

THE APPLICATION OF TOD IN DALIAN RAIL-TRANSIT CONSTRUCTION

Qianyu WANG¹, and Yoshihide NAKAGAWA²

¹Student Member of JSCE, Master, Dept. of Civil and Environ Eng., Waseda University
(3-4-1, Okubo, Shinjuku-ku, Tokyo 169-8555, Japan)
E-mail:qianwa16@fuji.waseda.jp

²Member of JSCE, Professor, Dept. of Civil and Environ Eng., Waseda University
(3-4-1, Okubo, Shinjuku-ku, Tokyo 169-8555, Japan)
E-mail: naka@waseda.jp

In recent years, with the rapid development of urbanization and economic in Dalian, automobile quantity and traffic demand also grows fast. At the same time, the integrated development of public transport facilities and surrounding land use has not yet been adopted in Dalian's urban planning and construction. And thus urban traffic congestion and air pollution is getting worse at present. Therefore, this research will take Dalian metro line as the object, summarize and analyze the experience of TOD cases domestic and abroad, and then put forward improvement suggestions according to the TOD standard proposed by ITDP, to create a more sustainable city of Dalian.

Key Words: TOD, public transport, land use, sustainable, Dalian

1. INTRODUCTION

(1) Background

Dalian is a major city and seaport in the south of Liaoning Province, China, with the total population of 69.87 million and total area of 13,237 square kilometers. The city administrates seven districts, two county level cities, and one county. Although the total population density of Dalian has only 527.8 person/km², the population density in urban area has reached to 4,834 people per square kilometers. The layout of Dalian has gone through five periods: Russian lease Period (1898-1905), Japanese occupation period (1905-1945), PRC centrally-planned economy period (1949-1990), early economic reform period (1990-2000), and economic transition period (2000-2010), and during these periods Dalian has become a multi-centered city¹.

However, because of the delay of the idea introduction of public transport using, Dalian citizens still prefer driving private car instead of traveling by public transit. Moreover, with the increase in the number of private cars, a series of problems has been highlighted: there is no public transit line can replace automobile in some high-density residential areas; automobile-lead urban form will be more easily spread to suburbs; and high carbon dioxide (CO₂) emission by automobile.

Transit Oriented Development (TOD) can effectively improve the urban problems such as the dependence on driving, traffic congestion, as well as urban sprawl in Dalian. And in 2015, new rail-transit: Dalian Metro Line 1 and 2 have been constructed and opened to traffic.

Actually, in some developed countries and other Chinese cities such as Hong Kong SAR, Chongqing, Guangzhou, Kunming had been implemented TOD for a long times and got success. So the application of TOD in Dalian is imperative.



Fig. 1 Location of Dalian, China

(2) Research objectives

Based on the above urban problems in Dalian, the

main purpose of this research is to design a more convenient and pedestrian-friendly environment for public-transit use and walking, by learning experiences from TOD cases in other regions and analyzing the situation in Dalian. Besides, due to the reduction of utilization of automobile in Dalian, the traffic congestion could be alleviated, and CO₂ emission could be reduced, so as to create a more livable and sustainable Dalian city.

2. LITERATURE REVIEW

(1) TOD concepts

American scholar, Peter Calthorpe codified the concept of TOD in 1986. TOD became a fixture of modern planning when he published his book: “The Next American Metropolis - Ecology, Community, and the American Dream” in 1993, which emphasized a set of relevant theories and specific criteria of TOD.

Besides, the following represents a sample of TOD definitions found in the literature:

- “The practice of developing or intensifying residential land use near rail stations”²⁾.
- “Development within a specified geographical area around a transit station with a variety of land uses and a multiplicity of landowners”³⁾.
- “A mixed-use community that encourages people to live near transit services and to decrease their dependence on driving”⁴⁾.
- “A compact, mixed-use community, centered around a transit station that, by design, invites residents, workers, and shoppers to drive their cars less and ride mass transit more”⁵⁾.
- “Moderate to higher density development, located within an easy walk of a major transit stop, generally with a mix of residential, employment, and shopping opportunities designed for pedestrians without excluding the auto”⁶⁾.
- “A place of relatively higher density that includes a mixture of residential, employment, shopping and civic uses and types located within an easy walk of a bus or rail transit center. The development design gives preference to the pedestrian and bicyclists, and may be accessed by automobiles”⁷⁾.

(2) Common element of TOD concepts

While such definitions vary in scope and specificity, most TOD definitions share several common elements:

- Mixed-use development (residential, employment, shopping and civic uses);
- High density development;

- Development that is close to and well served by transit;
- Development that is conducive to transit riding;
- Pedestrian-and-cycle friendly

Therefore, TOD has been defined generally as “a mixed-use community that encourages people to live near transit services and to decrease their dependence on driving”⁴⁾.

3. RESEARCH METHODOLOGY

The research methodology includes six steps for the achievement of the main goal of this research:

➤ Step 1:

This step introduces location, population, population density, as well as the history of city’s layout of Dalian, China. The reason why focused on this research is also included.

➤ Step 2:

This step is essentially the literature review of several TOD concepts from different authors or organizations. Additionally, I concluded the common elements of most TOD definitions.

➤ Step 3:

A large number of successful TOD cases in other countries and regions that can be draw lessons from. So first of all I made an analysis of those cases, then find useful concepts or ideas that can be applied to Dalian.

➤ Step 4:

Seven standards in China on selecting a TOD area, and eight TOD standards (score system) will be introduced in this step. The total score of the TOD standard is 100.

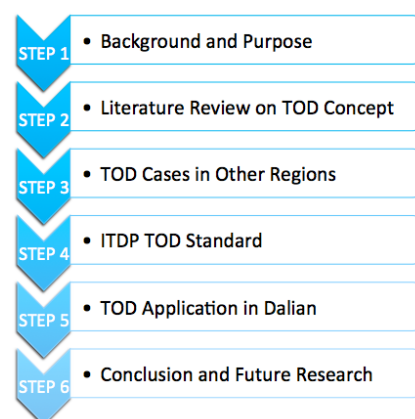


Fig. 2 Research methodology

➤ Step 6:

In the last step of the research conclusion and limitation on data getting from Dalian will be drawn, and future research will also be drawn.

4. TOD CASES IN OTHER REGIONS

(1) Copenhagen, Denmark

Copenhagen's "finger plan" for urban development was implemented in 1947 as figure 3 shown. In order to steer growth along desired growth axes, rail infrastructure was built in advance of demand. Greenbelt wedges set aside to preserve agricultural, open space and natural habitats were designated, and major infrastructure directed away from districts with these features. In addition, the integration of public transport, promenade and bikes reinforced traffic functions⁸⁾.

Although per capita income in Copenhagen is one of the best in Europe, residents prefer using public transportation, walking, or cycling, which brings extremely low automobile quantity in the city⁸⁾.

There are several reasons why the planning is successful and ideas that can be learned from Copenhagen's "finger plan", which are: making long-term development planning, constructing rail-transit network, combining land development and rail-transit system, bike friendly, as well as easy transfer among various modes of transportation.

(2) Stockholm, Sweden

Though Stockholm has a relatively high level of car ownership (555 cars per 1,000 inhabitants), it is still one of the few places where automobile use appears to be receding because of the application of TOD⁸⁾.

Stockholm's investment in radial rail lines has given rise to a "string of pearls" urban form and a balanced use of land for work and housing⁹⁾. For the convenience of surrounding residents, many public squares, and roadside chairs and other public infrastructure were constructed in each transit station according to this strategy regional planning, which has increased the attractiveness of residents to use public transport⁸⁾.

(3) The U.S.

Many of TOD projects in the U.S have been applied to practical according to guideline principles proposed in "The Next American Metropolis".

Sacramento first constructed rail-transit system, and then developed surrounding areas; Portland uses TOD patterns to show that land use can reduce reliance on auto; The city of San Diego adopted TOD to

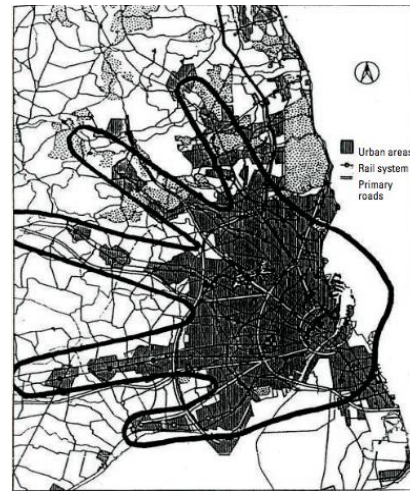


Fig. 3 The finger shape long-term planning of Copenhagen⁸⁾

help the city reduce urban sprawl, and support the trolley and bus transit system; The project of Jackson-Taylor in San Jose planned to transform the low-density old rail-oriented industrial zones into mixed-use neighborhoods with transit system¹⁰⁾.

Though some of the cases in the U.S. are still in planning or has already stopped due to some reasons, the ideas that popularize public transport, as well as mix use area to strengthen the convenience of citizen's life still can be draw lessons from.

(4) Hong Kong SAR, China

Public transit services took 80% of the traffic in Hong Kong SAR while the use of personal travel tools accounted for only about 6% of the total. Public transit is the lifeblood of the city including a high-capacity railway network, surface-street trams, ferries, and an assortment of buses and minibuses¹¹⁾.

According to the results of the demographic census of the district in 1990, we know that residents live within 400 meters from the metro station accounted for approximately 46% of the total population in Hong Kong. Among them, the proportion of residents living in Kowloon district, New Territories district, and Hong Kong Island district even as high as 65%¹¹⁾.

- Kowloon Station:

Kowloon station is one of successful urban TOD cases, which was designed to support residents' lives in west Kowloon area. Since the location is away from the city center and the no large facilities at early stage, the amount of customer has been low. However, after the opening of the property, the visitors flow rate has risen sharply and even overloaded during holiday.

As figure 4 shown, large commercial facilities, office buildings, residential area, hotel, kindergartens, and amenities are built within 200 meters of Kowloon station. Besides, golf club, parking lot, and

Austin station of West Rail Line are built within 500 meters¹²⁾.

Actually, besides Kowloon station, the construction of each station of metro lines in Hong Kong SAR were planned in accordance with TOD mode and have been succeed. The successful attribute to following points: the metro lines were constructed with the development of property; In core area and residential area, transfer among metro station, bus station and commercial facilities is convenient and pedestrian-friendly; Interfaces for planning buildings will be reserved during the process of metro line construction.

(5) Municipality of Chongqing, China

Yuelai Eco-city is a new area in the north of Chongqing, relies on metro line 6 to connect with the city center area at present¹³⁾.

There are lots of typical planning problems in the planning of the previous Yuelai Eco-City: single and scattered land use, large blocks that unsuitable for walk, as well as unintegrated of land use and public transport systems. Therefore, during the re-planning period of the city, narrower streets and smaller blocks have been used to improve the livability, transportation convenience, urban greening, and people's health¹³⁾. Figure 6 shows the land use change of Yuelai Eco-city.

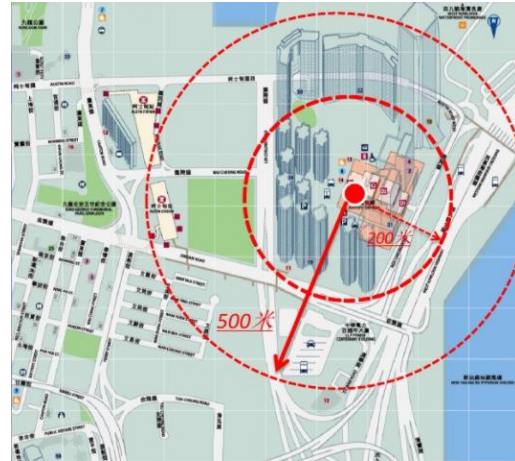


Fig. 4 Kowloon Station, Hong Kong¹²⁾

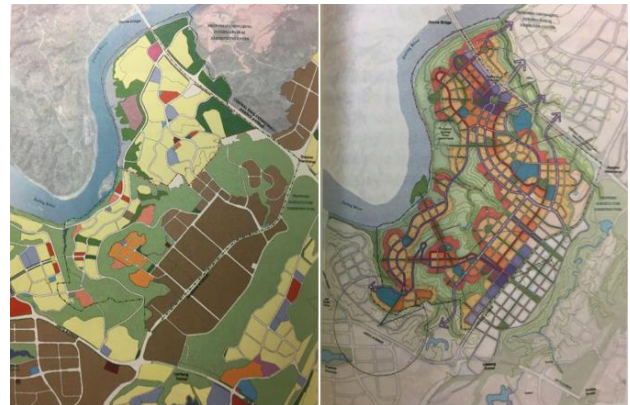


Fig. 5 Land-use before and after¹³⁾

5. TOD APPLICATIONI IN DALIAN

(1) Necessity of TOD Application in Dalian

Many of TOD projects have been successful applied in developed countries and other Chinese cities such as Hong Kong SAR, Chongqing, Guangzhou, and Kunming. However, because of the idea introduction of public transport using is delay in Dalian, citizens still prefer driving private car instead of traveling by public transit.

Dalian has two light-rail lines, two tram lines, and two metro lines, and more routes will be built to meet the demand of the citizens. Therefore, Dalian would be a rail-transit lead city in the future. So in order to create a more sustainable and livable city, the application of TOD in Dalian is imperative. Because TOD can effectively improve the following urban problems¹⁴⁾:

- reduce dependence on driving
- allow residents to live, work, and play in the same area
- reduce the area's carbon footprint on negative impact on the environment
- provide access to better life services

- stimulate the local economy
- provide better access between urban and sub-urban areas
- provide access to better entertainment or recreational services
- provide access to better jobs
- revitalize urban areas

So that urban issues such as the dependence on driving, traffic congestion, as well as urban sprawl in Dalian would be solved after the application of TOD.

(2) TOD standard by ITDP

The TOD Standard is an assessment, recognition and policy guidance tool uniquely focused on integrating sustainable transport and land use planning and design, and governed by the Technical Committee, convened by the Institute for Transportation and Development Policy (ITDP). The Standard was built on several experiences of many organizations all over the world and emphasize on the users-people¹⁵⁾.

The TOD Standard is designed to evaluate new development projects and station areas. And eight principles have been outlined by ITDP to guide the development of TOD, which are connect; compact; transit; densify; shift; mix; cycle; and walk¹⁵⁾.

The TOD Standard scoring system includes totally 100 points across 21 metrics, and the allocation of these points roughly reflects the level of impact of each metrics in creating a TOD¹⁵⁾. The following figure 6 shows the scoring detail of the completeness of the walkway network of “Walk” principle.

(3) Station selection

“Dalian Marine University Station”, as shown in orange color in figure 7 below, is one of the Metro Line1’s stations, located in Dalian High-tech Park of Ganjingzi district. The station is surrounded by commercial, recreation facilities (Jinhui Shopping Mall, Wandan Plaza), high-rise office buildings, pedestrian mall, buses and trams’ transfer stations, and residential area, and so on. And I’m going to give suggestion on the design of this station and its surrounding areas to improve the safety and convenience.

(4) Station area evaluation method

Since the target area of my research is the metro station of “Dalian Maritime University”, so the “Station Area Evaluation” method created by ITDP is going to be applied.

a) Understanding and sampling the station area:

The ITDP stipulates that one kilometer walking distance from transit station entrance to the entrance of building, so station areas can cover up to 3.14 square kilometers. Since the TOD Standard cannot be applied to such a large area, so I plan to use a sampling method to score those 21 metrics requiring measurements, which is identify and score as many representative blocks as possible and extrapolate the results to the entire relevant area¹⁵⁾.

b) Pre-scoring preparation:

In order to collect as much detailed information about the station area as possible, some basic data or policies I’m going to collect, includes¹⁵⁾:

- Boundary and total area of the station area being evaluated
- Number and location of transit stations nearby the development
- Relevant local area or existing station area plans
- General land use plans, zoning regulations and other city-wide land use and transport plans
- Number of residential units
- Amount of non-residential floor area
- The maximum vehicle speed on all streets
- Total length of all streets within the station area
- Car parking data

c) Desktop research:

Official local area plans, maps, statistics and data,

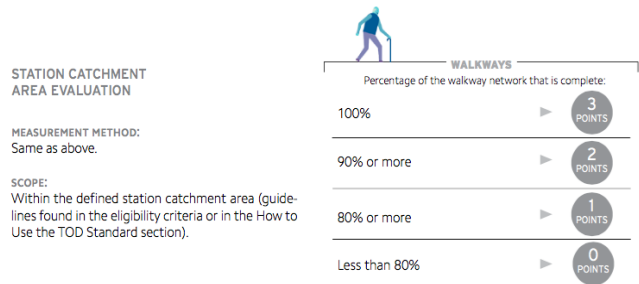


Fig. 6 Station Catchment Area Evaluation¹⁵⁾



Fig. 7 Dalian Metro Line 1

	MAXIMUM POINTS	SCORE	NOTES / DATA	
WALK	OBJECTIVE A. The pedestrian realm is safe, complete, and accessible to all.			
	1.A.1 Walkways	Percentage of walkway segments with safe, all-accessible walkways.	3	
	1.A.2 Crosswalks	Percentage of intersections with safe, all-accessible crosswalks in all directions.	3	
	1.B.1 Visually Active Frontage	Percentage of walkway segments with visual connection to interior building activity.	6	
	OBJECTIVE B. The pedestrian realm is active and vibrant.			
	1.B.2 Physically Permeable Frontage	Average number of shops, building entrances, and other pedestrian access per 100 meters of block frontage.	2	
	OBJECTIVE C. The pedestrian realm is temperate and comfortable.			
	1.C.1 Shade & Shelter	Percentage of walkway segments that incorporate adequate shade or shelter elements.	1	
		15	WALK SCORE:	

Fig. 8 Part of TOD Standard Score Sheet¹⁵⁾

as well as Google Earth will be good source for maps and information. Additionally, I will also visit to the site itself or interview with other people and organizations that are familiar with that area.

d) Site surveys & scoring:

I will bring TOD Standard Score sheet, a copy of the TOD Standard, a local area map and camera, and also take notes of information such as actual distances, observation notes.

6. CONCLUSION AND FOLLOW UP

TOD development period in China is relatively

short, and the relevant research and experience is slightly less. However, by drawing lessons from cases in foreign countries and other Chinese cities, and then combine with Dalian's own development situation, the integrated use of Dalian railway and land use will be realized, so as to provide citizens a more convenient and suitable environment for living.

In the following months I will have to do more analysis on TOD cases in other regions, and start up with the research about my target station (Dalian Marine University Station) in Dalian, including field trip, database collection and analysis, as well as score calculation. Finally, give my own suggestion on the construction of TOD in the station to get higher score.

REFERENCES

- 1) Mu, R., Jong, D. M.: Establishing the conditions for effective transit-oriented development in China: the case of Dalian. *Journal of Transport Geography*, September 2012. doi: 10.1016, 2012.
- 2) Boarnet, M., Crane, R.: L.A. Story: A Reality Check for Transit-Based Housing. *Journal of the American Planning Association*, Vol. 63, No. 2, pp. 189-204, 1998A.
- 3) Salvesen, D.: Promoting Transit Oriented Development. *Urban Land*, July, pp. 31-35, 37, 1996.
- 4) Still, T.: Transit-Oriented Development: Reshaping America's Metropolitan Landscape. *On Common Ground*, winter, pp. 44-47, 2002.
- 5) Bernic, M., Cervero, R.: *The Transit Village in the 21st Century*. New York: McGraw- Hill, 1997.
- 6) California Department of Transportation: Factors for Success in California's Transit-Oriented Development. Sacramento: Technical Advisory and Policy Steering Committee, 2001.
- 7) Maryland Department of Transportation, Report to Governor Parris N. Glendening. From the Transit-Oriented Development Task Force, December 2000.
- 8) Suzuki, H., Cervero, R., Iuchi, K.: *Transforming cities With Transit – Transit and Land-use Integration for Sustainable Urban Development*. The World Bank, 2012.
- 9) Cervero, R.: *The Transit Metropolis: A Global Inquiry*. Washington, D.C.: Island Press, 1998A.
- 10) Calthorpe, P. *The Next American Metropolis: Ecology, Community, and the American Dream*. New York: Princeton Architectural Press, 1993.
- 11) Wang, J.E., Jin, F. J., Mo, H. H., Chu, B.: Review of Transit Oriented Development. *China Science paper Online*, 2006. Retrieved from <http://www.paper.edu.cn/html/releasepaper/2006/05/354/>
- 12) Investigation on Development Mode of TOD in Hong Kong Metro, 2014. Retrieved from <https://wenku.baidu.com/view/305dcb08ee06eff9aef807df.html>
- 13) Calthorpe, P., Yang, B. J., Zhang, Q.: *Transit Oriented Development in China – A manual of Land-use and Transportation for Low Carbon Cities*. Beijing: China Construction Industry Press, 2013.
- 14) Benefits of Transit Oriented Development [image]. Retrieved from <http://www.tod.org/>
- 15) Institute for Transportation & Development Policy: *TOD Standard*, 2017. Retrieved from <https://www.itdp.org/wp-content/uploads/2014/03/TOD-2017-v3.pdf>