



## The Architectural Characteristics of Housing through the Rail and Property Model of MTRC in Hong Kong

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### ABSTRACT

**Purpose:** Domestically, a recent controversial part on Mixed-Use Development is its case that utilizes railroad sites among urban infrastructure. but most of all, a concern is being concentrated on the Mixed-Use Development that uses railroad depot. It has the advantage, which can give diversity and publicness to urban environment by using and planing the upper and bottom of railroad depot, a proximity site as Development Available Land. However, there are few cases except for only Yang-cheon APT in SinJeong railway depot as a domestic case even though a domestic concern about Mixed-Use Development is rising more than ever. **Method:** Accordingly, this study has something in common with a domestic case, dealing with a case of development in Hongkong that enhances efficiency for city space through Mixed-Use Development and solves various urban problems. **Result:** A purpose of this study, based on overall comprehension about Rail and Property Model of MTRC in Hongkong, is to figure out how it solve various problems in Mixed-Use Development using Railway Depot or stations in the base of Rail and Property Model of MTRC.

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### KEYWORD

홍콩 MTRC  
철도+부동산 연계형 개발사업  
인공지반 주거지 개발

Hong Kong MTRC  
Rail+Property Model  
Housing Developments on Artificial Ground

### ACCEPTANCE INFO

Received August 20, 2015

Final revision received September 2, 2015

Accepted September 4, 2015

## 1. Introduction

### 1.1. Research Background And Purpose

Rapid concentration of population in cities causes a lot of urban and social problems not only domestically but also overseas. Particularly, various urban problems emerge in relation with insufficient land, housing and infrastructure due to reckless housing construction to accommodate influx of population into cities. Accordingly, the concept of mixed-use development is earnestly being introduced as a solution to secure site available for development, recover isolated local communities and revitalize urban functions. Recently, a new attention has been drawn into the concept with respect to the development policy of residential area using the mixed-use development of railroad depot because it has the merit of assigning diversity and publicness to urban environment through mixed-use planning of the upper, lower and joining areas of railroad depot based in artificial ground. Such cubic mixed-used development as an attempt to tackle various urban problems has been implemented in many foreign countries including Japan, Hong Kong, France, and Germany. Especially, Hong Kong has actively executed the mixed-used rail+property projects since 1970s based on the development theory of TOD (Transit Oriented

Development), solving various urban problems such as residential stabilization and urban function.

Meanwhile, South Korea has only one case of mixed-use development, Yang-cheon Apartment built on the artificial ground of SinJeong railroad depot though interest in and expectation for mixed-use development has increased. And no other recent mixed-use development projects has not yet been reported since. On the other hand, Hong Kong, which felt it urgent to develop railroad site and others due to small territory and concentration population in urban areas, is implementing various experimental projects to utilize the upper space of rail base. In this respect, the present study looked into Hong Kong's successful cases of using railroad depot for residential development and thus find some implications and improvements for Korean situations where residential development projects using railroad depot hasn't much been explored and advanced.

Therefore, this study chooses the cases where residential complexes were successfully developed on railroad depot according to rail-property model of Hong Kong MTRC<sup>1)</sup> and analyzes each case regarding architectural characteristics such as construction status, characteristics of layout and planning, approaching methods and intra-complex connection system and proposes useful implications for mixed-use housing development connected to railway base.

The findings of this study is expected to be used as a basic data for mixed-use housing development with state-owned land and road as well as housing development through mixed-use development of railroad site.

### 1.2. Research Subject and Scope

This study carried out on the development cases of Hong Kong, where mixed-use development is actively executed, especially mixed-use housing development projects with railroad site of Hong Kong MTRC. 5 sites were chosen: Kowloon Bay Depot which was the first mixed-use housing development on Kowloon Bay railroad depot by Hong Kong's MTRC; Chai Wan Depot; Tsuen Wan Depot; Tai Wai Maintenance centre; and Tseung Kwan O Depot. For research methodology, this study reviewed domestic and foreign literature related to mixed-use development with railroad site and a field survey between September 11th through 15th in support of Hong Kong MTRC. First of all, this study looked into the project business methods of rail + property connection housing development of Hong Kong MTRC as well as the outline of general housing development in Hong Kong. And for case analysis of each research site, comprehensive analysis was carried away focusing on construction status, characteristics of layout and planning, approaching methods and intra-complex connection system as well as architectural characteristics of mixed-use housing development with railroad depot in Hong Kong in an attempt to know how such problems as accessibility, isolation of local community and noise issue, which are often observed in a development project with railroad depot turn up through mixed-use development based on artificial ground.

### 1.3. Literature Review

Looking into the precedent studies on the mixed-use development on railroad depot as seen in Table 1, it is known that most of the studies focused on the development projects for office, commercial and cultural facilities rather than housing. Although some studies have recently been conducted on mixed-use housing development on railroad depot, it is safe to say that studies on the topic are not sufficient in general.

Table 1. Previous Studies

Researcher	Title	Note <sup>2)</sup>
Kim, Young-Hoon (2014)	A Case Study on Housing Development of Domestic and Foreign through the Mixed Use Development of Railroad Site - Focus on analysis of connect system between surface and underground	●
Kim, Young-Hoon (2013)	A Study on the Characteristics of spatial connecting system in Yang-Cheon Apartment- Compared with Nishidai Housing Complex in Japan	●

Lee, Jae-Hoon (2011)	Multi Story, Mixed Use Development at Rail Stations for affordable Housing Provision in Urban Areas	△
Lee, Jong-Won (2010)	A study on planning Techniques and Regulatory Improvements for Enhancing Multi- dimensional Urban Planning	○
Kim Ju-Seok (2009)	A Study on the Residents' Satisfactions on Apartments at the Railroad Facilities	○
Lee, Jun-Won (2007)	A Study on the Planning Methods of Multi-Dimensional Development of the Main Subway Station : Focused on the Area of Gunja, Jichuk, Suseo and Chang-dong Station in Seoul	△
Lim, Ki-Taek (2007)	An Study on the Possibility of Mixed-use development of Social Housing and Commercial Facilities	○
Lee, Sun-Hyoun (2007)	A Study on the Typological Characteristics of Multi-Dimensional Land Use Planning : the Focus on the Seoul Metropolitan City	○
Park, Shin-Young (2006)	A study on application Multi-Dimensional Land use Planning on Real Estate Development : Focused on Rental Apartment Housing	○
Jung, Jong-Dae (2005)	Understanding and Application of the Multi-dimensional Urban Planning	●
Kim, Do-Nyun (2005)	A Study on the Design Guidelines of Railway Station Areas through the Comparative Analysis of High-Speed Railway Station Developments in Foreign Cities	△

※ The Note Sorted it with Three Phases by Association and the Utilization Value with the Study (●-High, △-Middle, ○-Low)

## 2. Outline of Hong Kong's Housing Development and Business Method of MTRC Housing Development

### 2.1. General Characteristics of Housing Development in Hong Kong

The total area of Hong Kong territory is 1,084 square kilometers and, as of 2014, its total population is about 7,234,800 with population density of 6,897/km<sup>2</sup> (World Bank, 2010 - 2014). Therefore, it is one of the most population-dense countries. 80% of its territory is hill areas and central districts are limited to ports, which makes it very difficult for urban area to expand. Therefore, housing policy can't not help but be oriented toward high-density housing plan. With this background, Hong Kong housing has grown tall and dense until now due to spatial limitation and increase of the urban poor. Particularly, the housing plan mainly pursues large-scaled multiple complex type where urban infrastructure

2) The degree of relevance with and usefulness of this study are marked with 3-point scale

such as school, commercial and cultural facility are integrated with collective housing to reduce dependence upon crowded downtown. In addition, Hong Kong is characterized with job-housing proximity that is supported by connection to key locations all over the cities via public transportation and to composite facility where housing, office, commercial and cultural facilities are combined. To relieve traffic congestion, multi-mode transfer system was established. Besides, Hong Kong aims for a compact city by enhancing accessibility to neighboring areas with 3-dimensional pedestrian space, which encourages walking activity and develop efficient use of land.<sup>3)</sup>

The housing market size of Hong Kong used to be equally divided into public and private housing, but, since mid 2000, private housing has become more dominant than public housing and this trend is estimated to grow further. This sluggishness of public housing is attributed to the spatial narrowness and poor inhabitability of public housing .

Table 2. 6 Distribution of Population by Type of Housing, <source; Hong Kong Housing Authority, 2015>

Type of Housing	2003	2008	2013
Public Permanent Housing	50.1%	47.4%	45.8%
Public Rental Housing	(31.1)	(29.3)	(29.3)
Subsidised Permanent Housing	(19.0)	(18.1)	(16.5)
Private Permanent Housing	49.1%	52.0%	53.7%
Temporary Housing	0.8%	0.6%	0.5%

Table 3. Actual Public Rental Housing Production, <source; Hong Kong Housing Authority, 2015>

Year	Rental Housing Flat
2005/06	17,153
2006/07	7,192
2007/08	13,726
2008/09	19,050
2009/10	15,389
2010/11	13,672
2011/12	11,168
2012/13	13,114
2013/14	14,057
2014/15	9,938

After the big fire in 1953, nonetheless, Hong Kong government started to get actively involved in housing policy to solve housing issue in highly dense districts, developed Mark I and Mark II , which were the first public housing, and is now building high-rise residential complexes in many types through various housing policies and economic supports.<sup>4)</sup> As a result, the population of public housing was 40% in 1973, increased to 45% in mid 1986 and to 50% at the end of 2000, which indicates the role of public housing is gradually expanding in Hong Kong.<sup>5)</sup> And because rent

for public housing is cheaper than that for private housing in Hong Kong, only the houses with monthly income of 20,000-23,000 Hong Kong dollar and single households with monthly income of 11,500 Hong Kong dollars are eligible for public housing. However, demand cannot meet supply due to continuously increasing population and thus general applicants for public housing have to wait 3.3 years on average (1.8 years for the elderly)<sup>6)</sup>. According to Hong Kong Housing Committee, larger supply of public housing than previous years is estimated, so demand for public housing is expected to be met to some degree in future. But Table 3 shows the different aspect of demand and supply that as private housing-resident population is also steadily increasing, demand for both public and private housing is expected to grow as seen in Table 2.

The layout of public housing in Hong Kong changed from flat type or double-loaded corridor type in 1960s to cluster type in 1990s. Recently, it is changing to changed to tower-shaped dwelling type.<sup>7)</sup> This layout transition indicates that existing flat-type dwelling layout has structural problems such as torsion (twist) and is hard to realize high spatial volume and high density, considering the narrow territory of Hong Kong, thought it has advantage of ventilation and lighting. Therefore, tower-shaped housing is more preferred. This kind of super-high and dense tower-typed housing has relatively smaller living space, so the living space per area unit in Hong Kong is relatively smaller than that in other countries, which is one of the characteristics of Hong Kong housing. In the other side, however, it also starts to appear that living area per resident population is increasing, which indicates that the trend is moving toward qualitative advancement of living beyond simple supply of houses. For reference, looking into the typical residential type and required space per person by year, it was 2.25m<sup>2</sup>/capita from early 1950s to late 1960s, 3.25m<sup>2</sup>/capita in 1970s, 5m<sup>2</sup>/capita in 1980s and 7m<sup>2</sup>/capita in 1990s<sup>8)</sup> and the number of occupants per household decreased from 3.3 in 2003 to 2.9 in 2013, which indicates that living pleasantness improved. (Table 4)

Table 4. Forecast Public Housing Production, <Hong Kong Housing Authority, 2015>

Year	Public Rental Housing	Subsidised Sale Flats	Total
2015/16	23,300	0	23,300
2016/17	11,300	3,000	14,300
2017/18	19,000	4,200	23,200
2018/19	12,800	4,300	17,100
2019/20	9,200	6,100	15,300

3) Kim Hyun-seok, 'A study on the Design Characteristic of Hong Kong based on Compact City Theory', partially quoted from master's thesis, Jungang University, 2012

4) Kim Sung-wha, Lee Jae-hun, A Study on the Characteristics of the Super High-Rise Housing Complex in Hong Kong, Journal of the Korean Housing Association, Vol.16, No.4, 2005, p.37

5) Lee Jae-hun, Kim Sung-wha, 'A Study on the Transition and Typological Characteristics of Hong Kong Public Housing', requoted from p.1

6) As of 2015, 140,200 general applicants wait for public housing. Hong Kong Housing Committed home page(<http://www.housingauthority.gov.hk/>), quoted from here

7) Lee Jae-hun, Kim Sung-wha, requoted from the above book

8) The book above, requoted from p.38

Table 5. Average Domestic Household Size, <Hong Kong Housing Authority, 2015>, No of person

Type of Housing	2003	2008	2013
Public Permanent Housing	3.3	3.0	2.9
Public Rental Housing	3.2	2.9	2.8
Subsidised Permanent Housing	3.4	3.3	3.1
Private Permanent Housing	2.9	2.9	2.9
Temporary Housing	2.3	2.3	2.4
Average	3.4	3.0	2.9

According to Kim Sung-wha and Lee Jae-hun (2005), the characteristics of these super-high residential planning of Hong Kong are 1) subsidiary facilities such as commercial facility, leisure facility, and parking lot are positioned in an annex building or outdoor transition zone. In case that it is a large complex building, adjacent complex is connected to outdoor transition zone to activate commercial facility. 2) The moving route between residential function and other functions is determined by the size of housing complex and neighboring buildings. Housing space and parking lot follow two moving modes: one in which a resident has access to his/her own house space through resident-exclusive elevator or the other in which he or she has access to his/her own house space through the elevator in housing core. 3) the top floor of outdoor transition zone is separated from traffic route to increase residents' community and encourage them to use external space actively. In addition, representative housing layout is outdoor transition zone + towered type housing and outer wall is characterized with curvy shape so that unit houses around housing core can contact as much outer space as possible. Housing layout and household arrangement are symmetrical with the core in general. The core shape is mostly centralized core. To avoid dark space in the core space, light well is installed to secure lighting and ventilation.

## 2.2. The Characteristics of Hong Kong Urban Development Policy

Hong Kong's urban development policy has efficiently coped with urban expansion, securing dwelling space in limited land space. Especially, the policy set rural parks or suburb preservation zones to prevent buildings for residential purpose from leaking out to the suburb areas. As a result, Hong Kong has clear division between urban and rural areas while most cities in Asian countries have blurred boundary between them.<sup>9)</sup> However, as urban boundary become clearly defined, population density in inner city area get more severe. Upon this, Hong Kong government implemented decentralizing development policy to curb the excessive development in inner city area. This policy is aimed to build new towns or satellite towns in a neighborhood of inner city areas to relieve

overpopulation of downtown areas and improve life quality of urban areas.

The factors for the successful decentralizing development policy of Hong Kong lie in the development of new towns and satellite towns based on Transit-Oriented-Development<sup>10)</sup> (TOD) theory. In particular, railroad-based development was predominant. It is the development in which buildings are decentralized within 500m radius from the center of Hong Kong subway station, which is called MTR (Mass Transit Railway). Looking into the characteristics of this urban development policy that Hong Kong government assumes, first of all, it follows high-dense development and build mixed-use (rail + property) complex to secure public and open space as much as possible. It reduces demand of vehicles that has risen due to high-density and compact development and shorten traffic length, which improves accessibility. In addition, transit-oriented-development promotes job-housing proximity, pedestrian environment, environmental conservation, and energy saving, inhibits town development in suburb areas, which protects the green and natural environment.<sup>11)</sup>

## 2.3. Development Method of MTRC's "Rail + Property" Project

Originally, MTR was a public corporation for urban rail service that Hong Kong government founded in 1975, but the government sold 23% of its shares to private sector after June, 2006, for high cost of train cars themselves, rising cost of maintenance and repair, low ROI, and budgetary burden on the government. And the name of the corporation changed to MTRC (MTR Corporation Limited) and the company listed in Hong Kong stock market on May the 5th, 2000, when it restarted as sort of an public company. MTRC is involved in various railway-related businesses. Of them, mixed-use development business with neighboring property, which is called 'Railway+Property Business' is the most distinctive. This business includes construction, leasing, managing, PR, communication service and financial consultation service of housing or commercial facility mainly built around railroad stations or available land near railway.<sup>12)</sup>

Rail + property connection business is a kind of railway funding model that when a business can not expect desired commercial profit or benefit solely from railway business, it acquires a right to development on available land around railroad from a government for rent and develops the site entirely and generates profit. And the profit is invested in the construction of railway again. This

10) Transit-Oriented-Development (T.O.D: Transit-Oriented-Development)

11) Kim Hyun-seok, 'A study on the Design Characteristic of Hong Kong based on Compact City Theory', Graduate School of Jungang University, 2012

12) MTR Homepage  
extracted from [http://www.mtr.com.hk/en/corporate/overview/profile\\_index.html](http://www.mtr.com.hk/en/corporate/overview/profile_index.html)

9) Urban Research, National Territory Information, 「Hong Kong's High Density Development Policy」, 1995, p.29

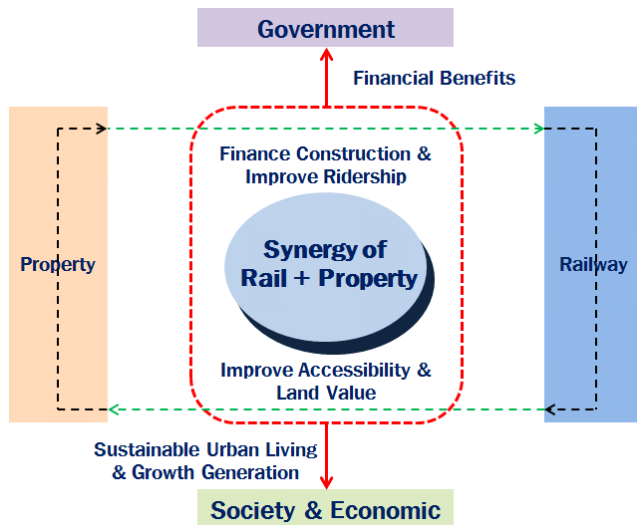


Fig. 1. Synergy of "Rail + Property" (Source: MTR-2014.09.12.)

development is in the same line of the government policy (railway-based development) for high-density development around a railway station and for integrating development of train garage and station, which provides sustainable living. Accordingly, rail + property connection development is mainly aimed for to TOD development, high-density integration of the areas around a railway station, increase of railway passengers and sustainability.

The main characteristics of MTRC's "rail + property" connection business are as follows.

- ① The government transfers to exclusively MTRC development to neighboring land related to railway upper part of a station.
- ② MTRC carries out thorough planning and management to maximize synergy effect between railway station and property development.
- ③ MTRC selects proper land, makes integrated development of subway station and high quality property, and developed property on a subway station in operation, the upper part of railway station house or neighboring land
- ④ "Railway + property" connection business model is aimed to enhance the quality of life.<sup>13)</sup>

Meanwhile, it is not MTRC that materializes realize "rail + property" connection model for itself. When MTRC gets an approval of exclusive land use from the authority, it selects actual developers and investors through open tender.

That is, MTRC provides a private developer with land for developing business and the appointed private developer constructs a project, carrying all the cost and expenses and risk related to construction and development. And after the completion of the project, the output of the development project returns (transfers) to MTRC. Through these series of development processes, MTRC

has various profits. Especially, the contract dictates that when a project is successfully completed, MTRC and a developer can share profit from the development at fixed rate. In addition, MTRC can earn a fixed land revenue from government for a successful development project. Besides, MTRC has a right to have profit of rent from facilities connected to a subway station, maintenance fee, and train fare.<sup>14)</sup> Like this, MTRC, based on diverse profit structure, is solving various urban problems through public train transportation and property development throughout Hong Kong. Currently, it is engaged in "rail + property" business in 50 sites of a total of 10 lines and 84 stations. Facilities constructed according to "rail + property" development are various: artificial ground on the upper part of railway, housing complex, commercial facilities such as shopping center and cultural and leisure facilities adjacent to railway and a station.

Besides, the meetings with MTRC employees held during the field survey informed of "rail + property" connection development methods that MTRC pursues. They can be summarized as below: ① sustainable financial model of urban railway structure and motion, ② sustainable community of high quality by integrating transportation, job creation, life and leisure, ③ housing development model using mixed-use development with railway land, focusing on transportation and urban development, ④ complex housing development by establishing artificial ground on railway land of easy access and convenience.

### 3. Characteristics Analysis of Architectural Plan and Layout of Case Subjects

#### 3.1. Reasons for Case Selection and Analysis Items

This study confined research scope to the cases of cubic mixed-use housing development on the artificial ground built above a railroad depot. Of many feasible cases, the present study chose 5 sites: Kowloon Bay Depot which was the first mixed-use housing development on Kowloon Bay railroad depot by Hong Kong's MTRC; Chai Wan Depot; Tsuen Wan Depot; Tai Wai Maintenance centre; and Tseung Kwan O Depot. Field survey was conducted on every case site and interviews with related individuals or companies to examine the basic characteristics of architectural layout. Table 6 summarizes the findings.

As seen in Table 7, items for analysis mainly include the layout design and design characteristics, access method to complex, access system by transportation, and connection system within complex in an attempt to examine how such factors, which are mostly pointed out as problem caused by railway, as lowered

13) Yam Pak Nin, 「Public private Partnership in Railway」, MTR Corporation Ltd, 2007

14) Ha Ik-hee, 'A Study on Success factors of Hongkong Subway', Master's thesis for the Graduate school of Railway, Woosong University, 2012

Table 6. Project Outline

Division	Kowloon Bay Depot	Chai Wan Depot	Tsuen Wan Depot	Tai Wai Depot	Tseung Kwan O Depot
Location	▪ Kowloon Bay Station, Ngau Tau Kok, Hong Kong	▪ 100 Shing Tai Road Chai Wan, Hong Kong	▪ Tsuen Wan, New Territories, Hong Kong	▪ 1 Mei Tin Road, Tai Wai, Hong Kong	▪ Tseung-Kwan.O area86 New Territories, Hong Kong
Development Time	▪ 1972~1982	▪ 1977~1982	▪ 1982~1984	▪ 2006~2012	▪ 2005~2015
Developer	▪ MTR Co.Ltd & Hang Lung Properties & Hopewell Holdings	▪ MTR Co.Ltd & Kerry Propertie	▪ MTR Co.Ltd & Hong Kong Land & Jardine Matheson Holdings & Dah Sing Group	▪ MTR Co.Ltd & Cheung Kong Holdings Ltd	▪ MTR Co.Ltd & Cheung Kong Holdings Ltd & City Investments Ltd
Development Purpose	▪ “Rail+Property” as a Railway Funding Model ▪ Integrating Rail and Property Promotes Patronage to New Lines	▪ “Rail+Property” as a Railway Funding Model ▪ Integrating Rail and Property Promotes Patronage to New Lines	▪ “Rail+Property” Model to” Investment development and Housing Supply	▪ “Rail + Property” Model to Quality Type Housing / The Strategic Center of Mainland China and Hong Kong	▪ “Rail+ Property” Model to Connect and Grow Communities
Artificial Ground	▪ 110,000m <sup>2</sup>	▪ 58,000m <sup>2</sup>	▪ 215,000m <sup>2</sup>	▪ 70,600m <sup>2</sup>	▪ 130,000m <sup>2</sup>
Facilities	▪ Housing(High-Rise) Facilities ▪ Educational Facilities ▪ Commercial Facilities ▪ Cultural Facilities ▪ Sport Facilities, Etc.	▪ Housing(High-Rise) Facilities ▪ Educational Facilities ▪ Commercial Facilities ▪ Cultural Facilities, Etc.	▪ Housing(High-Rise) Facilities ▪ Educational Facilities ▪ Commercial Facilities ▪ Cultural Facilities ▪ Plaza, Sport Facilities ▪ Parking, Etc.	▪ Housing(High-Rise) Facilities ▪ Educational Facilities ▪ Commercial Facilities ▪ Parking, Etc.	▪ Housing(High-Rise) Facilities ▪ Educational Facilities ▪ Commercial Facilities ▪ Cultural Facilities ▪ Plaza, Sport Facilities ▪ Parking, Etc.

accessibility, isolation of local community and noise, turned out or were solved when a cubic mixed-use development was introduced on an artificial ground.

Table 7. Analysis Item and Contents

Analysis Items	Contents
Block Planning	▪ Housing Planning Using Artificial Ground
	▪ Street System Formation Using Outdoor Transition Zone
Housing Complex-Approach System	▪ Pedestrian-Approach System
	▪ Traffic-Approach System
Public Transport-Approach Systems	▪ Inside Approach Type,
	▪ Outside Approach Type
	▪ Mixed Approach Type I , II
Connect System between Inside and Outside of Housing Complex	▪ Connect System of Horizontal Space and Vertical Space
	▪ Accessibility and Convenience

### 3.2. Architectural Plan and Layout Characteristics

To know the architectural plan and layout characteristics of the selected cases, this study first analyzed ground plan by case. It was found that the sites of selected cases had in common that their housing units were laid out crosswise with a core to accommodate many residents. Particularly, it was found in the field survey that the outdoor transition zone of the building was used as footpath, store, or parking space, which are not identified on a ground plan.

In Kowloon Bay railroad depot project, which was MTRC's first mixed-use housing development model with railway land, the whole apartment units were laid on the artificial ground and a

variety of facilities connected to the subway station such as shopping mall (Telford Plaza), kindergarten and school. Especially for the apartment units, some of the pilotis were also used as parking lot, pedestrian passage, or store.(Fig. 2)




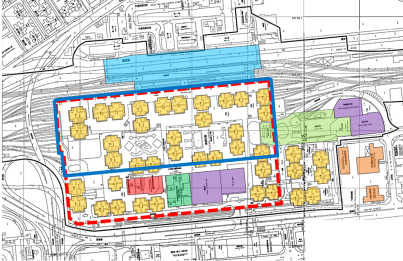
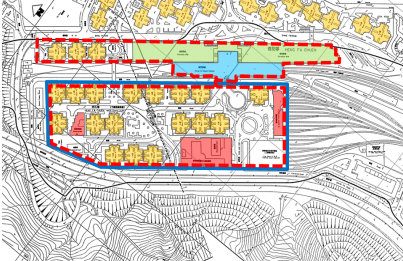
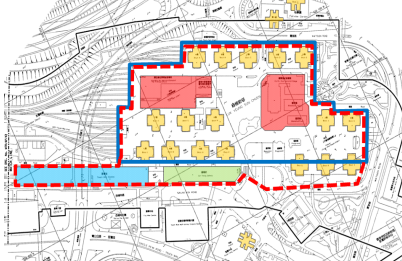
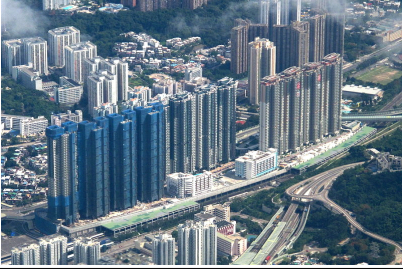










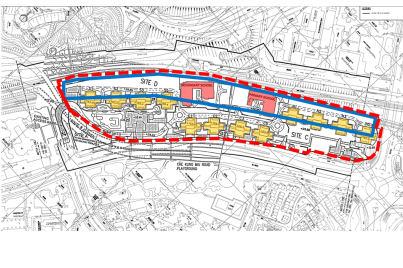



Fig. 2. Related Photo (Source: Photograph by Author-2014.09.11-15.)

In Chai Wan railroad depot model, apartment was also laid on the artificial ground and various convenient facilities such as shopping mall and educational facility were prepared. In this project, apartment was not only placed on the artificial ground, but also on other areas and the pilotis played a role of pedestrian passage and parking lot.

Tsuen Wan railroad depot model is similar to Kowloon railroad depot model in architectural plan and layout characteristics, but smaller in project scale. It was found that the apartment block at the

Table 8. Block Planning and Architectural Characteristics

Division	Kowloon Bay Depot	Chai Wan Depot	Tsuen Wan Depot
View			
Block Plan			
Characteristics	<ul style="list-style-type: none"> <li>Use of land approval from the government(1999)</li> <li>MTR-Offering Land, Private Developer-Construction and Pay Total Construction Cost</li> <li>Rail Depot, Artificial Ground and Housing Complex were designed at the same time</li> <li>MTR-Operating Shopping Mall</li> <li>Housing(High-Rise): ~26F</li> </ul>	<ul style="list-style-type: none"> <li>Rail Depot and Complex Housing were constructed on Coastal Landfill</li> <li>Shopping Mall(Station 1~2F)</li> <li>Housing Complex was built by the Shopping Mall upper part and can be connected each other</li> <li>Apartment Housing Complex is connected to the Station directly</li> <li>Housing(High-Rise): ~21F</li> </ul>	<ul style="list-style-type: none"> <li>After Subway Station Opening, an Apartment was built on the Artificial Ground</li> <li>Outdoor Transition Zone of the Apartment was maintained and was become the Internal Street</li> <li>Outdoor Transition Zone of the Apartment is Utilized in the Uses such as a Parking lot and Neighborhood Facilities including Pedestrian Transfer</li> </ul>
Division	Tai Wai Depot	Tseung Kwan O Depot	Note
View			<ul style="list-style-type: none"> <li> Housing(High-Rise) Facilities</li> <li> Community Facilities</li> <li> Commercial Facilities</li> <li> Educational Facilities</li> <li> Business Facilities</li> <li> Public Institution</li> <li> Subway Station</li> <li> Railroad Depot</li> <li> Artificial Ground</li> </ul> <p>※ Table 8 was made by Various Drawings provided including Documents Study by Cooperation(Steve C.Yiu) of MTR at the time of the Field Work(2014.9.11.~15)</p>
Block Plan			
Characteristics	<ul style="list-style-type: none"> <li>Use of land approval from the government(2004~2054)</li> <li>Rail Depot, Artificial Ground and Housing Complex were designed at the same time</li> <li>Housing Complex Development Case of High Quality Type</li> </ul>	<ul style="list-style-type: none"> <li>Site Area: 33 hectares</li> <li>50 residential towers</li> <li>45,000m<sup>2</sup> shopping center</li> <li>Community facilities</li> <li>Transport interchange facilities</li> <li>Extensive landscaped open space</li> </ul>	

entrance of the complex through which vehicles can have access was used for parking space and the outdoor transition zone of the apartment block located near the shopping mall accommodated commercial facilities to increase accessibility into the complex.

Particularly, 3 apartment blocks located at the center of the complex used outdoor transition zone as a street for passage.

Tai Wai railroad depot model was aimed for premium housing development. Accordingly, it showed quite different layout elements

from other development projects such as top floor duplex type, exterior landscaping, and no-car road zone. Particularly, the upper plane layout of the complex is similar to that of Tsuen Wan railroad depot model, but difference is found in that Tai Wai railroad depot model put space as high as one or two floors between the artificial ground on the railroad depot for parking space. As mentioned above, it was to secure parking space that yielded to a square and a park without car on the upper part of the artificial ground. In addition, the outdoor transition zone of the apartment units was designed to be street type so that moving to next buildings or to the club house inside the complex became possible. Like this, this club house is found only in Tai Wai railway depot development model as premium strategy to provide cultural convenience facilities not only to the residents of the complex but also certain outsiders. Besides it, this mixed-use housing development model developed not only the upper part of the railroad depot, but also the elevation at the boundary of the railroad depot, which was an attempt to visually beautify the area that had given aversion in other cases.

Tseung Kwan O railroad depot development project is still under construction now. It is the project that most represents the direction that MTRC pursues with mixed-use housing development with railway land (Rail+Property Model). Like the previous mixed-use housing development, it uses artificial ground that connects railway station to the residential area and various convenience facilities to connect it again to the neighborhood (good accessibility) to maximize the convenience of the residents in the complex and the local residents.

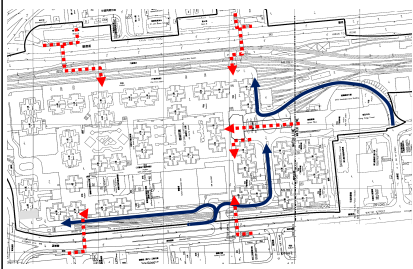
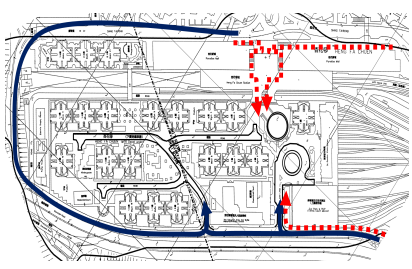
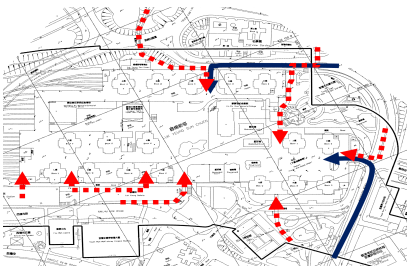
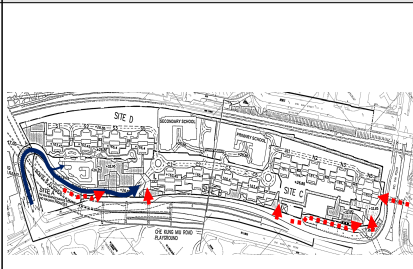
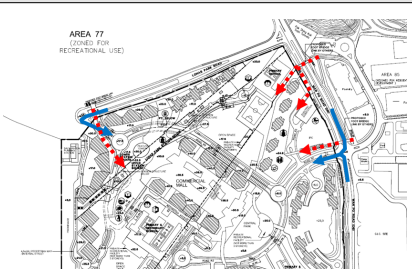
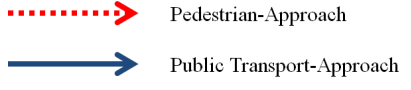


### 3.3. Access Method into Complex

As for approaching method to the complex, pedestrians and vehicles have problem with access in mixed-use development model using the upper part of artificial ground on the railroad depot in case that it is located where there are rails.

First, in Kowloon Bay railroad depot model, access is connected into the inside of the complex through stairs, ramps, and foot bridges. Inside the complex, however, inflow of population is possible because there are a park, a fountain, a bank, a school, a sports center, and a movie theater. particularly, foot entry is possible through the stairs and ramps bordered by a road and when access (into the complex) from outside is possible through the subway station building from the opposite direction because Kowloon Bay subway station is bordered with the complex. In addition, users can have direct access to the complex from a horizontal passage in the entry space of rotary type.

As for Chai Wan railroad depot development case, access is directly made into the shopping mall through ground-level stairs. Because the station and the shopping mall are bordered with the mixed-use complex, it is easy to get access to the complex by using the entrance/exit of the station. Furthermore, the complex is connected with the apartment in the opposite side through foot bridge, so there can not no inconvenience of traveling. The road that connects the complex from inside and outside is laid out in a form of wrapping the railroad depot all around, but there is only one spot at which the road is connected to the complex. Therefore, it is expected that there is inconvenience in the inflow of external

Table 9. Approach System

Division	Kowloon Bay Depot	Chai Wan Depot	Tsuen Wan Depot
Approach System			
Division	Tai Wai Depot	Tseung Kwan O Depot	Note
Approach System			 <p>  Pedestrian-Approach   Public Transport-Approach                 </p>



population. As for access to the complex through a road, on the other hand, the road wraps the railroad depot all around, but there is only one spot at which the road is connected to the complex. Although it doesn't seem the complex has a serious traffic congestion because it is located at the outskirts of the city, it is considered there is inconvenience of inflow from outside.

As seen in Table 9, Tsuen Wan railroad depot model uses the upper and right part border with the road to make an access to the complex. As seen in Table 8, the entrance is laid out avoiding the area that can be potentially congested due to subway station, bus terminal and shopping mall, so it is relatively easy to get in the complex. walking access to the complex is also actively connected to the neighboring buildings through the foot bridge and the underground passage. Shopping mall, school, and YMCA Center, which are located inside the complex, play as a community space for the area that is isolated by railroad depot.

In Tai Wai railroad depot model, vehicle access to the complex is limited to only one space despite geographical advantage that its three sides are surrounded with roads to meet the purpose of being premium housing development, as seen in Table 9. Furthermore, it is also designed to limit pedestrian access of outsiders into the complex. There are three lobbies (Shuttle Lift Lobby) at which access to the complex is possible. Security should be checked out before access and then escalator or elevator is used for access into it. In addition, it is possible to get access to the inside through outer stairs or the foot bridge connected with the station.



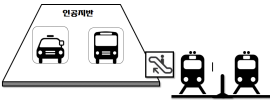
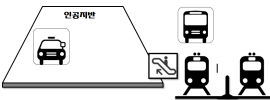
As for Tseung Kwan O railroad depot model, which is still under construction, the drawings acquired from MTRC during the field survey show access method into the complex as in Table 9. Vehicle access is completely separated from footpath access. Foot access is possible to each complex unit through a street-in-air. Especially, access methods by car and foot are optimized in a way to make the residents get easy access to the subway station and the shopping mall in any direction.

### 3.4. Access System by Public Transportation

This study divided the public transportation access system of the mix-use models into 4 types in consideration of accessibility by subway train and bus, which are the most public among public transportation in Hong Kong such as subway train, bus, taxi, and tram, to the complex, as seen in Table 10, and carried out 4 public transportation access systems. The findings are as follows.

First of all, the public transportation access system of Kowloon Bay railroad depot model is ‘inside approach type’. For subway train, the entrance/exit is designed to get connected to the lower part of the commercial facilities under the outdoor transition zone. For bus, a terminal is planned at the rotary part above the artificial ground to increase users' accessibility and convenience.

Table 10. Type Classification of Public Transport-Approach System

Type	Contents
	<p><b>【Inside Approach Type】</b></p> <ul style="list-style-type: none"> <li>Subway Station and Bus Stand can come close at the upper part of the Artificial Ground</li> </ul>
	<p><b>【Mixed Approach Type I】</b></p> <ul style="list-style-type: none"> <li>Subway Station can be connected directly at the upper part of Artificial Ground, but Bus Stand can approach it at the outside of Artificial Ground</li> </ul>
	<p><b>【Mixed Approach Type II】</b></p> <ul style="list-style-type: none"> <li>Bus Stand can be connected directly at the upper part of Artificial Ground, but Subway Station can approach it at the outside of Artificial Ground</li> </ul>
	<p><b>【Outside Approach Type】</b></p> <ul style="list-style-type: none"> <li>Subway Station and Bus Stand can come approach at the outside of Artificial Ground</li> </ul>

Besides, a taxi stop is laid out at the shopping mall center (Telford Plaza II) across the rotary space, so users have easy access in the artificial ground.

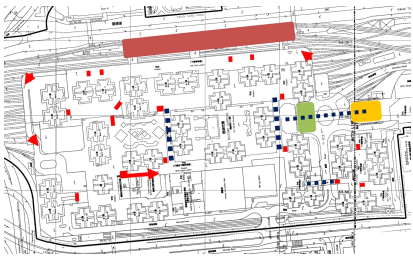
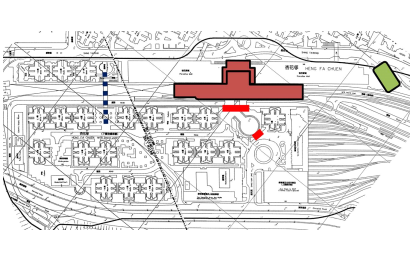
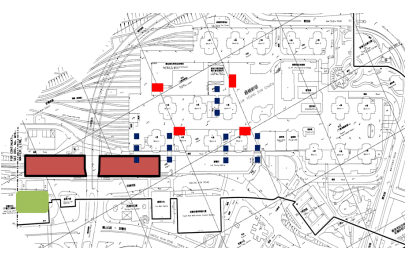
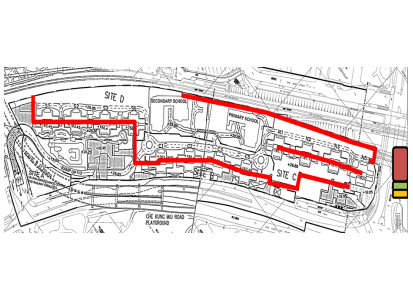
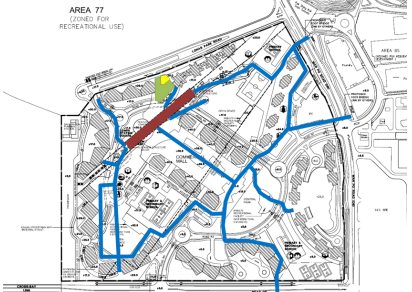







Both Chai Wan railroad depot and Tsuen Wan railroad depot model have the public transportation access system of ‘mixed approach type I’ in which that subway station gets an easy access to the complex on the upper part of artificial ground, but a bus terminal is planned outside of the complex. Compared with Kowloon railroad depot model, these two models have lower inter-accessibility. However, when traffic congestion is placed in consideration due to the bus terminal inside of the artificial ground, it seems ‘mixed approach type I’ is a right approach.



Fig. 3. Related Photo (Source: Photograph by Author-2014.09.11-15.)

The public transportation access system of Tai Wai railroad depot takes ‘outside approach type’, which is the only one among the case sites this study chose for analysis. In this system, access to subway train and bus terminal is possible through the foot bridge outside of the complex. As described above, it is one of the

Table 11. Public Transport-Approach Systems

Division	Kowloon Bay Depot	Chai Wan Depot	Tsuen Wan Depot
Public Transport-Approach Systems			
Division	Tai Wai Depot	Tseung Kwan O Depot	Note
Public Transport-Approach Systems			<ul style="list-style-type: none"> <li> Subway Station</li> <li> Bus Terminal</li> <li> Taxi Stand</li> <li> Stair, Ramp</li> <li> FootBridge</li> <li> Pedestrians Road</li> <li> Street-in-the-Air</li> </ul>

characteristics of the high-end strategy of the residence in consideration of the isolation of the complex from the outside, which was prepared from the planning stage.

Tseung Kwan O railroad depot model adopts ‘inside approach type’ for public transportation access by subway train, bus, and taxi. This system provides easy accessibility and convenience not only to the residents of the complex but also the neighboring residents. Like this, the public transportation access system of those cases is various by type, but Hong Kong mixed-use developments one railroad depot take Transit-Oriented-Development (TOD) theory, so in general they are equipped with high accessibility and convenience between complex and subway station and simultaneously provide transfer system to other means of public transportation.

### 3.5. Connection System Inside Complex

As examined with the cases of previous mix-use housing development projects using railroad depot, apartment complex built on the upper part of artificial ground are spatially separated from the outside due to the characteristic of the land (artificial ground) and there has been no space connecting two separate spaces. Although attempts have been made to connect the space inside of the complex on the artificial ground to the outer space through ramps, stairs, and foot bridge, such connection system is too simple. Furthermore, the lack of connectivity that can supports publicness has been pointed out as a problem of existing railroad depot for isolation from community.

On the contrary, the cases chosen for this study are different. First of all, Kowloon Bay railroad depot model uses the foot bridge

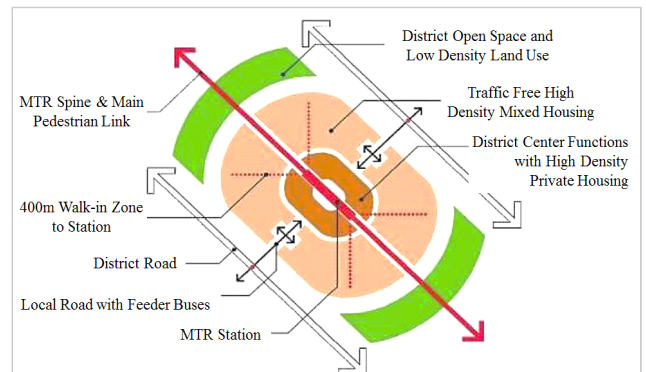


Fig. 4. Rail-Based Integrated Community (Source: MTR-2014.09.12.)

to build a connecting system between the complex to the outer space. In addition, the foot bridge that directly connects Kowloon Bay station to the shopping mall invites inflow of outer population into the complex. Besides, ramps and stairs that are accessed from the outside are installed to help access into the complex. Such horizontal and vertical connection systems inside and outside the complex built on the artificial ground well establish connection with neighboring areas, so that it is possible for outer population to get access into the complex.

As for Chai Wan and Tsuen Wan railroad depot model, their horizontal and vertical connection with the outside is simple in plane layout due to geographical limitations (they are bordered by mountains and the sea). However, they show various horizontal and vertical connection systems at the upper and lower level of the railroad depot. Especially, walking access system is connected to where vehicles have access to the complex or invites outer

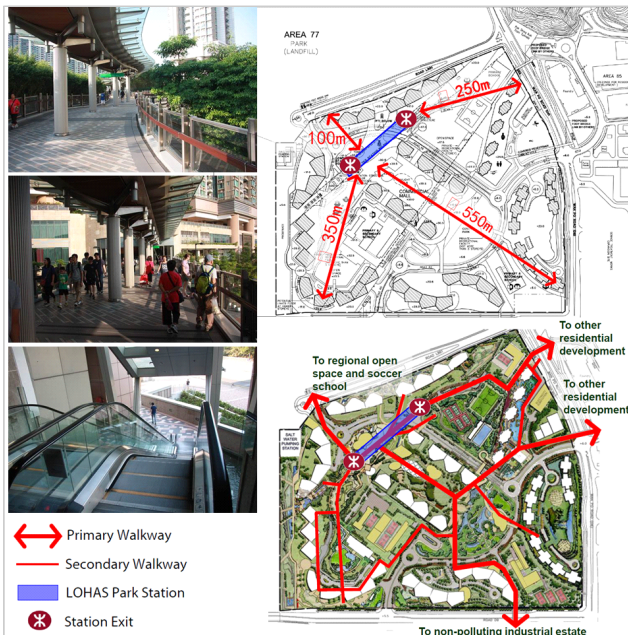


Fig. 5. Pedestrian Network (Source: MTR-2014.09.12., Photograph by Author-2014.09.11-15.)

pedestrians into the inside through the station on the other side of the entrance of car. That is, both inside (complex) and outside residents have easy access to the complex. This indicates an attempt to enhance publicness and activate community through improved accessibility into the complex by car and on foot.

In particular, Tseung Kwan O railroad depot, as shown in Fig. 5 before, is the good example of the latest MTRC's mixed-use housing development with railway land (Rail+Property Model) system. With Transit-Oriented-Development (TOD) as the basic city design platform and on the various connection systems to both the complex and the neighboring areas, the model project, except Tai Wai railroad depot project, secures 40% of the land as the green and open space as large as podium, which maximizes the users' accessibility and convenience. The contributor to this success is pedestrian network by which the users gets access to diverse community facilities on foot along the footpath inside the complex. (Fig. 5)

#### 4. Conclusion

This study carried out comprehensive analysis on Hong Kong mixed-use (rail + property) housing development projects built on railroad site with 5 cases (Kowloon Bay Depot Project, which is the most representative mixed-use housing development on Kowloon Bay railroad depot by Hong Kong's MTRC; Chai Wan Depot; Tsuen Wan Depot; Tai Wai Maintenance centre; and Tseung Kwan O Depot) by construction status, characteristics of layout and planning, approaching methods and intra-complex connection system as well as architectural characteristics. particularly, field survey was conducted on every case site and interviews with related individuals or companies to supplement what lack only with literature review such as precedent studies and reports. The findings are as follows.

First, as explained in this study, Hong Kong's cubic mix-use housing development projects on railroad depot was initiated by Hong Kong MTRC (MTR Corporation Limited) that is the primary developer under open tender. We have confirmed that since 1972 when MTRC started a project first, it has successfully conducted "rail + property" business model for 40 years on the basis of stable and diverse profit structure and consistent and active investment. This development is in the same line of Hong Kong government policy (railway-based development) for high-density development around a railway station and for integrating development of train garage and station, which provides sustainable living. Ultimately, these projects are playing an important role of solving the lack of residential space.

Second, This study analyzed architectural plan and layout characteristics by case and it was found that the sites of selected cases had in common that their housing units were laid out crosswise with a core to accommodate many residents. Particularly, it was found in the field survey that the outdoor transition zone of the building was used as footpath, store, or parking space, which are not identified on a ground plan. In addition, a variety of facilities connected to the subway station such as shopping mall

Table 12. Connection System of Inside and Outside the Housing Complex in the Upper Artificial Ground

Division	Points of Analysis	Kowloon Bay Depot	Chai Wan Depot	Tsuen Wan Depot	Tai Wai Depot	Tseung Kwan O	
Horizontal Connect System	Inside and Outside of Housing Complex in the Upper Artificial Ground	Pedestrian (Resident)	◎	◎	◎	◎	◎
		Pedestrian (Nonresident)	◎	○	◎	×	◎
		Vehicle (Residential Vehicle)	○	○	○	○	×
		Vehicle (External Vehicle)	○	○	○	×	×
Vertical Connect System	The Upper Part and the Lower Part of the Artificial Ground	Pedestrian (Resident)	◎	◎	◎	◎	◎
		Pedestrian (Nonresident)	◎	◎	◎	×	◎
		Vehicle (Residential Vehicle)	×	×	×	×	×
		Vehicle (External Vehicle)	×	×	×	×	×

※ ◎ High ○ Middle × Low

Table 13. Comprehensive Consideration

Points of Analysis	Kowloon Bay Depot	Chai Wan Depot	Tsuen Wan Depot	Tai Wai Depot	Tseung Kwan O
Accessibility and Convenience	◎	◎	◎	×	◎
Horizontal-Vertical Connect System(Pedestrian)	○	○	○	×	◎
Horizontal-Vertical Connect System(Vehicle)	○	○	○	×	◎
Pedestrian Network & Spacious Living Space	◎	◎	◎	○	◎
Cooperation with the Public Transport in the Artificial Ground(Subway Station, Bus, Taxi, Etc.)	◎	◎	◎	○	◎
Enhancement of Publicness (Parks-Plazas, Open Space, Etc.)	◎	◎	◎	○	◎
Local Community Revitalization	◎	◎	◎	×	◎
Cooperation with the Area that Utilized the Artificial Ground	○	◎	◎	×	◎
Development Application Possibility to the Domestic and Suggestion	◎	◎	◎	×	◎

※ ◎ High ○ Middle × Low

(Telford Plaza), kindergarten and school are planned. Especially, Lohas Park Development Project on Tseung Kwan O railroad depot, which is the best example of MTRC's "rail + property" connection development, uses the artificial ground that connects railway station to the residential area and various convenience facilities to connect it again to the neighborhood (good accessibility) to maximize the convenience of the residents in the complex and the local residents.

Third, for access method to the complex, all of the case projects turned out they make the best use of ramps, pedestrian overpass, stairs, and foot bridge to connect between inside and outside, which enhances users' accessibility and also contributes to improving the lack of publicness in the complex to great extent. Especially in Tseung Kwan O railroad depot model, vehicle access is completely separated from footpath access. Foot access is possible to each complex unit through a street-in-air. Especially, access methods by car and foot are optimized in a way to make the residents get easy access to the subway station and the shopping mall in any direction.

Fourth, 4 case projects, except Tai Wai railroad depot that chose low accessibility between inside and outside and thus low convenience due to strategic reason (high-end residence), basically take Transit-Oriented-Development (TOD) theory for public transportation access system and thus have a good connection with public transportation such as subway train and bus.

Last, it turned out that the case projects make attempt to enhance publicness and activate community with foot bridge, ramps, street-in-air, escalator/elevator, stairs, and pedestrian overpass in medium space to establish connection system between the complex and the outer space.

As examined above, Hong Kong MTRC's mixed-use housing development projects (Rail+Property Model) on railway depot show that they are solving the problems that can occur from railroad depot development such as lack of publicness, isolation of

local community and housing problems in various ways. The success factors can include active investment of a developer and stable profit structure that make it possible, expansion of ground facilities and enhancement of publicness through diversifying the upper levels of railroad depot, recovering local community through active connection with neighboring areas, and improved awareness of mixed-use development on railroad depot through improving traffic access system. These factors need considering when domestic housing development project is initiated using railway depot.

The present study carried out case studies to find an alternative to solve the lack of available land for housing development in domestic urban areas in future, from urban infrastructure. Now that similar studies are being conducted on mix-use housing development using railway land and this the findings of this study can be used as the basic data for the studies. Meanwhile, since Lohas Park Development Project on Tseung Kwan O railroad depot, which is the best example of MTRC's "rail + property" connection development, is still under construction, in-depth and consistent research needs to carry out again at the point when the construction completes.

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「Received」, 「Revised」, 「Accepted」