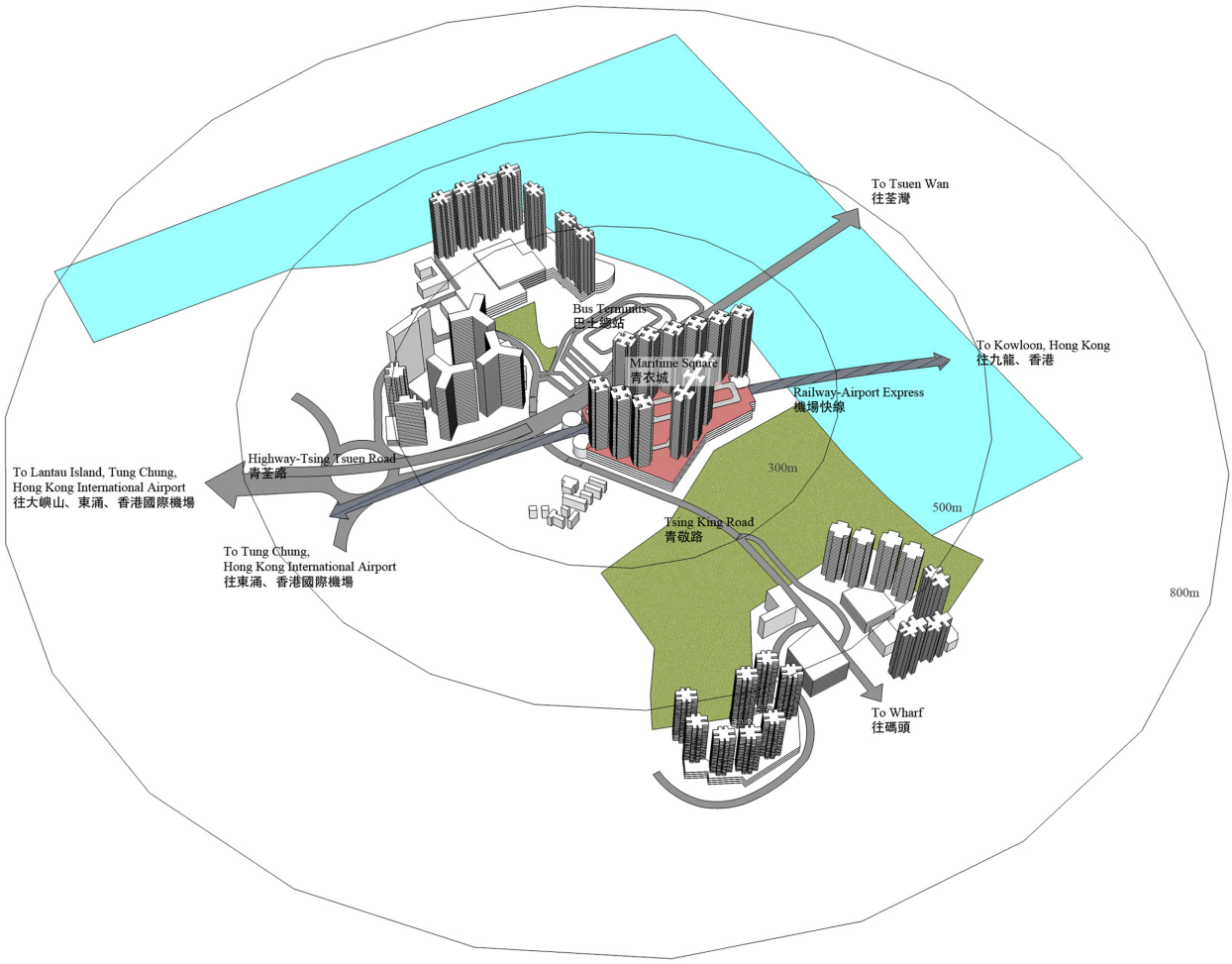


Figure 9. Catchment area of Tsing Yi Station. Drawn by Yang Ke.

and Nam Cheong. Tung Chung's R value is 66, which is reached by stretching the radius of the catchment area to over 1,000 m. Residents have a choice of walking to the station via pedestrian bridges or a taking mini-bus. As Tung Chung is at the west end of Hong Kong territory, most users of public transportation take the metro as their primary commuting choice. At Kowloon Station, a development of 60 times larger than the station house takes place on podium and skyscrapers upon podium.

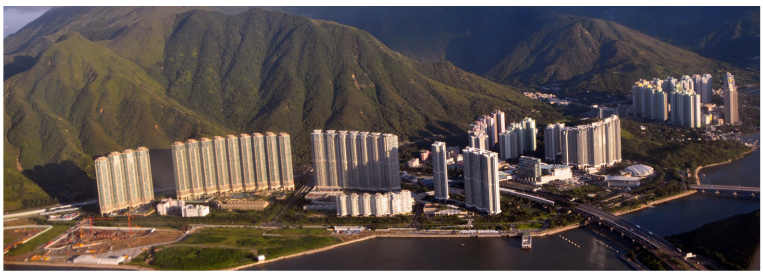
In general, the density around metro stations in Hong Kong is much higher than similar areas of other "high-density" cities like Tokyo, Shanghai, London and New York. The high density of rail stations is mainly realized by the following design methods.

6.1. Adapted Mega-structure Prototype

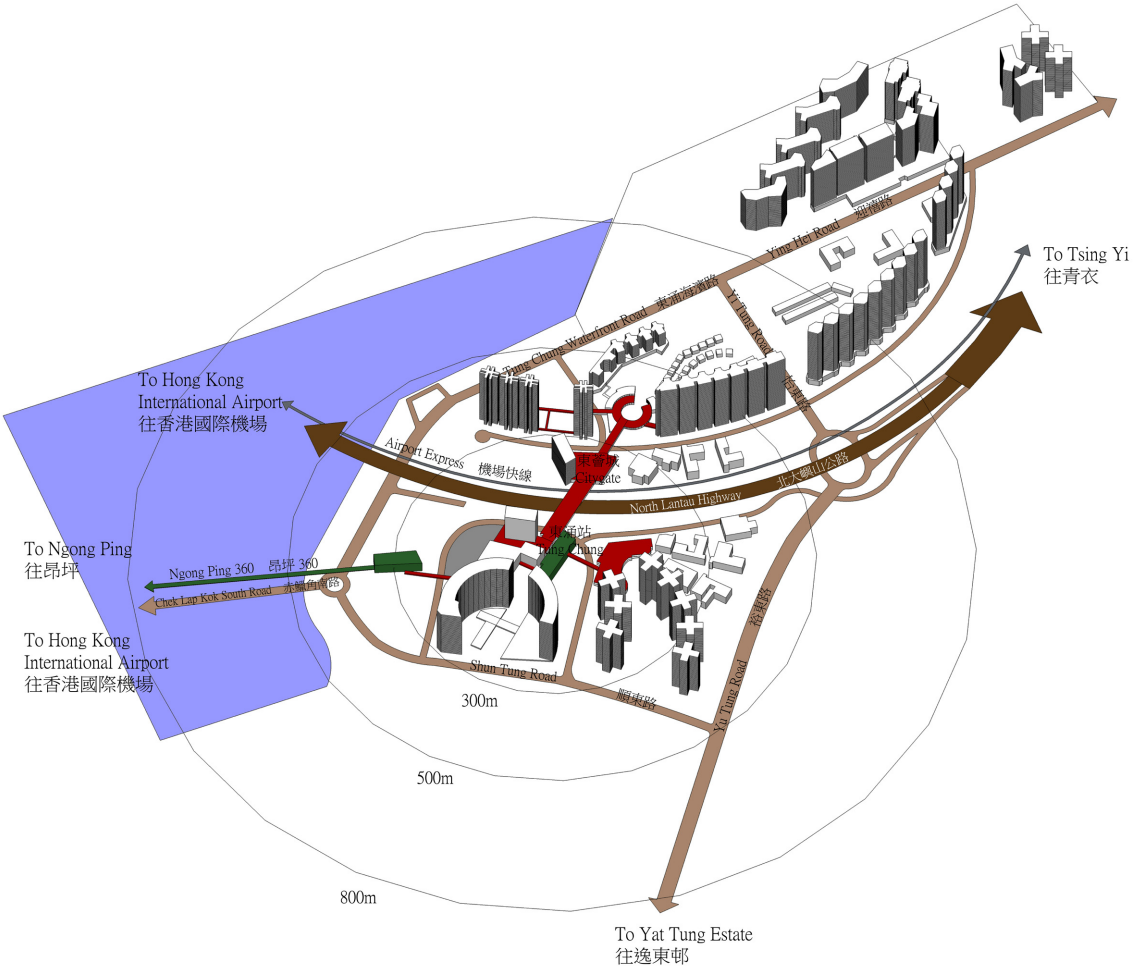
Driven by the land-scarce economy of Hong Kong, the West Kowloon and Tsing Yi developments certainly deploy all of the concepts of a mega-structure as elucidated by Maki (1964): "a large frame in which all the functions of a city or part of a city are housed." Therefore, on these terms, the development can be considered a mega-structure, albeit one that differs significantly from the historical precedents, due to the unique constraints and local context that gave it shape. For example, as the block was subdivided into several plots, each given over to different developers, the architectural and structural grids that would normally be deployed at uniform intervals to facilitate future design and construction have been abandoned. The current grid dimensions do not invite any further modular design.

6.2. A station as an Integrated Transport Interchange

Like the Airport Express and the stations on the Tung Chung Line, the principal aim of Hong Kong, Kowloon and Tsing Yi stations is to bring the airport back to the city. The location of the old Kai Tak Airport, along the harbor and almost directly in the center, was highly convenient. Kowloon Station acts as a remote terminal of the airport, complete with in-town check-in and an express train that takes passengers to the terminals in just 30 minutes.



(a) Residential estates arranged near Tung Chung Station



(b) Catchment area of Tung Chung Station

Figure 10. (a) Residential estates arranged near Tung Chung Station, (b) Catchment area of Tung Chung Station. Drawn by Yang Ke and Kwok Shing Yan.

Based on this idea, Hong Kong, Kowloon and Tsing Yi stations were designed and built in a manner far removed from the usual image of the modern train station. Serving as an integrated transport interchange, the stations are well-organized, using different layers to maximize efficiency. Instead of a giant plaza in front of the station to collect the flow of passengers from all directions, the giant foyer on the ground floor has direct access to traffic nodes such as taxi tanks, coaches, private and public bus stops. Pedestrians enter the foyer from the upper floor, where the commercial arcades and pedestrian networks are integrated. Underground, the Airport Express Line and Tung Chung Line are separated into overlapping platforms that share vertical connections to facilitate direct interchanges. Owing to the clear zoning of the different modes of transport, these mega-stations provide maximum convenience for the maximum number of passengers. These stations not only provide the best experience for departing travelers,



(a) (b)

Figure 11. Tung Chung Station. (a) Shopping mall, (b) Station house.



Figure 12. Master plan of Tung Chung town, 2014. The opposite (near) side is the manmade island for the Hong Kong-Macau-Zhuhai bridge border crossing.

Table 1. Comparison of five MTR stations and their "rail villages"

	Hong Kong Station	Kowloon Station	Olympic Station	Tsing Yi Station	Tung Chung Station
Location	City	Reclaimed city area	Reclaimed city area	New Territories (commuter town)	New Territories (commuter town)
Building type and function in the rail village	Shopping mall, office, hotel, serviced apartment	Shopping mall, residential, hotel	Shopping mall, residential, office	Shopping mall, residential	Shopping mall, residential, hotel
Rail village area (ha)	74.7	13.5	77.2	5.4	97.4
Approximate catchment radius (m)	200-300	podium 369×503	300-800	300-800	300-1,200
Floor area of train station (m^2)	20,000	18,000	15,660	50,000	15,500
Floor area of buildings in the catchment (m^2)	415,900	1,090,000	1,749,258	291,870 (immediate 300 m) 336,900 (800 m)	1,028,910
Development ratio (R)	**1:21**	**1:60**	**1:112**	**1:5.8-6.7**	**1:66**

but also present a new gateway for those arriving in Hong Kong. However, compared with the well-integrated vehicular modes, the pedestrian routes from the ground floor are limited, and access by foot is not encouraged.

6.3. Elevated Ground Floor

Offices and residential towers stand on the roof gardens of the podiums of the Tung Chung Line stations. The towers share closed-circulation routes for vehicles and pedestrians, and the entrances are connected to different levels according to their specific privacy requirements. The Kowloon, Olympic and Tsing Yi stations were designed with semi-private gardens and squares on the podium rooftops, in an attempt to create a coherent relationship between private properties and the public realm. In Kowloon Station, the podium is elevated 18 m above the ground (the maximum height allowed by the Hong Kong Building Regulations for 100% coverage of the site). Although it still serves as the traditional ground floor of the towers, the mega-structure that has been lifted to the top of this podium level is fundamentally different in terms of its spatial structure and relationship with the elevated public streets and vehicular traffic on the ground.

6.4. Towers and Real Estate Properties

As an urban development project involving several of the biggest real estate investors, tower-block housing became the main means by which building designs met the market requirements in Hong Kong. In the 1990s, the centrally symmetric, eight-unit cruciform plan became popular and now dominates high-rise housing layouts and designs. Compared with high-rise "slab" buildings, a centralized high-rise design has advantages in terms of ventilation and daylight, a crucial consideration for the warm, humid climate of Hong Kong. Consequently, several towers based on this design were inserted into the West Kowloon, Olympic and Tsing Yi projects, with the entrance lobbies connected to commercial arcades and podium floors. Situated alongside Victoria Harbour, these towers form the silhouette of the Hong Kong skyline and can be considered as smaller units that were "plugged in" or "clipped on," as opposed to forming the main structural framework.

Skyscrapers are expensive to build. Due to their proximity to train stations, the skyscrapers described here conform to market expectations and bring in plenty of revenue. In the sequence of construction, residential buildings are usually built before shopping malls, so as to quickly generate sales revenue. The residential towers of Kowloon Station have been occupied since 2001, although The Element shopping mall only opened in 2007. The tenants of the IFC at Hong Kong Station include the Hong Kong Monetary Authority, foreign currency settlement companies and the Henderson Property headquarters. The Four Seasons Hotel and up-market serviced apartments also sit on the Hong Kong Station podium. The Ritz Carlton, Credit Suisse AG, Morgan Stanley, and ABN AMRO are the main tenants of the ICC at Kowloon Station. These companies are an active part of the financial center and international metropolis of Hong Kong. In the economic boom years, property sale and rental prices skyrocketed. In 2016, the selling price of a residential flat in Kowloon Station was above HK$40,000 (US$5,200) per square foot.

Mega-structures and high towers are attractive features of the rail village. The stations along the Tung Chung and other lines have generated various types of developments, far bigger than the stations themselves. The height, span and density of a rail village are completely different from those of classical cities and most people's conventional spatial experiences. For example, the tower jungle above Kowloon Station, the continuous commercial, underground concourses between Central and Hong Kong stations, and various linking spaces and roof gardens are pleasant places for users to linger and look at, both inside and out. Externally, these building complexes form a unique townscape. When people view the Kowloon and Olympic stations from the West Kowloon Highway or look at the IFC complex from Tsim Sha Tsui, they are astonished by the panorama revealed between the sky and the sea. This man-made miracle was brought about by infrastructure and transportation. The urban development of more vertical sub-centers has become the inevitable trend of megacities. Moreover, the practice in Hong Kong enriches the "infrastructural urbanism" that termed in English literature (Allen, 1999).

In terms of development value, the authors hope to analyze more rail villages in Hong Kong and other cities. Future works should include more detailed analyses of ridership, proportion of different building types, pedestrian behavior in rail villages, and an explicit conclusion of the design methods for high-density environments.

Most of today's populous megacities are concentrated in Asia. The unlimited sprawl generates city problems such as traffic jams, long commuting times, deteriorating living environments and high crime rates. The idea of separating vehicles from people, mega-structures and rail villages first emerged in the West but was soon adopted in Hong Kong, Singapore and other Asian cities, where the new town and rail systems partly alleviate the problems caused by the increasing population. Hong Kong demonstrates that living conditions can be maintained at a civilized level even with the highest density in the world. There is no doubt that this is a direction for sustainable development. Several types of high-density railway villages in Hong Kong have not only effectively improved people's lives and offset the huge investment in stations and railway construction, but have also reduced the total traffic demand, playing a positive role in the adjustment of the urban spatial structure, redistributing the urban passenger flow and alleviating traffic congestion.

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