Global Environment Facility 6
CHINA SUSTAINABLE CITIES
INTEGRATED APPROACH PILOT PROJECT

TECHNICAL SUMMARY SERIES

TIANJIN
SUMMARY REPORT

gef global environment facility
INVESTING IN OUR PLANET

WORLD BANK GROUP

北京交通大學
BEIJING JIAOTONG UNIVERSITY

TIANJIN

Publications by the Project

Executive Summary

Technical Summary Series

The National Platform for TOD Information Management
Beijing
Tianjin
Shijiazhuang
Ningbo
Nanchang
Guiyang
Shenzhen

Special Topics in TOD

Urban Regeneration
Public Participation
Urban Rail Financing

TIANJIN

SUMMARY REPORT

GEF-6 CHINA SUSTAINABLE CITIES INTEGRATED APPROACH PILOT PROJECT

1818 H Street NW
Washington, DC 20433
Telephone: 202-473-1000
Internet: www.worldbank.org

Contents

List of Illustrations vi

Preface vii

Abstract ix

Part 1: TOD Strategy at the City Level 1

1. Tianjin Urban and Rail Development Overview 1
2. Problems Facing Tianjin's Rail Transit Development 5
3. Project Vision Development 7
4. Station Diagnosis 8
5. Planning Strategies at the City Level 11

Part 2: TOD Strategy at the Corridor Level 17

1. Application of Corridor Level Strategy: Northern Section of Line 4 17
2. Conceptual Planning 18
3. Forecast and Evaluation of TOD Corridor Planning 20

Part 3: TOD Strategy at the Station Level 21

1. Overview of the Jianchang Road Area 22
2. TOD Station Strategy 23
3. Evaluation of Effects at Stations 24

Part 4: Evaluation of Achievements 27

1. Project Operation 27
2. Key Experiences 28
3. Future Directions 29
4. Conclusion 30

Bibliography 31

Illustrations

Figures

1: Spatial Pattern of the Beijing-Tianjin-Hebei Urban Agglomeration 2

2: Tianjin Urban Rail Transit Plan, 2020 2

3: Density of Pedestrian Walkways within 800 Meters of Rail Transit Stations 5

4: Current and Planned Floor-Area Ratios within 800 Meters of Tianjin Rail Transit Stations 6

5: Morning Peak Passenger Flow (In- and Outbound) at Tianjin Rail Transit Stations 7

6: Tianjin TOD Information and Evaluation Platform 7

7: Station Classification: 5V Indicators 9

8: Classification Evaluation of Tianjin Urban Rail Transit Stations 10

9: Distribution of Tianjin Urban Rail Stations, by Category 10

10: Layout of Passenger Transport Hubs in Tianjin 11

11: Planning for the Northern Section of Line 4 19

12: OD Volume between Stations along the Northern Section of Line 4, 2025–50 20

13: Jianchang Road Research Area 22

14: Road System in the Jianchang Road Area 23

15: Spatial Pattern Planning of the Jianchang Road Area 23

16: Land Use and Development Intensity for the Selected Stations 24

17: TOD Effects on Transportation Systems and Underground Space in the Jianchang Road Area 26

Tables

1: Rail Transit Operations in Major Cities in China, Ranked by Passenger Traffic, 2022 3

2: Policies Related to Development of Rail Transit in Tianjin, 2015–21 4

3: Development Implementation Strategy for Regional (Hub) and Urban Center Stations 13

4: Development Implementation Strategy for Key Stations 14

5: Development Implementation Strategy for General Stations 15

6: Suggested Types and Quantities of Entrances/Exits, by Station Grade 15

7: Planning and Layout of Transportation Facilities at Jianchang Road Area Metro Stations 25

Preface

The Sustainable Cities Integrated Approach Pilot was a worldwide program established by the multinational Global Environment Facility in its sixth funding round (GEF-6). As implemented in China, it was aimed at helping Chinese cities use the principles of transit-oriented development (TOD) to achieve sustainable land-use policies and transit plans at the levels of city, transit corridor, and transit station. The five-year China project (GEF-6 China TOD) ran from December 2017 to March 2023. It was managed by the World Bank and implemented by China's Ministry of Housing and Urban-Rural Development (MoHURD) and seven representative large cities: Beijing, Tianjin, Shijiazhuang, Ningbo, Nanchang, Guiyang, and Shenzhen.

The Tianjin GEF-6 Project Management Office was managed by the Tianjin Housing and Urban-Rural Development Commission. The planning and design of the Tianjin project was undertaken by several consulting technical organizations.* This report is prepared by the team from Beijing Jiaotong University, it summarizes and evaluates the technical outputs of the project.

* The city-level study was undertaken by Tianjin Green Building Promotion and Development Center and Institute for Transportation and Development Policy.
The corridor-level study was undertaken by China Sustainable Transportation Research Center.
The station-level study was undertaken by Tsinghua University Institute of Transportation, Beijing Harmoney Engineering Consultants, and Jinan Quantong Information Technology.

TIANJIN

Abstract

Tianjin, a municipality governed directly by the central government of the People's Republic of China, contains a free-trade zone and is the largest coastal city in northern China. Implementing a sustainable transit-oriented development (TOD) model that focuses on public transportation in Tianjin will deepen the implementation of the national strategy of coordinated development of the Beijing-Tianjin-Hebei region. The GEF-6 China TOD project in Tianjin included research at three levels: city, corridor, and station. At the city level, evaluation and classification of rail transit stations and planning strategies was proposed for different types of rail transit stations. At the corridor level, taking a section of the northern part of Metro Line 4 as an example, planning and financing studies were carried out to alleviate the financial pressure of urban rail transit construction. The station-level work focused on the three rail stations in the Jianchang Road area to explore the potential of TOD in urban renewal areas. Promotion of the TOD concept was directed at government, industry, and the public through the distribution of project brochures and promotional videos and the production of posters and short films on the theme of experiencing a green lifestyle through green urban development in Tianjin.

TIANJIN

Part 1: TOD Strategy at the City Level

The technical teams developed a city-level TOD strategy based on the status of urban and transportation planning in Tianjin. Rail transit stations were categorized, and principles and specific requirements were proposed to achieve high-intensity mixed development around the stations. To achieve sustainable growth, suggestions for coordinating TOD planning and construction mechanisms were developed to ensure synchronized development of rail transit, station surroundings, and connecting transportation.

1. Tianjin Urban and Rail Development Overview

Tianjin, abbreviated 津 (Jin), is one of China's four municipalities directly under the central government of the People's Republic of China and one of its first-tier cities. Tianjin was one of the first coastal cities opened to foreign markets; it contains a free-trade zone and is a leading area for reform and opening up. It has an advanced manufacturing base, a core area for international shipping, and a demonstration zone for financial innovation. Located on the Pacific coast in the northern part of the North China Plain, Tianjin is bordered by the Bohai Sea to the east and Beijing to the west.

It is at the confluence and estuary of five major tributaries of the Hai River, earning the nickname 九河下梢 (the confluence of nine rivers) and 河海要冲 (a vital hub of rivers and seas). Tianjin is situated within the Beijing-Tianjin-Hebei city cluster (figure 1), enjoying a strategic location as a gateway to Northeast Asia and a land-sea hub for the Belt and Road Initiative. It is an important channel for exchanges between more than a dozen provinces, regions, and cities in northern China and is the largest port city in northern China. As of 2022, Tianjin had 16 districts, with 124 streets, 125 towns, and three townships.[1] Tianjin covers a total area of about 1264 square kilometers; it has a resident population of 11.6 million, including 11.6 million urban and 2 million rural residents, for an urbanization rate of 85 percent. In 2022, the GDP of Tianjin reached CNY 1,631 billion, ranking it 11th among cities in China.

1 The districts are Binhai New Area, Heping, Hedong, Hexi, Nankai, Hebei, Hongqiao, Dongli, Xiqing, Jinnan, Beichen, Wuqing, Baodi, Jizhou, Ninghe, and Jizhou.

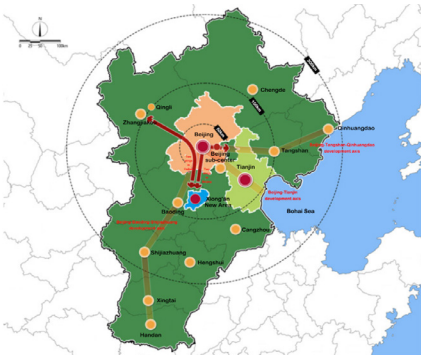
Advancing the Beijing Tianjin-Hebei Integration Plan in Tianjin with TOD

Tianjin, Beijing, and cities in Hebei Province form the city cluster that is the target of the Beijing-Tianjin-Hebei Integration Plan, launched in 2014. The Beijing-Tianjin-Hebei plan, an essential national-level strategy, provided new opportunities for Tianjin's development. Its new national mission and responsibilities include involvement in the transfer of industrial functions from the capital city and optimizing its own land use and spatial structure, strengthen Beijing-Tianjin linkage, jointly play a radiating and driving role, respond to citizens' visions and demands for Tianjin's future development, optimizing its own land use and spatial structure. These tasks made its participation in the GEF-6 China TOD project—with its own focus on compact land use, ecological sustainability, and responding to citizens' visions for Tianjin's future development—a key means of meeting its Beijing-Tianjin-Hebei plan responsibilities. And in the process, the TOD process would help accelerate Tianjin's development as a modern international metropolis characterized by ecological leadership, innovation competitiveness, and harmonious livability.

Overview of Rail Transit Development

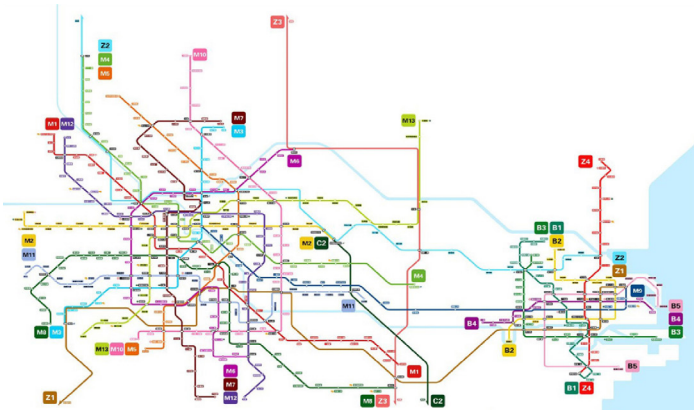
Tianjin's first urban rail line officially opened on December 28, 1984, making it the second city in mainland China to have an operational urban rail transit system. As of November 2022, Tianjin's urban rail transit system consists of nine lines, a network length of 293.9 kilometers, and 225 stations, including 23 transfer stations. The current operating rail lines connect major transportation hubs such as Tianjin Station; Tianjin North, South, and West stations; and Binhai International Airport. According to Tianjin's urban rail transit plan, the lines will be expanded to the Binhai New Area, forming a dual-centered structure with one primary center and one secondary center (figure 2).

Figure 1: Spatial Pattern of the Beijing-Tianjin-Hebei Urban Agglomeration



Source: Institute of Transportation Studies and Development Policies, *Urban TOD Strategy Master Report*, 2021.

Figure 2: Tianjin Urban Rail Transit Plan, 2020



Source: Institute of Transportation Studies and Development Policies, *Urban TOD Strategy Master Report*, 2021.

Although Tianjin's rail transit development started early, it lags behind that of similar Chinese cities in construction and operation. At the end of 2022, Tianjin ranked 13th in annual passenger traffic (about 320 million passengers), and its operating length and passenger density (passengers per kilometer) were likewise at low levels (table 1). For example, Tianjin's rail transit passenger density was less than half that of Xi'an, a city with similar operating length.

Table 1: Rail Transit Operations in Major Cities in China, Ranked by Passenger Traffic, 2022

City	Passenger Traffic (10,000 people)	Operating Length (km)	Passenger Density (10,000 people/km)	Number of Lines
1. Guangzhou	231,874	610	380	18
2. Shanghai	227,926	825	276	20
3. Beijing	226,192	864.1	284	27
4. Shenzhen	175,426	564.8	314	17
5. Chengdu	157,176	558	282	13
6. Hangzhou	96,365	516	187	12
7. Chongqing	91,084	435	210	10
8. Wuhan	89,353	504	177	14
9. Xi'an	76,881	272	282	8
10. Nanjing	76,515	449	170	14
11. Changsha	57,783	209	276	7
12. Suzhou	33,344	254	131	7
13. Tianjin	31,950	293.9	112	8
14. Zhengzhou	29,275	233	126	8
15. Shenyang	29,232	217	135	10

Source: Beijing Jiaotong University, *Urban Rail Transit 2022 Annual Statistics and Analysis Report.*

TOD Strategy to Alleviate "Big-City Problems"

In the past 20 years, China's urban population has grown massively, and its urbanization rate has reached 65 percent. Due to the rapid progress of urbanization and the extensive, decentralized urban footprint generated by real estate investment, Tianjin has experienced many big-city problems such as traffic congestion, environmental pollution, and the functional decline of old urban areas. One of the reasons for these problems is the increasing demand for motorized transportation and the inadequate supply of public transportation.

Since 2016, with the large-scale development of rail transit in China, the benefits of urban development brought by the TOD development model for rail transit hubs have gained widespread attention. In response, under the GEF-6 China project, Tianjin proposes to again apply TOD principles to guide the integration of land use with transportation planning to alleviate its big-city and achieve sustainable development in the city (table 2).

Table 2: Policies Related to Development of Rail Transit in Tianjin, 2015–21

Planning Document	Date	Main Objectives
Outline of Beijing-Tianjin-Hebei Coordinated Development Plan	April 2015	Build a multinode, grid-like, fully covered transportation network with rail transit as the backbone
		Develop an efficient and dense rail transit network, improve convenient and smooth road transportation networks, remove bottlenecks on national expressways, and eliminate bottlenecks on interregional and interprovincial trunk lines.
		Promote urban transportation prioritizing public transit, enhance the level of intelligent transportation management, improve regional integrated transportation services, and develop safe, green, and sustainable transportation.
Tianjin's 13th Five-Year Plan	April 2016	Accelerate the construction of a green transportation system.
Tianjin Urban Master Plan (2015–2030)	August 2016	Form a spatial structure of "Dual Cities and Dual Corridors," including the core areas of the central city and the Binhai New Area: "Establish two urban development corridors on both sides of the Haihe River, relying on intercity railways and urban rail transit." The plan reserves rail transit connections between the central city, the Binhai New Area, and various satellite cities and clusters.
Implementation Opinions on the Comprehensive Development and Utilization of Rail Transit Stations and Surrounding Land in Tianjin	December 2019	Basic principles, development scope, development mechanisms, development benefits, and safeguard measures for TOD of station areas.
Special Plan for Tianjin's Regional (Suburban) Railways (2019–2035)	December 2020	Emphasize efficient transfer connections between regional (suburban) railways and urban rail transit, trunk lines, intercity railways, conventional buses, taxis, bicycles, and other transportation modes.
Tianjin's 14th Five-Year Plan	April 2021	By 2025, increase the operational length of rail transit from 267 km to 500 km.
Comprehensive Transportation and Transport Plan for Tianjin's 14th Five-Year Plan	August 2021	By 2025, establish a "Double-Ring Seventeen Lines" rail transit network in the Tianjin metropolitan area, with the operational length exceeding 500 kilometers, and achieve a 45-minute commute within the main urban areas of the twin cities and a 20-minute travel time between the twin cities.
		Improve the convenience of bus travel, with a 100 percent coverage rate within 500 meters of bus stops and an 80 percent coverage rate within 300 meters, and achieve a green travel proportion of more than 75 percent.
Transportation and Transport Plan for Tianjin's 14th Five-Year Plan	September 2021	Build a comprehensive rail transit service system that integrates high-speed railways, intercity railways, regional railways, and urban rail transit, strengthening the leading role of rail transit in promoting the coordinated development of the Tianjin-Binhai twin cities.
		Establish fast rail transit connections between Tianjin and Binhai, providing express services for transportation within the main functional areas of the cities, and strive to achieve a 20-minute direct connection between the core areas of the cities.
		Achieve full coordination and high integration between transportation, ecology, production, and living spaces in Tianjin as part of the development plan for the Beijing-Tianjin-Hebei urban agglomeration.

Source: Beijing Jiaotong University.

2. Problems Facing Tianjin's Rail Transit Development

The main problems facing the development of urban rail transit in Tianjin can be divided into two categories. The first pertains to rail transit use, including issues such as low service levels, poor walkability, and difficulties in transportation connections. These problems significantly impact the sustained low passenger volume of rail transit in Tianjin.

The second category of issues mainly include the lack of integrated station-city development, ineffective capture of land value, and the inability of the existing rail transit development model to adapt to new development environments. These problems impose enormous financial pressure on rail transit construction in Tianjin. At the same time, the low operational efficiency and insufficient rail passenger volumes also impose a heavy burden on the city's finances and its ability to invest further in infrastructure to promote economic growth. The continuous low passenger volume, the lack of coupling between rail transit and land use along the corridor, the poor land value capture, and the high investment with low returns all hinder the ability of TOD principles to lead urban development in Tianjin.

Low Level of Rail Transit Service

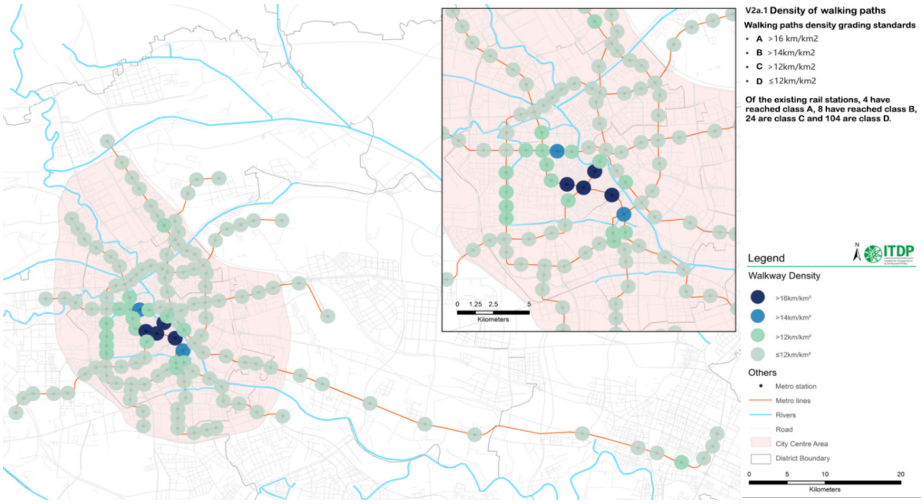
Service-related issues such as low population coverage around rail transit stations, low train frequency, and limited entrances/exits will significantly affect the passenger travel experience.

The proportion of the population within 800 meters of transit stations that uses transit is only 33 percent. In the city center, it is only 60 percent. The typical time between trains on workdays is about 4 to 8 minutes, and on nonwork days, it is 7 to 10 minutes, both of which are higher than the ideal interval of 3 minutes or less. Due to land ownership and cost control issues, 57 percent of the stations have at most two entrances/exits.

Poor Walkability near Rail Transit Stations

The plaza areas in front of rail transit stations are too small for efficient gathering and dispersing of passengers. Chaotic pedestrian and vehicular flows and unregulated parking of bicycles also hinder the walkability of the stations. About 38 percent of the station areas have a low pedestrian walkway density, less than 12 km/km². The proportion of the land area within 800 meters of stations that can be reached within a 5-minute, 10-minute, and 15-minute walk are only 13 percent, 42 percent, and 73 percent, respectively (figure 3). In high-demand areas, as much as 27 percent of the actual walking distance exceeds 15 minutes, beyond the acceptable travel time for pedestrians.

Figure 3: Density of Pedestrian Walkways within 800 Meters of Rail Transit Stations



Source: Institute of Transportation Studies and Development Policies, *Urban TOD Strategy Master Report*, 2021.

Connection Difficulties

The inability to synchronize the planning and design of rail transit interconnection facilities with rail transit has become a bottleneck constraining rail transit service and the choice of public transportation modes. The central urban area has a dense coverage of conventional bus stops within the rail station coverage area, but in some peripheral areas the density is significantly lower. The current density of bicycle lanes is relatively low, and almost all stations lack adequate bicycle parking, leading to disorderly surroundings and inefficient traffic flow. In contrast, there is an oversupply of on-street parking spaces, but a lack of parking management often results in motor vehicles occupying setback areas and sidewalks.

Lack of Integrated Development between Transit and Land Use

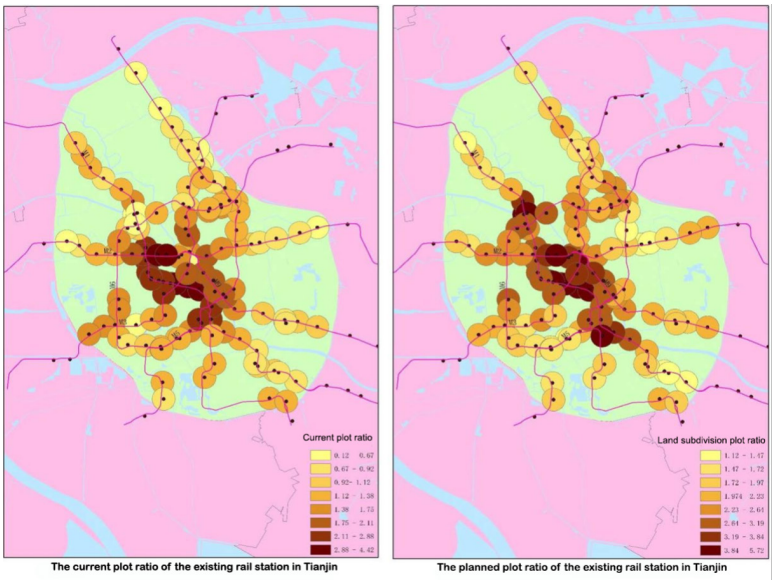
The rapid growth of rail transit infrastructure brings enormous demands for the financing of construction and operations. That burden falls largely on the city as the primary entity responsible for the investment. The sustainable further development of rail transit in Tianjin requires revising the investment model of direct government funding and market financing.

The land development intensity within the coverage area of Tianjin's transit stations is relatively low and offers little potential for land value capture. Currently, the ratio of building base area to land area within 800 meters of metro stations is 21 percent, with a floor-area ratio (FAR) of 1.7. The planned building base area ratios and FAR within 800 meters of metro stations are 18.02 percent and 1.36, respectively, lower than the minimum requirements for plot floor area ratios specified in MoHURD's 2016 *Guidelines for Planning and Design of Urban Rail Transit Corridor Areas* (figure 4). Issues such as the disconnect between land use and transportation construction and difficulties in implementing comprehensive development plans (typically because of land supply policies, mismatched construction sequences, and unclear property rights) affect the quality and benefits of comprehensive development that TOD can offer (including well-balanced passenger flows—figure 5).

Figure 4: Current and Planned Floor-Area Ratios within 800 Meters of Tianjin Rail Transit Stations

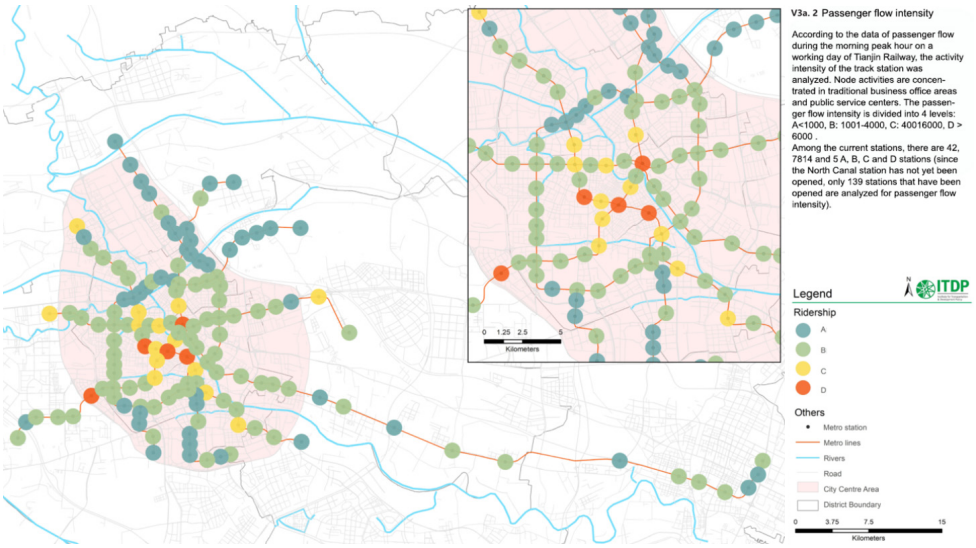
a. Current

b. Planned under the GEF-6 China TOD project



Source: Institute for Transportation and Development Policy, *Urban TOD Strategy Report*, 2021.

Figure 5: Morning Peak Passenger Flow (In- and Outbound) at Tianjin Rail Transit Stations



Source: Institute for Transportation and Development Policy, *Urban TOD Strategy Report*, 2021.

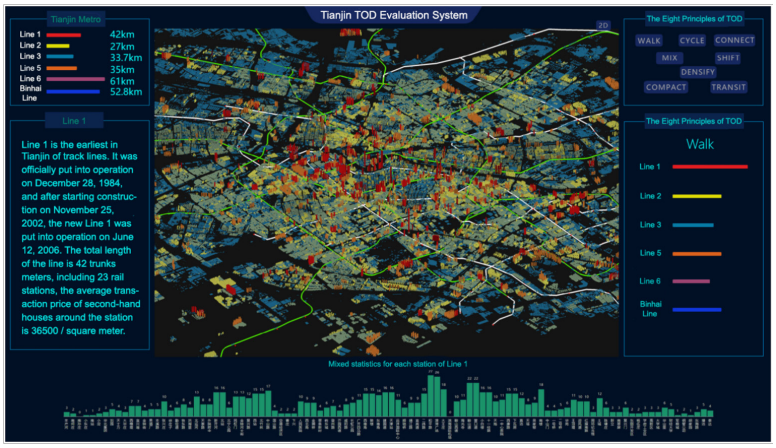
3. Project Vision Development

To comprehensively understand the development of urban rail transit in Tianjin, the technical team integrated various data on society, economy, and transportation in Tianjin. It developed a data platform to aid its work, created a vision expressed in eight TOD principles and a program of four transition strategies.

TOD Evaluation Platform

The technical team used GIS (geographic information system) technology to construct the Tianjin TOD Information and Evaluation Platform (figure 6). The platform provides an analytical basis for the diagnosis of urban rail transit stations in this project. It also offers technical support and services for subsequent urban rail transit planning and construction in Tianjin.

Figure 6: Tianjin TOD Information and Evaluation Platform



Source: Institute for Transportation and Development Policy, *Urban TOD Strategy Report*, 2021.

TOD Vision and Implementing Principles for Tianjin

Based on the identification of issues and public participation, the technical team developed an overall vision for TOD in Tianjin:

- Ensure that everyone has convenient modes of transportation
- Improve the quality of urban life
- Promote healthy lifestyles
- Minimize the negative impacts of urbanization.

This vision can be summarized by eight principles to explain the TOD concept:

1. Creating pedestrian-friendly neighborhoods
2. Prioritizing nonmotorized transportation networks, including for pedestrians, bicycles, and e-bikes
3. Establishing dense street grids
4. Developing around high-quality public transportation
5. Planning mixed-use communities with diverse functions
6. Increasing density according to the carrying capacity of public transportation
7. Creating short commuting distances
8. Enhancing travel capacity through regulated parking and right-of-way allocation

Strategies for the Development of Urban Rail Transit

Under TOD, the strategy of rail transit development itself must change. The technical team proposed the following four overall strategies for the development of urban rail transit under TOD:

- Transition from prioritizing rail transit construction to synchronizing rail transit construction with urban development, promoting sustainable economic development, and creating compact cities.
- Shift the focus from transportation efficiency to the integration of rail transit with neighborhoods, fostering station-centered community regeneration, and creating urban charm and vibrancy.
- Transition from emphasizing engineering design to considering communication and lifestyle aspects.
- Integrate the development of station and city, creating multifunctional and compound stations that cater to diverse needs.

4. Station Diagnosis

Identifying the issues and setting the vision for urban rail transit paved the way for a detailed diagnosis and analysis of each station. At the city level, the Tianjin technical team focused on the most critical funding issues in constructing Tianjin's urban rail transit. They adopted a TOD station evaluation standard called the 5V methodology, which differs from that of other cities: it adds environmental and social values to node and place values, and the resulting categorization of stations is scaled by market value.

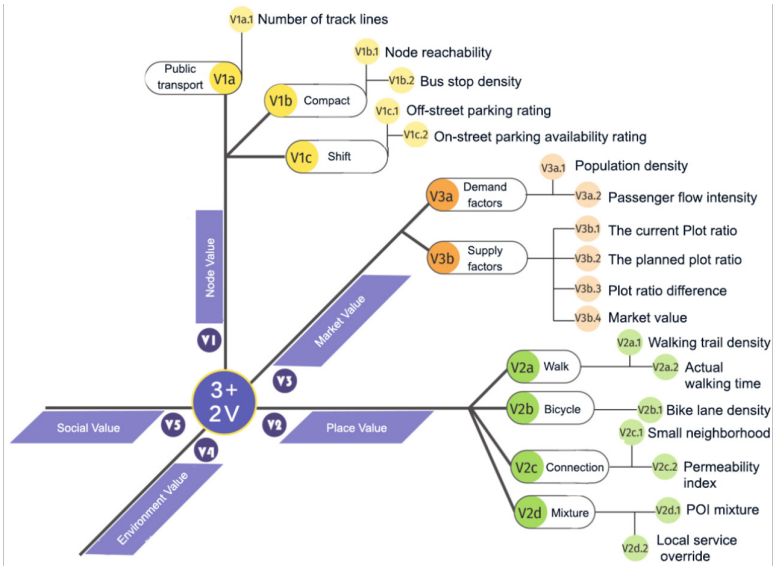
The 5V method revealed issues such as low service levels, weak coverage, poor accessibility, and the need to improve the built environment and realize market value. To address these problems, the technical team proposed a strategy of zone-based development for Tianjin's rail transit. The zone scheme aims to enhance market value, optimize road traffic, improve the built environment, achieve sustainable development for low passenger flow in rail transit, ensure spatial coverage and work-residence balance, and optimize slow and connecting transportation.

Transit Station Diagnosis: The 5V Approach

Building upon the 3V model adopted by the World Bank for TOD evaluation of development around stations (node value, place value, and market value), the technical team proposed a 5V model using two additional factors that should be considered: environmental value and social value (figure 7).

- Node value refers to the transportation capacity of stations, such as the actual walking time within the station coverage area and the provision of parking facilities.
- Place value focuses on the quality of public spaces and their attractiveness to residents, including indicators such as pedestrian and bicycle network density and the surrounding land development intensity.
- Market value considers the potential for economic growth driven by TOD, assessing market value by comprehensively considering demand and supply factors, such as population density, station passenger flow intensity, and nearby job opportunities.
- Environmental value aims to protect land resources and promote environmental sustainability.
- Social value emphasizes social equity in the TOD process, providing fair transportation supply for low-income populations and sharing the benefits of TOD. It includes the following goals:
  - Promoting mixed-income housing
  - On-site relocation of original residents
  - Retaining existing commercial and service functions in development projects to mitigate social imbalances and minimize disruptions to original community relationships.

Figure 7: Station Classification: 5V Indicators



Source: Institute for Transportation and Development Policy, *Urban TOD Strategy Report*, 2021.

Classification of Rail Transit Station Types

Using the 5V methodology, the technical team analyzed and identified problems at existing urban rail transit stations (figure 8). The exercise yielded a matrix of public transit categories (node value + place value) crossed with market value categories (figure 9).

For a given area, the public transit categories were (1) adjacent to public transit, (2) with transit connections, or (3) oriented to public transit.

The market value categories for each transit category were (1) dormant, (2) awakening, or (3) active.
The intersection of these categories yielded four station types: Long-Term Planning, Mid-Term Transformation, Short-Term Strengthening, and Hub Station.

Long-Term Planning Type

- Adjacent to public transit: Dormant market
- With transit connections: Dormant market
- Oriented to public transit: Awakening market

Mid-Term Transformation Type

- Adjacent to public transit: Active market
- With transit connections: Awakening market
- Oriented to public transit: Dormant market

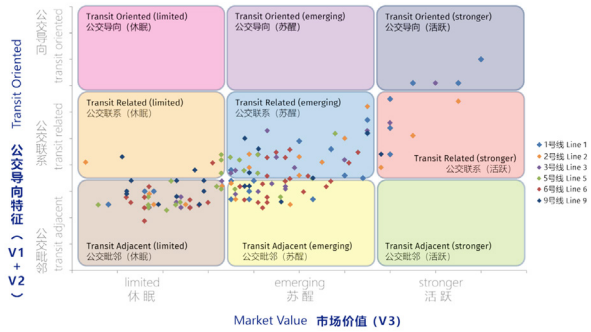
Short-Term Strengthening Type

- Adjacent to public transit: Active market
- With transit connections: Active market
- Oriented to public transit: Awakening market

Hub Stations

Hub Stations are uniquely important as nodes for intermodal transportation within and outside the city, supporting and guiding urban development. Their market value is inherently "active."

Figure 8: Classification Evaluation of Tianjin Urban Rail Transit Stations



Source: Institute for Transportation and Development Policy, *Urban TOD Strategy Report*, 2021.

Figure 9: Distribution of Tianjin Urban Rail Stations, by Category

Source: Institute for Transportation and Development Policy, *Urban TOD Strategy Report*, 2021.

5. Planning Strategies at the City Level

To alleviate the excessive concentration of urban functions, population growth, increasing traffic congestion, and environmental pressures in the central city area, Tianjin proposes the extensive further development of rail transit. While achieving the goal of transit-oriented urban development, Tianjin aims to revitalize the old city through renewal and transformation and develop the underutilized land along the rail transit corridors.

Driving New Area Development and Inner-City Renewal through Corridors

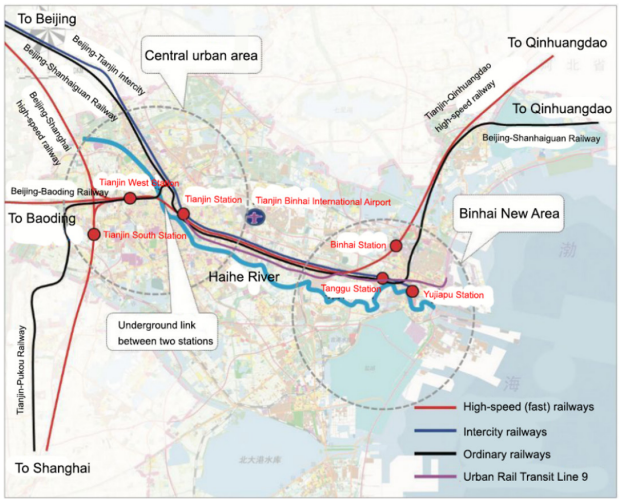
According to the *Tianjin City General Plan (2015–2030)* and *Tianjin Land Use Master Plan (2006–2020)*, Tianjin currently has only a relatively small amount of unused buildable land. To achieve more intensive and sustainable development, the city's urban construction efforts in the next 20 years should focus on a stock planning and urban renewal model associated with TOD corridors and core stations. For newly developed land, the focus should be on the integrated development of public transportation and land by incorporating residential, office, commercial, and public facilities along the public transit lines to promote the integration of stations and cities. This approach improves investment efficiency and reduces operating costs, thereby alleviating the financial burden.

Integration of Urban Rail Transit and Slow Traffic Systems

Tianjin's rail transit still faces challenges in terms of low population coverage at stations, low average daily ridership, low service levels, and difficulties in connecting stations with other modes of transportation (figure 10). These issues severely hinder the development of Tianjin's transportation; and, because of the low land value capture they imply, they hinder finance.

In the context of persistently low rail transit ridership, integration with slow traffic modes effectively improves the current situation. In the corridor and station research, Tianjin's technical team analyzed features such as land use functions, transportation environments, and station levels in the Jianchang Road area and along Line 4. Improvement measures were proposed with a focus on slow traffic to enhance the efficiency of urban rail transit.

Figure 10: Layout of Passenger Transport Hubs in Tianjin



Source: Institute for Transportation and Development Policy, *TOD Diagnosis and Type Identification*, 2020.

Classification of Stations and Surrounding Land

Tianjin's published plans indicate that the next three to five years will involve constructing 190 subway stations. The technical team classified the 190 planned subway stations into three types based on transportation characteristics, travel purposes, land functions, and development potentials.

The planned stations are categorized as follows (with number of stations in category):

- *Regional and Urban Center Stations* (8) are (regional) hubs and city center stations.
- *Key Stations* (49) are primarily located in the central areas of urban districts or around important commercial areas near large public facilities, showing a clear concentration trend.
- *General Stations* (133) are mainly distributed in residential communities and industrial areas. Residential General Stations are relatively evenly distributed throughout the city; industrial General Stations are primarily located in the outer areas, away from the city center.

An analysis of the construction situation in the vicinity of these stations produced three types of land:

- Built-up Area: Construction has been completed, and basic municipal and public facilities are already in place. These areas are mainly located in the central city area and the geometric center of the Binhai New Area.
- Partially Renewable: Some land is available for renewal and transformation. These scattered areas are mainly located within the urban built-up areas.
- Newly Added and Adjusted: Most of the land is undeveloped or can be adjusted for use. The municipal and public facilities still need to be completed in these areas, located in newly developed areas outside the central urban area.

Implementation Plan for Station Classification

The above three station types—Regional/Urban, Key, and General—are analyzed in terms of the types of land in their vicinity—Built-up, Partially Renewable, and Newly Added/Adjusted.

Regional and Urban Center Stations

The goal is to enhance the agglomeration effect and urban charm around the hub stations, integrating them with surrounding blocks with mixed land use and increased development intensity. Urban center stations are major destinations and important centers of vitality—cultural, commercial, and service. The construction of these stations focuses on increasing land mix and development intensity to expand the potential for land value appreciation.

For hub and urban center stations in the midst of the Built-up Area land category, development is conditioned on the potential for integrated improvement of available land. For those surrounded by Newly Added and Adjusted land, future development will follow a regional model (table 3).

Table 3: Development Implementation Strategy for Regional (Hub) and Urban Center Stations

Facility Arrangement	**Station Core Area**	Aggregation of public transportation, large commercial complexes, urban or regional public cultural and entertainment facilities, and interconnecting transportation facilities
	Station Influence Area	Aggregation of commercial and business functions, urban-level sports, education, medical public facilities, parks, and small block residential and commercial communities.
	Station Transitional Area*	Combining residential and commercial mixed functions, enhancing public service facilities such as kindergartens, farmers' markets, etc.
Development intensity	The minimum floor-area ratio (FAR) for land within the Station Core Area is 6, while for land within the Station Influence Area, the minimum FAR is 4. The building density should be between 60 percent and 85 percent. For residential land within the Station Radiation Area, it is important to ensure a good living environment in the community. For urban renewal projects, the requirements of transportation and environmental carrying capacity should be considered comprehensively to determine the actual construction intensity.	
Transport connectivity and convenient facilities development	Adequate facilities should be provided, such as long-distance bus stations, bus terminals, parking lots for private vehicles, taxi parking lots, bicycle parking lots, etc., to ensure the integrated connection between urban rail transit and external transportation hubs.	
	Vertical space should be utilized for traffic distribution, providing dispersed evacuation channels and avoiding large-scale plazas.	
	Parking facilities should implement strict traffic demand management policies. It is not advisable to set up public parking lots in the city. The parking provision standards for each functional unit should be reduced based on the urban development standards.	
Station space organization	Encourage the integration of transportation transfer functions with public open spaces such as squares, atriums, sunken plazas, or elevated platforms to accommodate the temporary influx of large crowds.	
	Adopt a three-dimensional layout that separates pedestrian and vehicular traffic, effectively managing the relationship between transfer traffic and traffic generated by development above the station.	

* The transitional area is also influenced by the station but distant enough from it for the direct impacts to be milder.

Source: Beijing Jiaotong University.

Key Stations

Key stations are primarily located in urban core areas or functional cluster centers. They provide high-quality transportation services, have a dense road network, favorable market conditions, and high intensity of land development. These stations exhibit highly mixed land use, including commercial facilities and other services. They have been distributed into three categories based on their importance and their TOD potential: high, medium, and low potential (table 4):

- *High potential*: Centrally located in urban areas with sufficient space for development or redevelopment. Their significant radiating effect on the surrounding areas and ample undeveloped land resources make them highly suitable for regional comprehensive development as the main planning strategy.
- *Medium potential*: Near community service centers, industrial parks, commercial and business districts, and important public service facilities. They serve as the core of various functional clusters in the city. The recommended implementation plan for these stations focuses simultaneously on renovation and development.

Table 4: Development Implementation Strategy for Key Stations

Facility Arrangement	**Station Core Area**	Aggregation of public transportation, integrated development above the railway, commercial and office spaces, urban or district-level public cultural facilities, and urban parks and squares.
	Station Influence Area	Aggregation of commercial and office spaces, entertainment and fitness facilities, urban or district-level sports, education, and healthcare public facilities.
	Station Transitional Area*	Layout of mixed-use commercial and residential functions, as well as public service facilities.
Development intensity	The minimum FAR for land parcels within the core influence area of the station is 5, while for land parcels within the station influence area, the minimum FAR is 3.5. For residential areas and urban renewal sites, the FAR requirements should also be adjusted based on actual circumstances.	
Transport connectivity and convenient facilities development	As the main nodes for transferring between walking, cycling, surface transit, and rail transit in service communities, it is encouraged to allocate transit hub facilities within urban construction land outside of road boundaries, where the urban land conditions permit.	
Station space organization	Encouraging rail transit stations to serve as visual centers of spatial organization, by setting up appropriately sized green spaces, greenways, and open spaces, closely connecting them with the development spaces above rail yards. These open spaces can be transformed into community activity centers.	

* The transitional area is also influenced by the station but distant enough from it for the direct impacts to be milder.
Source: Beijing Jiaotong University.

- *Low potential*: Located in developmentally saturated areas within the existing urban fabric. As new rail lines are planned, these stations become important transfer hubs. The primary approach for these stations is incremental upgrades and improvements. Future considerations include transfer design for the station, enhancing the surrounding basic service facilities, improving pedestrian connectivity, enhancing the landscape environment, and diversifying the use of surrounding buildings.

General Stations

General Stations are primarily located in residential communities and industrial areas with a predominantly residential function in the surrounding areas. They typically have some ground-floor commercial facilities and community amenities and exhibit moderate land use mix and intense overall development.

The coverage area is often characterized by enclosed communities forming large blocks and a relatively low density of roads. Pedestrian and connectivity facilities need development.

The stations have been distributed into three scope-of-development categories based on their TOD potential: regional, local block, and micro (tables 5 and 6):

- *Regional integrated development*: The surrounding land is mainly undeveloped or in a state of potential development. The focus is on encouraging integrated development and utilization. Alongside the construction of station facilities, the development of surrounding land can be considered, with initial emphasis on the development of basic infrastructure within the region. Adequate provisions for pedestrian connectivity and the allocation of public service facilities should be considered.

- *Local block transformation*: Mainly located on the periphery of the central urban area and the riverside new district, serving as drivers for urban renewal. Future development should gradually carry out organic land renewal, construction of public service facilities, and enhancement of the infrastructure services within the region while improving pedestrian connectivity and connectivity facilities.
- *Micro upgrading*: Primarily located where the surrounding development situation is relatively saturated. Micro upgrading focuses on integrating the station with the organization of surrounding traffic, improving service facilities, and enhancing the landscape.

Table 5: Development Implementation Strategy for General Stations

Facility Arrangement	**Station Core Area**	Arrange public transportation, community complexes, residential supermarkets, and recreational spaces.
	Station Influence Area	Lay out residential functions and neighborhood service centers.
Development intensity	The minimum floor-area ratio (FAR) for land within the station core influence area is 3, and for land within the station influence area, it is 2.5. For residential land within the general influence area, the community activity center should be located as close to the subway station as possible.	
Transport connectivity and convenient facilities development	Set up bicycle parking facilities and, if necessary, establish bus transfer stations.	
Station space organization	Encourage the use of linear pedestrian paths to connect surrounding functions, integrate transportation transfer facilities, extend the commercial service interface of the rail station, and create all-weather, high-quality pedestrian spaces.	

Source: Beijing Jiaotong University.

Table 6: Suggested Types and Quantities of Entrances/Exits, by Station Grade

Entrance/Exit Type	Regional and City Center Stations	Key Stations	General Stations
Ground level	Not less than 8	Not less than 8	Not less than 8
Underground interface*	Not less than 4	Not less than 4	

* Connections reserved for adjacent development parcels.

Source: Beijing Jiaotong University.


TIANJIN

Part 2: TOD Strategy at the Corridor Level

At the corridor level, the low passenger flow of Tianjin's urban rail transit results in significant financial pressures for its operation and further development. To address those pressures, the technical team selected Tianjin Metro Line 4 to study TOD investment and financing models. Line 4 serves as a link between the city center and the suburbs. Starting from the Civil Aviation University of China in the south (adjacent to the Binhai International Airport), it passes through the old city area, goes through Tianjin West Station, and enters the northwest suburbs, serving as an important transportation corridor connecting the city's north and south. For this corridor, the TOD analysis focuses on its northern section, which is near the Beijing-Tianjin corridor and has a significant amount of underdeveloped land, which gives the exercise a wide scope for application of the TOD model.

1. Application of Corridor Level Strategy: Northern Section of Line 4

Line 4 is 41 kilometers long, passing through seven administrative districts. The south section of Line 4, which opened on December 29, 2021, has a total length of approximately 19 kilometers and 14 stations starting from the southeast corner of Nankai District and ending at Xinxingcun Station in Dongli District.

Overview of the Northern Section

The northern section of Line 4, which is still under construction, starts from Xiaojie in Beichen District and ends at Hebei Avenue in Hongqiao District, with a total length of approximately 22 kilometers and 17 stations. After the completion of the entire Line 4, a station will be set up at Tianjin West Station, establishing a connection with other lines and significantly increasing passenger flow: transfers to Line 2 for travel to Binhai International Airport, and transfers to Line 3 at Heping Road for travel to Tianjin Station.

The northern section of Line 4 is mainly characterized by residential and commercial functions. Of the 17 stations, the technical team has selected 11 north of Liutan Station for corridor planning. The remaining six stations are primarily surrounded by residential areas with well-established facilities. The construction and opening of the northern section of Line 4 will promote the westward extension of the urban area of Tianjin, improving the transportation conditions in the northwest area.

Issues Addressed

Once the northern section of Line 4 is completed, it will become one of the most important lines in Tianjin, generating a significant amount of passenger flow and promoting the urbanization of the areas surrounding the stations and the development of the economy.

Promoting Coordinated Development of the Beijing-Tianjin-Hebei Region

The northern section of Line 4 is along the main transportation corridor of the Beijing-Tianjin Highway. The project's construction will further enhance bus services along the corridor and promote the integrated development of transportation in the Beijing-Tianjin-Hebei region.

Alleviating Traffic Pressure in the City's Core Area

Line 4 connects the old and new areas of the city, serving as a major commuting corridor. Completing Line 4 will alleviate congestion along the corridor, relieve traffic pressure in the city's core area, and increase the supply of public transportation for residents in the surrounding areas.

Facilitating the Riverfront Expansion Strategy in the Central Urban Area

According to the overall plan of Tianjin, Line 4 closely aligns with the development axis of the central urban area along the riverfront. It passes through the West Station Subcenter and Xiaobailou Main Center, and completion of the northern section will contribute to the transformation of these areas.

Driving Land Development along the Corridor

The metro line connects the main and sub-centers of the city. Its fast and convenient service can facilitate the conversion of residential areas in the central district to public service facilities primarily focused on the service industry while shifting industrial land to the periphery. The resulting increase in land revenue will play a role in optimizing the internal structure of the central urban area and strongly supports the development of the old village renovation areas.

2. Conceptual Planning

Of the three station types identified earlier—Regional and Urban Center, Key, and General—the 17 stations along the northern section of Line 4 fall into the Urban Center and General categories. The 11 selected stations are in three types of land-use areas:

- *Industrial, academic, research, and residential*: Located in the northernmost part, and equipped with commercial and residential service facilities, these areas serve as important industrial and educational supporting bases in Beichen District.
- *Vibrant renewal*: Located in the middle section, these areas are designated for high-quality residential construction. This area's main types of land use are residential, commercial, and public facilities.
- *Hub and business areas*: Located in the southern part, these serve as business and residential areas extending the functions of Tianjin West Station in the southeast. The main types of land use are residential, mixed use, and commercial (figure 11, panel a).

Road Traffic Optimization

The plan retains all existing roads. It aims to increase the connection of north-south main arteries and improve the density of support road networks around the stations. After optimization, the average road network density will rise 130 percent, to about 10 km/km2.

Regular bus connections will be strengthened during peak hours, and special bus routes between areas with high travel demand will be established. For stations serving community centers, a three-ring public transportation connection system will be established consisting of rail transit at the station, regular buses, and community buses. For terminal stations, bus services will be enhanced, and bus stations will be set up.

The parking standards within 500 meters of the rail transit stations will be determined according to the higher-level region's standards, reducing Tianjin's current standards by 20–25 percent (figure 11, panel b).

Land Structure Adjustment

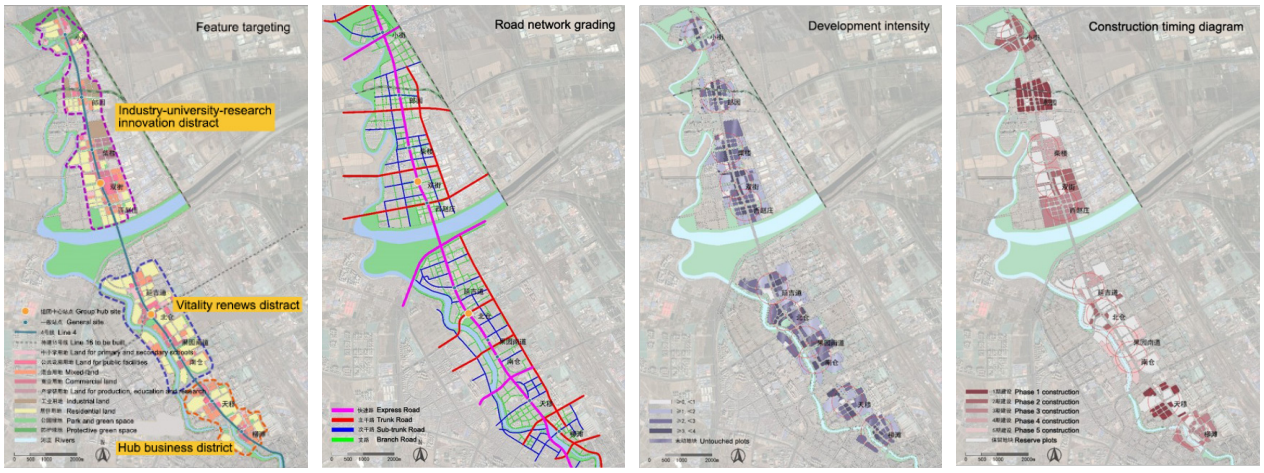
For a significant amount of undeveloped land, the technical team proposes a land-use strategy that combines residential, commercial, and public service functions. The strategy will create a 24-hour community, promote a good job-housing balance, and diversify the functional mix. Land use around the stations emphasizes commercial and mixed uses complemented by residential areas and public service facilities, thus encouraging differentiated plot ratios (figure 11, panel c).

Simultaneous Development of Land and Rail Transit Stations

The technical team proposes that each rail transit station and the land surrounding it be developed at the same time. Considering demolition costs, potential land area, station level, and job-housing balance, the development will be divided into five phases, each taking three years (figure 11, panel d).

Figure 11: Planning for the Northern Section of Line 4

a. Existing land-use types b. Roads c. Land-use adjustment d. Development timing



Source: China Sustainable Transportation Research Center, *Summary Report on Financing Research for Urban Rail Transit Corridors Using TOD Model*, 2021.

3. Forecast and Evaluation of TOD Corridor Planning

To predict passenger inflow, outflow, and OD distribution on the northern section of Line 4 after it opens, the technical team used historical passenger data and indicators of the existing and planned built environment around the segment's rail transit stations.[2] The technical team also considered the overall implications of the plan for the development of the corridor segment.

Forecast of Flows

The forecast results indicate yearly gains in passenger flow at each station. Through the analysis of residential and office stations, the project team believes that increasing the number of entrances and exits and improving the bus connections will enhance the accessibility of stations and lead to greater rail traffic inflow. However, the presence of expressways provides alternative transportation modes that may decrease forecasted flows. Similarly, increased commercial density may reduce the demand for external travel and likewise lower the passenger flow.

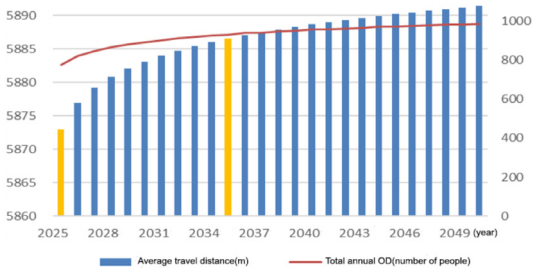
Nonetheless, the planned construction of the northern segment of Line 4 has improved land use, transportation, development intensity, and public space along the that segment. Low development intensity and use will be resolved. With the improvement in the number of entrances, exits, and bus connections, the accessibility of stations will be enhanced, which will tend to drive higher passenger inflow. The mixed-use land function around the stations will contribute to the job-housing balance in the area.

Evaluation of Corridor Plan

The TOD rail plan for the northern section of Line 4 will strengthen Tianjin's dual-city dual-corridor spatial structure, creating closer connections among various functional clusters within the city. The development of the old-city areas along Line 4 will shift its focus from emphasizing transportation efficiency to promoting the integrated development of rail transit and neighborhoods and fostering community revitalization centered around stations. The improved corridor will enhance connectivity, significantly improve transportation conditions in the northern suburbs, and gradually narrow the gap in transportation services between the city's north and south sections (figure 12).

To study the investment and financing of the Tianjin urban rail transit construction project, the Tianjin technical team selected three stations in the southern section of Line 4, the same area as the corridor level research, to design investment and financing plans. The conceptual planning at the corridor level will serve as the basis for later investment and financing analysis aiming to calculate the revenue and expenditure of rail transit construction.

Figure 12: OD Volume between Stations along the Northern Section of Line 4, 2025–50



Note: OD = origin-destination.
Source: China Sustainable Transportation Research Center, *Summary Report on Financing Research for Urban Rail Transit Corridors Using TOD Model*, 2021.

2 OD (origin-destination) data measure the movement of people or goods between locations and identify patterns and trends in this movement.

Part 3: TOD Strategy at the Station Level

Through the exploration and innovation of TOD, the rail construction project offers the opportunity to address the issues of residential areas and public facilities, initiate urban regeneration projects, and enhance the vitality of the region. How to achieve good community renewal, improve the quality of the living environment, enhance functional diversity, and meet the transportation needs of residents in the TOD mode is the key issue to be addressed at the station level.

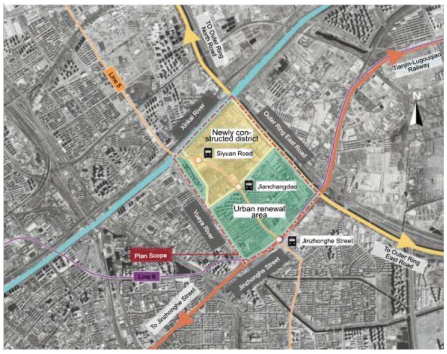
In selecting the Jianchang Road area, located along the Tianjin Metro Line 5, the Tianjin Project Office aimed to test strategies of the TOD model at the station level for urban renewal and create a model for the construction and development of TOD stations in Tianjin.

Line 5 has three stops in the selected area: Jingzhonghe Street Station, Jianchang Road Station, and Siyuan Road Station. The technical team has formulated development goals and approaches on the basis of the conditions and development potential of these three stations.

1. Overview of the Jianchang Road Area

The Jianchang Road area is in the northeastern section of Tianjin's Hebei District, 4.5 kilometers away from the Hebei District People's Government. Primarily a residential community, it covers 5.3 square kilometers (figure 13).

Figure 13: Jianchang Road Research Area



Source: Tsinghua University Transportation Research Institute, *Current Diagnosis and Evaluation Research Report*, 2021.

Basic Situation

The research area is divided by Jianchang Road into a northern and southern part. In the north is the planned new development area and a significant amount of land awaiting construction for residential and commercial use. The southern part is mainly the developed area, which falls within the scope of Tianjin's shantytown transformation and urban renewal.

The metro stations research area includes Siyuan Road, Jianchang Road, and Jingzhonghe Street. There are some old residential areas between Jingzhonghe Street Station and Jianchang Road Station, while Siyuan Road Station has mostly undeveloped land nearby. The land around Jianchang Road Station and Siyuan Road Station is generally laid out in disorderly fashion.

Existing Problems

The technical team identified the following issues in the area: lack of vitality in regional economic development; low-end and small-scale industrial patterns; a large, aging population with severe separation of work and residence; and insufficient labor reserves.

The overall road network density is low, with fragmented and disconnected roads, poor connectivity, limited bus routes, and inadequate transportation facilities to meet the current demand (figure 14).

The level of facilities around the stations varies significantly, resulting in a large disparity in usage rates among the three stations. Only Jingzhonghe Street Station has relatively well-developed surrounding facilities and higher passenger flow. Jianchang Road and Siyuan Road Metro Stations have yet to form integrated development, resulting in lower passenger flows.

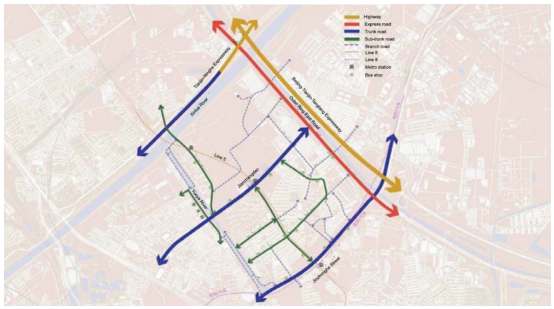
The intensity and complexity of land use in the area are relatively low, with chaotic building layouts, mixed architectural styles, and varying quality. The number of schools, medical facilities, sports venues, and other facilities in the area is inadequate to meet the needs of residents, as is their distribution.

The overall ratio of green space in the area, including for recreation, is low and unevenly distributed, particularly in residential areas.

2. TOD Station Strategy

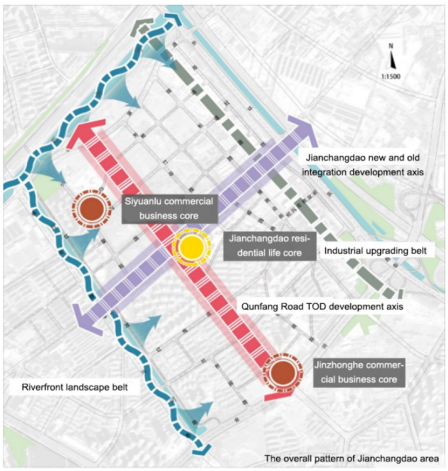
To achieve the renewal of the Jianchang Road area and enhance regional vitality, the technical team has defined the area as a humanistic community with Tianjin's distinctive characteristics: a healthy community for walking and cycling, a friendly community that embraces diversity, and an ecological community for recreation and proximity to water. This overall positioning guided the land-use planning around the three stations (figure 15).

Figure 14: Road System in the Jianchang Road Area



Source: Tsinghua University Transportation Research Institute, *Current Diagnosis and Evaluation Research Report*, 2021.

Figure 15: Spatial Pattern Planning of the Jianchang Road Area



Source: Tsinghua University Transportation Research Institute, *Research Report on Public Space and Urban Quality Enhancement*, 2022.

Station Area Land Use and Planned Positioning

Siyuan Road Station

The Siyuan Road stop is a general station located in an area where a low-income population is concentrated. A commercial and industrial park and partially renovated shantytowns are within 600 meters of the station.
Its planned position is that of an information, media, cultural, and technological innovation hub and a gathering place for information technology companies and innovation workshops.

Jianchang Road Station

This stop is also a general station, but within 600 meters is a relatively complete array of public service facilities, such as education, medical care.

Its planned position is that of a gathering place for a wider range of urban services, such as hotel-style apartments, guesthouses, commerce, leisure, and health care, including elder care and nursing facilities.

Jingzhonghe Street Station

This is a high-potential key station that will serve as a showcase for the TOD of station areas and bring new vitality to the Hebei District. Within 600 meters of it are three shantytown areas whose renovation is essential to the area's renewal.

Its positioning is as a commercial and business-oriented center. It will become an interchange station for Lines M5, M6, and Z2, thus serving as an important hub for both Tianjin and Binhai. The development potential is enormous. Integrated development between the station and the city will create a comprehensive city reception area that includes commercial centers, business centers, high-end apartments, and so on.

Adjustment of Land Layout and Development Intensity

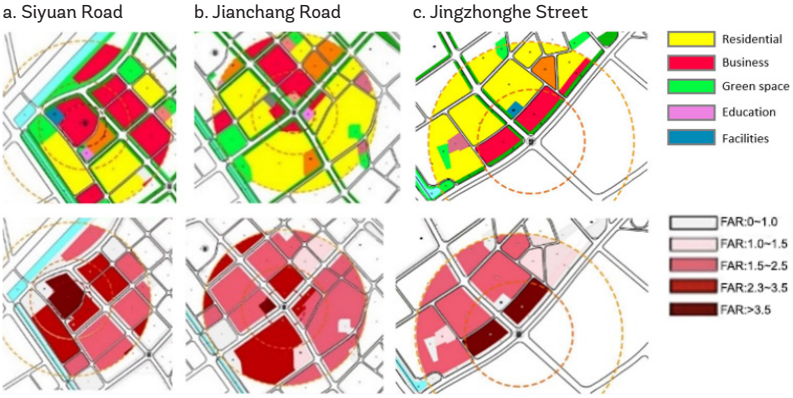
In response to the land layout around the three stations, the technical team proposes the following adjustments (figure 16).

Land Layout

- For the *Siyuan Road Station*, where land is predominantly for residential and commercial use, the proportion of commercial and business land will be increased.
- For the *Jianchang Road Station*, the core will be urban services, but the area surrounding the core will contain a large amount of residential land.
- The *Jingzhonghe Street Station*, as a regional transportation hub, will have commercial and business centers along the main roads and high-end residential areas on the outskirts.

Figure 16: Land Use and Development Intensity for the Selected Stations

Top row: Land use
Bottom row: Development intensity



Source: Tsinghua University Transportation Research Institute, *Comprehensive Development Research Report*, 2022.

Development Intensity

The city's minimum requirement for the floor-area ratio (FAR) in the core impact area of key and general stations is 5 and 3, respectively; for land beyond the core, it is 3.5 and 2.5, respectively. Since all three stations in the area are urban renewal-oriented, with many existing buildings, the planned development intensity will be slightly lower.

Siyuan Road Station will have a FAR exceeding 2.5 within 300 meters, a station overlay FAR above 3.5, and a FAR of around 1.5 in the outer area.

Within 300 meters of the Jianchang Road Station, the FAR will range from 1.5 to 3.5, gradually increasing toward the center, and with FARs otherwise similar to those at the Siyuan Road Station.

The core area of Jingzhonghe Street Station will have the highest development intensity, with a FAR above 3.5 along the main road and mostly ranging from 1.5 to 2.5 within the impact area.

Optimization of Transportation Facilities

To address the current inadequate transportation conditions in the Jianchang Road area (table 7), the technical team proposes the following development goals:

1. Clear hierarchical functions, good connectivity, and higher density for the road network.
2. Use stations as important transportation interchange hubs within the area, optimize the surrounding traffic organization, and improve passenger flow capacity.
3. Ensure safe, convenient, and comfortable pedestrian environments around the rail transit stations.
4. Enhance the connection between rail transit and other modes of transportation, expand the coverage of rail transit stations, and improve the competitiveness of rail transit.
5. Implement differentiated parking supply and pricing policies for stations.
6. Achieve integrated passenger flow encompassing rail, bus, and pedestrian networks, with a modal rate of 85 percent for green transportation (public transport + walking + cycling).

Table 7: Planning and Layout of Transportation Facilities at Jianchang Road Area Metro Stations

Facilities	Jinzhonghe Street Station	Jianchang Road Station	Siyuan Road Station
Entrances/exits	2 new ones	1 new ones	2 new ones
Bus stops	2 within a 300m radius 4 within a 500m radius	2 within a 300m radius 6 within a 500m radius	1 within a 300m radius 2 within a 500m radius 4 new bus stops added
Motor vehicle parking	Construction of 2 multi-level public parking lots to meet the demand of passengers on the Z2 Line.	Planning of underground public parking lots within park green areas, with a capacity of 450 parking spaces.	Planning of 1 underground public parking lot with a capacity of 200 parking spaces for motor vehicles.
Taxi stands	Setting up 4 taxi and K+R drop-off/pick-up spaces near subway entrances/exits.	Setting up 4 taxi and K+R drop-off/pick-up spaces near subway entrances/exits.	Setting up 4 taxi and K+R drop-off/pick-up spaces near subway entrances/exits.
Nonmotorized vehicle parking	Setting up and distributing nonmotorized vehicle parking spots at subway stations, residential area entrances/exits, bus stops, and other public places.		Increasing the number of shared bicycles at each entrance/exit and distributing nonmotorized vehicle parking spots.
Pedestrian walkways	• Main roads: sidewalks 3.5–5.0m wide on both sides. • Secondary roads: sidewalks 2.0–3.5m wide on both sides, with nonmotorized vehicle lanes 2.5–3.0m wide on both sides. • Other roads serve as minor connector roads: sidewalks 2.0–3.5m wide on both sides and nonmotorized vehicle lanes 2.0–2.5m wide. • When the red line width of minor connector roads is limited, a bidirectional nonmotorized vehicle lane 2.0–3.0m wide can be set on one side.		
Pedestrian crossings	• In the near term, ground-level pedestrian crossing systems will meet the current pedestrian crossing needs. • In the long term, a two-level elevated pedestrian corridor will be planned to connect surrounding plots, with provisions for pedestrian overhead crossing.		

Note: K+R = Kiss and Ride. Nonmotorized vehicles include bicycles and e-bikes.
Source: Beijing Jiaotong University.

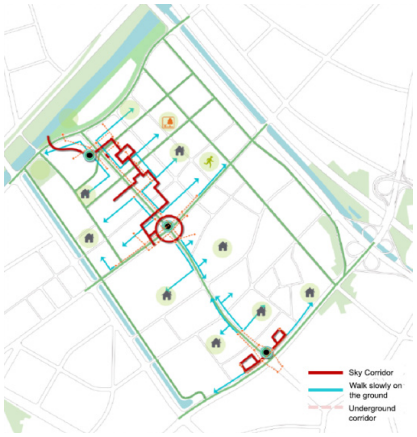
3. Evaluation of Effects at Stations

The rail-bus-pedestrian network has become more ample and integrated (figure 17). Various transportation indicators in the area have significantly improved through comprehensive improvements to the transportation system:

- The overall low density of road networks has been alleviated, and the accessibility of the basic road system has been improved. The construction of park-and-ride facilities will address the current shortage of parking facilities and outdated management practices in the Jianchang Road area.
- The increase in residential bus stops and bus routes will enhance public transportation accessibility.
- The integration of the three metro stations through comprehensive TOD has significantly strengthened their connection to surrounding areas, resulting in a substantial increase in passenger flow.
- The construction of pedestrian systems has increased to meet residents' desire for green travel.

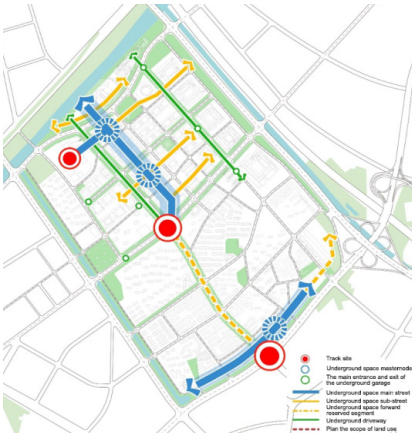
Figure 17: TOD Effects on Transportation Systems and Underground Space in the Jianchang Road Area

a. Walking system



b. Nonmotorized vehicle system

c. Underground space



Note: Nonmotorized vehicles include bicycles and e-bikes.
Source: Tsinghua University Transportation Research Institute, *Research Report on Public Space and Urban Quality Enhancement*, 2022)

Service functions have become more refined. TOD around the three rail stations in the Jianchang Road area will improve the type, scale, and service capacity of businesses. The distances separating homes and jobs will be lessened. Planning has improved the area's distribution of educational resources and cultural and entertainment facilities. The land-use layout of the Jianchang Road area has been refined, optimizing the structure and use of undeveloped land and addressing the issues of chaotic land layout and insufficient development intensity.

The quality of the public environment has improved, with architecture becoming more diverse in style and consistent in quality. The overall supply of green space has increased, but there is still significant room for improvement in the number of such parcels.

Part 4: Evaluation of Achievements

This assessment of the Tianjin GEF-6 China TOD project covers organization, technological support, and substantive achievements, as well as recommendations for continuing the project's successes in TOD.

1. Project Operation

The operation of the GEF-6 China TOD project encompasses the organization of government support and the strategy for implementing the project.

Government Organization

Tianjin has a long and rich history of implementing World Bank projects, and the city government has established a relatively complete organizational system for the planning, approval, construction, and operation of rail transit stations and the integrated development of surrounding land.

- In the early stages of the GEF-6 China TOD project, Tianjin established the World Bank Loan Projects Office of the Tianjin Municipal Commission of Housing and Urban-Rural Development to manage it.
    - In 2019, it was integrated into the Tianjin Green Building Promotion and Development Center (World Bank Loan Management Affairs Center of the Tianjin Municipal Commission of Housing and Urban-Rural Development) as a permanent institution responsible for the specific implementation of the GEF-6 China TOD Tianjin project.
- At the city level, the project's operation was mainly managed by the Green Building Promotion and Development Center.
    - At the same time, Tianjin established the Working Group for the Coordination of the Construction of Rail Transit Station Complexes and the Integrated Development of Surrounding Land.[3]
- At the corridor level, multiple city departments coordinated the planning of urban rail transit lines, land use, financing schemes, and development cost-benefit analysis.[4]
- At the station level, a comprehensive coordination and working mechanism centered on the project leader was established, with a project leadership group, expert advisory group, and working group.
    - Government agencies, represented by the Hebei District Housing and Urban-Rural Development Commission, assisted in data collection, site visits, and field research to ensure the high-quality progress of the project. Each department has clear responsibilities and has established construction management standards. They have studied policies that promote the development of rail transit station complexes and land compound utilization, ensuring the effective implementation of rail transit construction and overlying development.

3 The group included Tianjin's mayor and vice mayor, city departments (the Planning and Natural Resources Bureau, Land Transaction Center, Municipal Commission of Housing and Urban-Rural Development, Municipal Transportation Commission, and State-Owned Assets Supervision and Administration Commission), Tianjin district governments, rail transit construction entities, and other relevant stakeholders.

4 These departments included the Municipal Commission of Housing and Urban-Rural Development, Municipal Transportation Commission, Planning and Natural Resources Bureau, Rail Transit Group, and the construction and operation units of existing metro lines in Tianjin.

Technological Implementation

The Tianjin project was divided into three research levels: city, corridor (investment and financing), and station.

- The city level was studied by the Institute for Transportation and Development Policy (ITDP). The team focused on diagnosing the current issues and formulating strategies for developing and planning different types of rail transit stations based on the TOD model.
- The corridor level was the responsibility of the Sustainable Transport Research Center (CSTC). The group addressed the issue of high investment and low returns in Tianjin's current rail transit construction to alleviate the financial pressure of urban rail transit construction.
- The station level was undertaken by the Tsinghua University Institute of Transportation Engineering. The team used rail transit stations to drive urban renewal in the surrounding areas. They proposed detailed planning and design for the station areas to activate the development vitality of the area and improve the living environment for residents.

2. Key Experiences

Key experiences during the five-year GEF-6 China TOD project in Tianjin encompassed the following activities:

- Building a database platform to guide development decisions
- Developing TOD strategies focused on creating greater transit financing capacity
- Creating TOD pathways for effective urban renewal
- Applying quality of life as a key metric for TOD
- Creating a vigorous, multifaceted public information campaign.

Establishing a TOD Evaluation and Assessment Platform

To establish suitable evaluation criteria for TOD in Tianjin, the technical team developed a data platform to assess the current status of TOD and identify TOD types for the city. Using data and plans published by the Tianjin municipal government, the project office and technical team used GIS technology to integrate multidimensional indicators to score the TOD development level in different regions of the city.

The technical team combined TOD principles with the 5V model to assess and formulate implementation plans for each station. The construction of the TOD evaluation and assessment platform enabled Tianjin to evaluate its urban rail transit development more effectively, diagnose current issues, and support the formulation of subsequent strategies.

Mitigating Financial Pressure on Rail Transit

To address the issue of insufficient funds for rail transit, the technical team analyzed relevant national and local policies, drew lessons from domestic and international rail transit financing and TOD development projects, and combined them with Tianjin's economic and social characteristics. They analyzed and researched various financing methods and established balanced financing models at the station and corridor levels. The result was feasible specific investment and financing measures, TOD financing risk control measures, and implementation guarantee mechanisms. These results will alleviate the financial pressure of Tianjin's rail construction and increase the reinvestment of land value along the rail lines into more rail transit construction and operation.

Rail Construction with Urban Development and Renewal through the TOD Model

To promote urban expansion and the transformation of old cities, the technical team selected the Jianchang Road area for an in-depth TOD study. They used TOD to integrate the development of land along the rail transit lines with a focus on the areas around the stations.

The neighborhood has three transit stations; the area in the north is developing, and the area in the south is slated for renewal. In both areas, they designed improvements to traffic patterns, the quality of the urban environment, and public service facilities in the context of mixed-use development appropriate to the characteristics of the urban fabric around each station. The result was differentiated but clustered development of areas centered around stations, creating a multicore pattern arising from the interaction of rail development and TOD of urban land use.

Focusing TOD on Improving the Near-Term Quality of Resident Life

Achieving long-term development goals, such as promoting regional economic development and commercial prosperity through rail transit development, takes time. Therefore, for the nearer-term, the project office aimed to improve the quality of life for residents, use rail transit construction to renovate the urban environment along the rail transit lines, improve the quality of old neighborhoods, enhance the level of public service facilities, and improve urban transportation accessibility. Based on rail transit operational data and feedback from residents, they are upgrading the service level of existing rail transit, optimizing the planning of rail transit networks and stations, and adjusting the quantity and location of station entrances and exits. These efforts aim to make rail transit more convenient for users and increase rail transit ridership for the longer term.

Promoting the TOD Concept to the Public

The Tianjin GEF-6 China TOD project included activities for promoting the TOD concept, the theme of a green lifestyle through green urban development, and the project's research achievements. To increase the awareness of these points among government departments and industry entities, the project produced brochures, a series of short films and posters on green travel experiences in Tianjin, and other materials. These promotions were disseminated through Tianjin broadcast outlets, road signs, outdoor screens, subway advertisements, and new media platforms.

3. Future Directions

Tianjin must accelerate the TOD mode of urban growth while finding ways to balance the demands of ecological protection, growth, and efficient transit.

Accelerate Sustainable Urban Development through TOD

Tianjin was one of the first cities in China to implement urban rail transit, but the development could have been faster. Currently, Tianjin has only six operational rail transit lines, a number that must be greatly expanded for a megacity with a population of tens of millions. Tianjin's continued reliance on private cars in the midst of growth creates urban sprawl. To achieve economic, social, cultural, and environmental sustainability and become an ecologically resilient city, Tianjin must accelerate a shift to a public transportation-oriented development model that also emphasizes pedestrian and bicycle mobility.

Balance Ecological Protection, Economic Development, and Efficient Travel

The key factors constraining the development of Tianjin's urban rail transit are low passenger flow and low floor-area ratio, resulting in significant financial pressure. Increasing the passenger flow of Tianjin's rail transit and capturing the value of surrounding land is crucial to alleviate the financial stress of rail transit construction.

However, there are two conflicting points in the current development of urban rail transit in Tianjin. The first is the contradiction between protecting the ecological landscape along the Haihe River and high-density development for economic benefits. Protecting the environmental landscape of the Haihe River Basin means constructing an ecological green barrier belt around the city. Yet that approach imposes limitations on the floor-area ratio of development along the rail transit lines. A similar trade-off involves the need for ecological protection along the coast of the Bohai Sea as part of the coordinated development of Beijing, Tianjin, and Hebei.

The second point of conflict is the choice between "the people follow the line" or "the line follows the people" development model for rail transit. "The people follow the line" model extends rail transit lines to undeveloped areas to increase land value along the lines and facilitate real estate development. This model involves less financial pressure during rail transit construction but may take time to generate sufficient passenger flow and improve urban transportation conditions. The "line follows the people" model focuses on developing rail transit in densely populated areas. However, this model requires more urban renewal and building demolition during rail transit construction, putting more significant pressure on city finances.

Balancing the demands of ecological protection, economic development, and efficient travel poses substantial constraints on the development of Tianjin's urban rail system. Selecting a suitable development model and achieving a balance will be one of the main challenges for future rail transit development in Tianjin.

4. Conclusion

Tianjin was a pioneer in the construction of urban rail transit in China, and its transit system is under great pressure to develop more rapidly as the city grows. As part of the Tianjin GEF-6 China TOD project, the Tianjin government explored TOD models for alleviating the financial burden of expanding its transit system while making the urban landscape more compact, efficient, and ecologically sustainable. The project has successfully addressed critical technical bottlenecks and policy barriers and stimulated Tianjin's thinking and practices in sustainable urban development. The city's experience gained in the process will serve cities of similar scale in China and other developing countries globally.

Bibliography

China Sustainable Transportation Research Center. 2020. *D1 Tianjin World Bank TOD Financing Preliminary Report.* Tianjin GEF Shijiazhuang Project Management Office.

China Sustainable Transportation Research Center. 2021. *D3 Summary Report on Financing Research for Typical Urban Rail Transit Station TOD Projects in Tianjin.* Tianjin GEF Shijiazhuang Project Management Office.

China Sustainable Transportation Research Center. 2021. *D4 Summary Report on Financing Research for Urban Rail Transit Corridors Using TOD Model.* Tianjin GEF Shijiazhuang Project Management Office.

Institute for Transportation and Development Policy. 2019. *Vision Report.* Tianjin GEF Shijiazhuang Project Management Office.

Institute for Transportation and Development Policy. 2020. *Tianjin TOD Development Guidebook.* Tianjin GEF Shijiazhuang Project Management Office.

Institute for Transportation and Development Policy. 2020. *TOD Diagnosis Analysis and Type Identification.* Tianjin GEF Shijiazhuang Project Management Office.

Institute for Transportation and Development Policy. 2021. *Urban TOD Strategy General Report.* Tianjin GEF Shijiazhuang Project Management Office.

Institute for Transportation and Development Policy. 2023. *Knowledge Dissemination and Communication.* Tianjin GEF Shijiazhuang Project Management Office.

Tsinghua University Institute of Transportation. 2021. *Current Situation Diagnosis and Evaluation Research Report.* Tianjin GEF Shijiazhuang Project Management Office.

Tsinghua University Institute of Transportation. 2022. *Comprehensive Transportation Development Report for Jianchangdao Area, Tianjin.* Tianjin GEF Shijiazhuang Project Management Office.

Tsinghua University Institute of Transportation. 2022. *Public Participation and Promotion Report.* Tianjin GEF Shijiazhuang Project Management Office.

Tsinghua University Institute of Transportation. 2022. *Research Report on Public Space and Urban Quality Enhancement.* Tianjin GEF Shijiazhuang Project Management Office.

Tianjin Green Building Promotion and Development Center. 2023. *Completion Report of Tianjin Project.* Tianjin GEF Shijiazhuang Project Management Office.