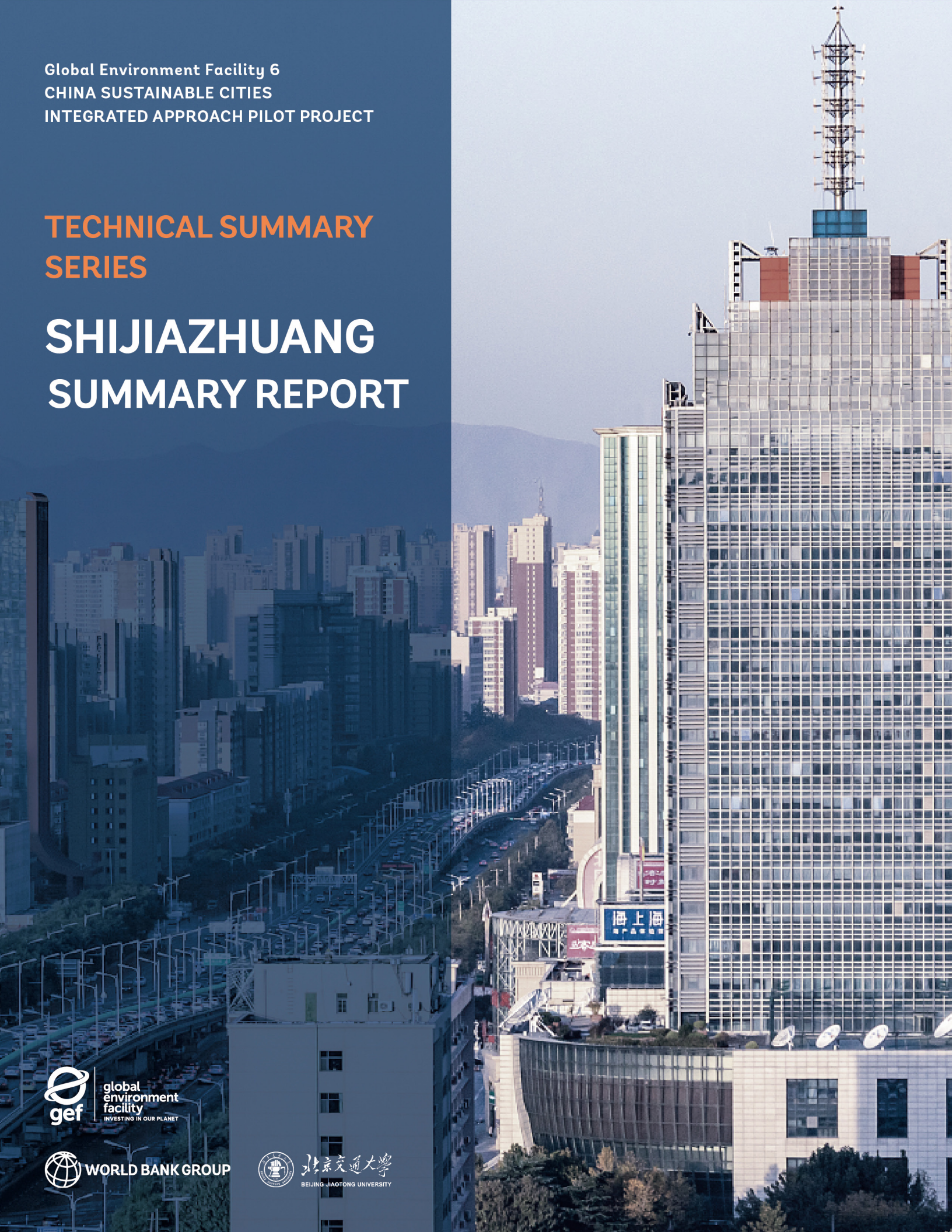
Global Environment Facility 6
CHINA SUSTAINABLE CITIES
INTEGRATED APPROACH PILOT PROJECT

TECHNICAL SUMMARY SERIES

SHIJIAZHUANG
SUMMARY REPORT



gef global environment facility
INVESTING IN OUR PLANET

WORLD BANK GROUP

北京交通大學
BEIJING JIAOTONG UNIVERSITY

SHIJIAZHUANG

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

SHIJIAZHUANG

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

Illustrations

Figures

Tables

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 deputy mayor of Shijiazhuang City served as the project team leader and set up the Shijiazhuang GEF-6 China TOD project Management Office under the Municipal Development and Reform Commission, which served as the main body responsible for project supervision and implementation. Among the city departments leading the effort were the Bureau of Planning and Natural Resources, the Bureau of Transportation, the Bureau of Housing, the Bureau of Commerce, the Bureau of Finance, the Planning Institute, and the Railway Group. The planning and design of the project were undertaken by several consulting 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 the China Academy of Urban Planning and Design.

The corridor-level study was undertaken by the Beijing Municipal Engineering Design and Research Institute and the Shenzhen Peking University Planning and Design Research Center.

The station-level study was undertaken by the Shenzhen General Research Institute of Comprehensive Transportation and Municipal Engineering Design and the Shenzhen Urban Planning and Design Research Institute.


SHIJIAZHUANG

Abstract

In early 2018, Shijiazhuang joined the GEF-6 China TOD project along with six other major cities in China. The project advances the concepts of TOD at three geographic scales, or levels—that of the city, the transit corridor,and the transit station.

At the city level, the GEF-6 China TOD project aims to establish an effective framework for urban spatial development, maintain balanced urban-rural development momentum, and ensure overall economic, social, and ecological benefits. At the corridor level—this report takes Metro Line 4 as an example—the project focuses on realizing efficient connectivity between urban clusters, the redistribution of urban functions, and specific opportunities for spatial optimization along the rail corridor.

At the station level—this report takes four stations on Metro Line 1 located north of Shijiazhuang East Railway Station as an example—the project formulates detailed planning and design schemes for rail station areas. The station-level aim of the GEF-6 China TOD project is to drive the development and construction of surrounding areas, achieve innovative integration of urban and rural areas, and create an ideal habitat that integrates people, greenery, industry, and the city.

The project has integrated international TOD standards with local characteristics in Shijiazhuang. Valuable experiences and insights have been derived from the project's engagement with spatial patterns, construction sequence, benefit generation, ecological integration, and pedestrian- and bicycle-friendly coexistence. Shijiazhuang has used the project to integrate TOD into its long-term development strategies, making it an essential tool for the city's land-use planning. These experiences will guide the city's future development of rail transportation and station-city integration, and—along with the experiences of the six other program cities—they will influence TOD practices in China and other developing countries worldwide.


SHIJIAZHUANG

Part 1: TOD Strategy at the City Level

Shijiazhuang is the capital of Hebei Province and a prefecture-level city with a total metropolitan population of more than 11,350,000 across 12 counties. In March 2021, Shijiazhuang issued the *Shijiazhuang 14th Five-Year Plan for Economic and Social Development and the Outline of Vision 2035 (2021–2025)*, which includes the construction of transit-oriented development (TOD) urban complexes in Shijiazhuang. The outline emphasizes the need to integrate rail transit construction with land development around rail lines and stations, optimize urban space, and promote economic development, aiming to create a "Shijiazhuang on Rails."

To accomplish those goals, it proposes the formation of a backbone rail transit network in the central urban area during the 14th Five-Year Plan period. It calls for accelerating the establishment of an interconnected main metropolitan area, accessible transit lines, metro stations within 500 meters of any residence, and an efficiently connected rail transit network for major functional areas. These goals were the outcome of Shijiazhuang City's participation, beginning in December 2017, in the GEF-6 China TOD project.

Beyond the Five-Year Plan, and beyond the metropolitan boundaries of Shijiazhuang, the Shijiazhuang GEF-6 China TOD project is closely aligned with the city's ongoing territorial and spatial planning, providing specific recommendations and strategies for station-city integration.[1] The project serves as a vital means to implement major urban land-use spatial planning strategies. These include "strongly supporting the construction and high-quality development of provincial capitals"; "implementing development along rivers in cities"; and "subtracting within the second ring road and multiplying outside the second ring road." At the regional, metropolitan, and city levels, the Shijiazhuang GEF-6 China TOD project has proposed sequential strategies that align with long-term urban development goals, such as integrating with Xiong'an New Area, supporting multiple focal points, and promoting development along rivers. The core objective of the project is establishing a comprehensive urban spatial framework and ensuring development effectiveness. Station-city construction guided by TOD is essential to facilitate urban spatial expansion and guarantee economic, social, and ecological benefits.

1 Station-city integration refers to the goal of integrating the development of rail transit hubs with investments in the development of surrounding neighborhoods. It encourages comprehensive land development around the stations coupled with strong financial support for high-density properties.

However, the current implementation of TOD in Shijiazhuang at the city level faces impediments such as slow progress in regional integration, lack of coordination in the old and new urban areas, and insufficient functionality along the rail corridors. To address these challenges, the project proposes strategies that align with Shijiazhuang's unique development requirements. These strategies include establishing a comprehensive regional integrated transportation network, developing high-quality TOD new towns on the outskirts of the central urban area, reorganizing the functional layout of land along the rail lines, and promoting the integration of rail transit and pedestrian-friendly development. From a macro perspective, these strategies aim to promote the overall growth and enhancement of the region and the city.

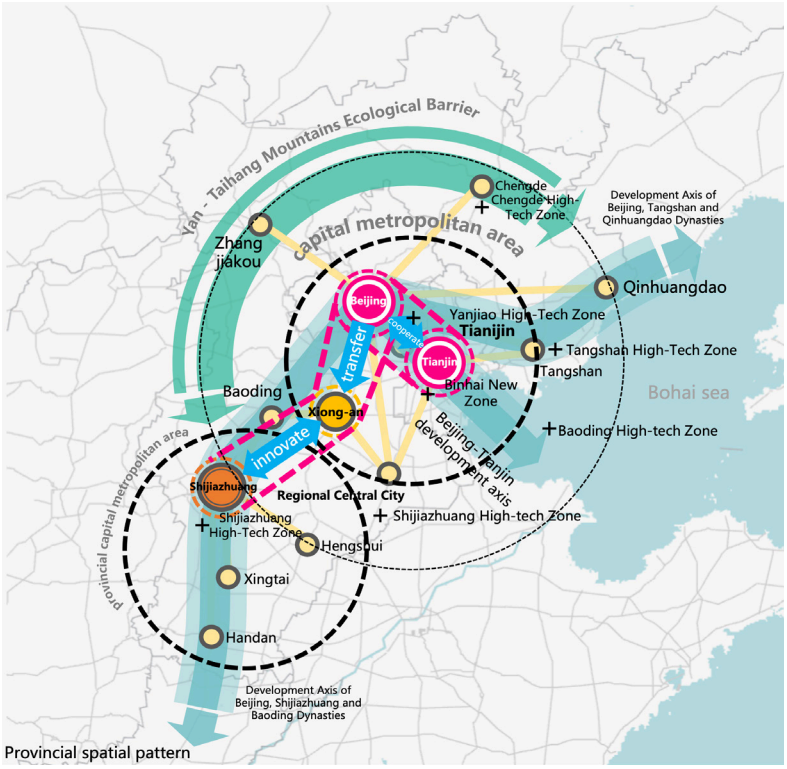
1. Overview of Urban Development in Shijiazhuang

Shijiazhuang is the capital of Hebei Province and its largest central city. It serves as a "subcenter" of the Beijing-Tianjin-Hebei region, contributing to the overall development of the southern part of the region. Promoting the TOD model is an important component of Shijiazhuang's strategy to build a modern, international, and beautiful provincial capital city, aligning with the overall requirements of its regional development positioning.

Integration with Xiong'an and Coordination with Beijing-Tianjin

Currently, while consolidating its position as the core city in the metropolitan area, Shijiazhuang is trying to connect with the Beijing Metropolitan Area by driving the integration between the provincial capital metropolitan area and the Beijing metropolitan area (figure 1). In this regard, Xiong'an New Area is the western wing of the "one core and two wings" development strategy in the Beijing-Tianjin-Hebei region.

Figure 1: Shijiazhuang and Beijing Metropolitan Areas



Source: Consortium of Beijing Municipal Engineering Design and Research Institute and Shenzhen PKU Planning and Design Institute, *Study Report on Land Adjustment Planning along Shijiazhuang Urban Rail Transit Line 4 for World Bank Inspection*, 2022.

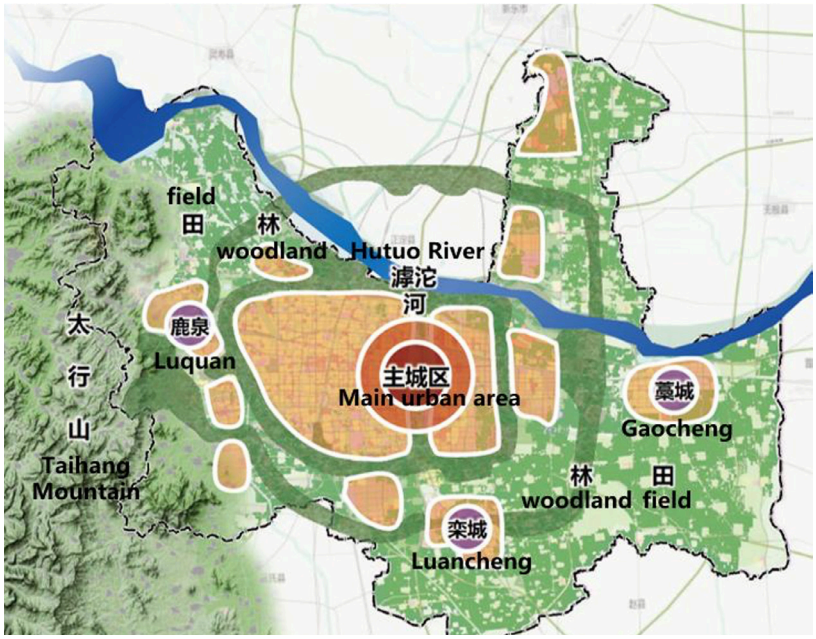
Leveraging its proximity to Xiong'an, Shijiazhuang aims to leverage its excellent industrial foundation, foster innovative cooperation, enhance its capacity, and achieve mutual growth and benefits with Xiong'an. This regional development pattern requires the support of an efficient and well-connected modern transportation network, both internally and externally. Therefore, Shijiazhuang will take the lead in constructing an "orbiting and networked" intercity railway network with Beijing, Tianjin, and Xiong'an as its core. Doing so will strengthen the connection between Shijiazhuang, Xiong'an, and Beijing-Tianjin, and the new rail network will be part of the construction of the international comprehensive transportation hub cluster in the Beijing-Tianjin-Hebei region. Internally, Shijiazhuang will develop regional (suburban) railways and urban rail transit, establishing a commuter-oriented rail transit system between the city center and surrounding town clusters.

Scale Expansion and Cluster Support

By the end of 2020, the permanent population of Shijiazhuang City reached 11.22 million, with an urbanization rate of about 70 percent and an area of 334.7 square kilometers. Being located on the plain, the main urban area of Shijiazhuang has always maintained a development model of single-center expansion, an approach that creates environmental and efficiency issues. To address those issues while expanding the city's scale, the *Shijiazhuang Territorial and Spatial Master Plan (2021–2035)* establishes four new city clusters in the outskirts of the main urban area: Luquan, Luancheng, Gaobeidian, and Zhengding.[2]

These clusters provide multiple points of support to the main urban area, collectively forming the central area (or central city) and leading to the differentiated development of characteristic industries (figure 2).

Figure 2: Spatial Structure of Shijiazhuang according to Its Master Plan



Source: Shijiazhuang Natural Resources and Planning Bureau, *Shijiazhuang Territorial and Spatial Master Plan (2021-2035)*.

2 The plan was prepared by Shijiazhuang Natural Resources and Planning Bureau.

Furthermore, under the master plan, county-level central towns, central villages, and general towns are distributed around the central urban area, forming a four-level urban system within the city area. The TOD model provides a decisive technical means for realizing Shijiazhuang's clustered urban development structure. Conversely, the clustered design also establishes anchor points for the connectivity patterns between urban railways in the central urban area and the peripheral city clusters, as well as between the central area and the outer towns within the city area.

Urban Development with River Embrace, Balancing Growth and Reduction

In 2021, Shijiazhuang proposed the "Development with River Embrace" strategy, referring to the Hutuo River, the principal river of Shijiazhuang (figure 3). This strategy involves transitioning from a development layout focused on concentrated areas along the railway to a spatial pattern of "one river, two banks." The emphasis is on the central urban area, where the urban structure aims to implement "subtraction" within the Second Ring Road and "multiplication" beyond it. "Multiplication" entails developing along the river, expanding the framework, and guiding the concentration of emerging urban functions in the Hutuo River ecological and economic belt. At the same time, it maximizes the use of land on both riverbanks to ensure its strategic use for emerging industry, create a new growth pole, and offer an attractive urban image that is internationally influential.

Figure 3: Hutuo River in Shijiazhuang

Source: Shenzhen Comprehensive Transportation and Municipal Engineering Design Research Institute and Shenzhen Urban Planning and Design Institute, *Research Report on Planning and Design of the Northern Area of Shijiazhuang East Station of Shijiazhuang Metro Line 1 Based on the TOD Concept*, 2022.

"Subtraction" refers to the relocation of population and low-end and low-efficiency industries. It optimizes the layout of "public service facilities"—a term used throughout this report that encompasses parks and other green space and facilities for sports, healthcare, elder care, education, and cultural activities. The structural adjustments in the central urban area present specific requirements for the refined design and implementation of TOD in Shijiazhuang. They align closely with the urban development and construction principles advocated by the TOD model.

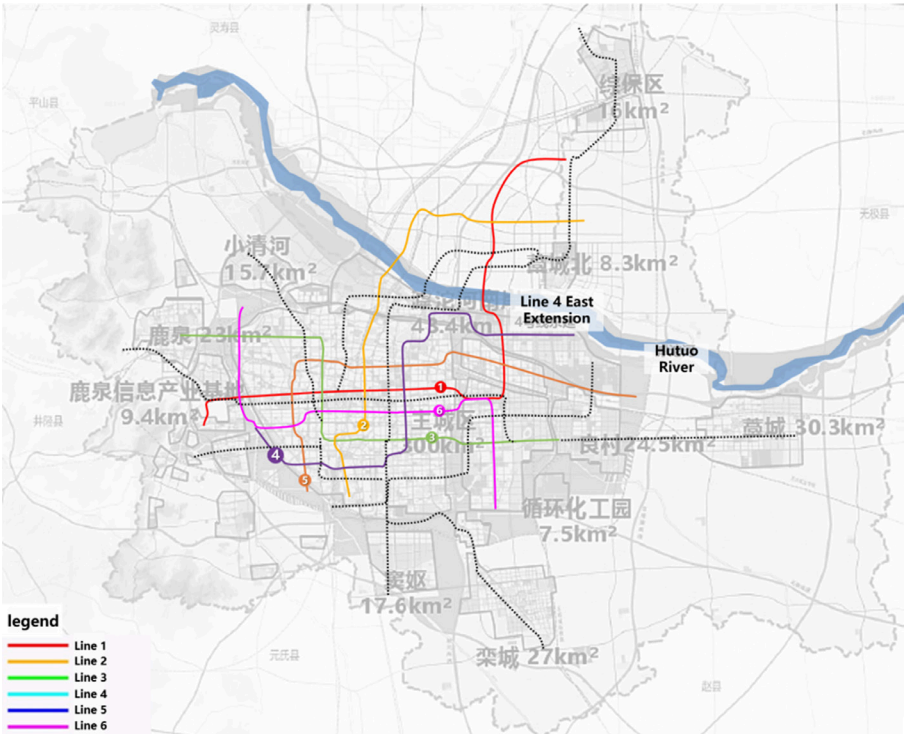
The Current Status of Rail Transit Construction

The construction of urban rail transit in Shijiazhuang is currently transitioning from initial development to rapid construction. The city's rail transit system primarily comprises three subway lines, which currently are the only lines operating: Phase 1 and Phase 2 of Line 1; Phase 1 of Line 2; and Line 3. As of the end of 2019, the average daily passenger flow on Line 1 and Line 3 was around 260,000, accounting for approximately 15 percent of the city's public transportation passenger volume. In 2020, due to the impact of the pandemic, the combined average daily passenger flow on all three lines was 196,000, with a passenger flow density of less than 4,000 people per kilometer. These metrics place Shijiazhuang relatively low among cities with operational rail transit.

However, the operational rail lines in Shijiazhuang have expanded from 38.4 kilometers in 2019 to 74.3 kilometers in 2022, representing a year-on-year growth of 93 percent. Upon the anticipated approval of additional lines, the city's rail transit network is expected to consist of six main and auxiliary lines totaling 144.2 kilometers. The overall network will have a radial coverage pattern, predominantly serving the central urban area, while certain areas will have a grid-like configuration to facilitate convenient travel. Ultimately, this will form an interconnected pattern characterized by a "large radial, small grid" layout (figure 4).

- Line 1 runs east-west through the city center and will connect with the High-tech Zone. It will extend north to connect with the Zhengding cluster, playing a vital role in driving the development of the old and new city areas.
- Line 2 runs north-south through the city center, accelerating the connectivity between the north-south outer ring roads and the urban area. It will provide an interchange with Line 3 at Shijiazhuang Station, linking to important external transportation hubs.
- Line 3 is a crucial passenger corridor running east-west and will connect the urban area with Luquan.
- Lines 4 and 5 will intersect on the outskirts of Shijiazhuang, forming a suburban metro ring.
- Line 6 will fill in the internal transportation network within the urban area.

Figure 4: Planned Rail Transit Network in Shijiazhuang City



Source: Beijing Municipal Engineering Design and Research Institute and Shenzhen Peking University Planning and Design Research Center, *Joint Research Report on Land Adjustment Planning along Line 4 of Shijiazhuang Urban Rail Transit*, 2022.

Rail Transit and Slow Modes

Rail transit and "slow" (walking and bicycling) modes of transportation are already strongly related in Shijiazhuang. As a plain city, it also possesses favorable geographic conditions for employing TOD to prioritize the expansion of slow modes as it expands its rail network.

According to research in the *Comprehensive Transportation Plan of Shijiazhuang (2016–2025)*, slow modes are currently the most common means of travel for residents, accounting for about 65 percent of all trips. Among these, walking accounts for 25 percent, and bicycles (including e-bikes) for 40 percent. Roads in Shijiazhuang that are wider than 2.5 meters account for nearly all the city's arterial roads, so it is not surprising that the share of trips made by bicycle in Shijiazhuang is the highest among cities of similar scale in China.

Slow modes are likewise the dominant means of access to Shijiazhuang's rail system (which accounts for more than 35 percent of all trips on public transit). Passenger surveys conducted at the city's rail transit stations showed that 76 percent accessed the stations via slow modes (walking—33 percent; and bicycling, including e-bikes—43 percent). Shared bikes accounted for more than half—27 percentage points—of the 43 percent arriving by bicycle. Other modes of connecting to rail transit, such as bus, account for 15 percent, while the proportions for taxis and private cars are the lowest, at 3 percent and 5 percent, respectively.

These conditions point to the advantages of enhancing the accessibility of rail transit stations through slow modes of transportation. Developing the interconnections will deepen the integration of TOD and station-city connectivity and enlarge the benefits derived from both modes.

2. Challenges of Urban TOD in Shijiazhuang

The slow development of the Shijiazhuang metropolitan area relative to the rest of the region has created an urgent need to upgrade the transportation connections between Shijiazhuang and the surrounding cities. Slow progress in the construction of suburban railways and urban rail transit has hobbled the transit connections between the central urban area and the surrounding town clusters.

Although Shijiazhuang is the only city within the metropolitan area with a subway system, its total length is only 61.6 kilometers, and it mainly serves the center city. Its connection with the surrounding new town clusters needs to be more closely integrated. However, rail transit that connects the central urban area and peripheral towns is either still in the planning stage or has not yet been put in service.

Lack of Coordination between the Old City and New Districts

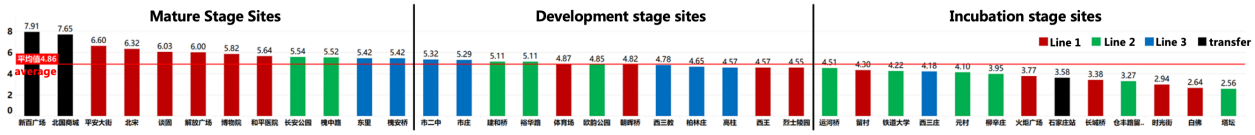
As shown in the *Shijiazhuang Territorial and Spatial Master Plan (2021–2035)*, the central urban area includes the old city area and four new town clusters: Luquan, Luancheng, Gaocun, and Zhengding. The extensive and unplanned urbanization in Shijiazhuang has resulted in high density and excessive concentration of functions around the train station in the old city area west of the Beijing-Zhuhai Expressway. An area of only about 20 square kilometers (enclosed by Zhonghua Avenue, Tiyu Avenue, Heping Road, and Huai'an Road) contains numerous provincial and municipal administrative centers, cultural activity centers, transportation hubs, financial centers, commercial centers, medical centers, and commodity markets have been concentrated.

The high population density in this area has led to deteriorating environmental quality, traffic congestion, insufficient green space, and encroachment on land for community-level public service facilities. Yet, the new town clusters, have remained economically weak because the proximity of Xiong'an takes away financial support for construction. Construction in the new towns for public facilities such as sports centers, museums, libraries, and youth centers are progressing, but the development of office, commercial, and other business facilities has been slow.

The significant difference in development between the old city area and the Zhengding new town cluster is a typical reflection of the imbalanced development between the core and peripheral areas of Shijiazhuang. This imbalance is also directly reflected in the level of development and construction of the current TOD in Shijiazhuang.

A statistical analysis has shown that development along transit lines in Shijiazhuang is the highest along Line 1 (figure 5), and development around the core area stations is significantly greater than around stations in the peripheral areas. In particular, the concentration of essential functions around the peripheral rail stations is relatively low, with a lack of public service facilities such as hospitals and primary and middle schools. On the other hand, high-density areas in some core regions—including the north side of Xinhua District, the Luquan urban area, and the southeast side of Yuhua District—are without rail coverage. Overall, there is a disconnect between the transit-oriented development of the core area and the peripheral areas, leading to a severe urban-rural divide.

Figure 5: Composite Scores of Stations and Station Classification (Existing Stations in Developed Areas)



Source: China Academy of Urban Planning and Design, *Report on Platform Development and Evaluation of TOD Development Level in Shijiazhuang*, 2022.

Insufficient Job-Housing Coverage and Lack of Public Services

The relatively high level of development along rail corridors in the core area nonetheless contains significant deficiencies. Extensive and unplanned urbanization with little regard for social needs has resulted in a homogeneous spread of high-density development that lacks adequate public service facilities such as those for sports, healthcare, education, and cultural activities. Analysis of data gathered within 500 meters of existing rail stations shows that only 16 percent of the employed population in the catchment/service area and 8 percent of the housed population there are covered. According to *the 2020 National Commuting Monitoring Report* published by the China Academy of Urban Planning and Design, only 8 percent of the commuting population within 1 kilometer of rail stations opts to use rail transit services, which is low relative to other major cities nationwide.

3. City TOD Planning Strategies

The overall goal of the Shijiazhuang GEF-6 China TOD project is to create an interconnected transportation network that will address Shijiazhuang's internal and external transportation needs. The network will encompass the main urban area, new interfaces for future city-level rail connections, major functional areas, the new city clusters, and intercity railways. It will work with high-speed railways, expressways, national and provincial trunk roads, and other transportation modes to collectively build an efficient, convenient, internally connected, and externally linked transportation network.

At the regional scale, the Shijiazhuang GEF-6 China TOD project will initiate the construction of dedicated high-speed intercity railways between Shijiazhuang and other major cities within the metropolitan area. This will also connect a portion of small and medium-sized cities. The goal is to create a one-hour commuting circle within the Shijiazhuang metropolitan area with intercity railways as the backbone. In addition, the construction of the Shijiazhuang-Xiong'an intercity railway will link with the Beijing-Xiong'an intercity railway to establish efficient connectivity between

Shijiazhuang, Beijing, and Xiong'an.

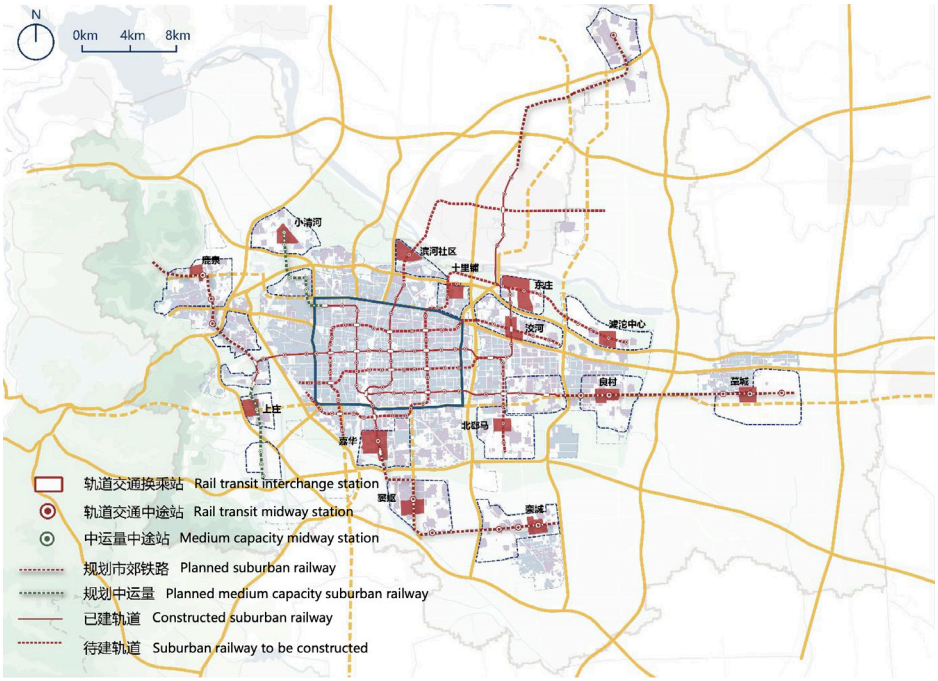
In the context of regional transportation development, the Shijiazhuang GEF-6 China TOD project actively conducts feasibility studies on urban rail construction within the city, promoting rail transit extension beyond the main urban area. For example, the construction of Phase 2 of Line 1 will connect the western and eastern parts of the old city, linking to the High-tech Zone and extending northward to the Zhengding cluster. Line 3, running in an east-west direction, will connect the main urban area with the Luquan cluster, while Line 4 will connect the main urban area with the Zhengding cluster in the future. New lines 5, and 6 will further tie city and suburbs together.

The Shijiazhuang GEF-6 China TOD project also designs rail-centered TOD to connect the vibrant central areas of the city with the land-rich suburban areas of the new towns. Appropriate policy and financing drive the integrated development of stations and towns, providing sustainable financial support for rail construction and operation. Similarly, by establishing connections for commuting, entertainment, and business between the city center and the periphery, the approach creates passenger flows to support rail development.

Constructing High-Quality TOD on the Outskirts of the Main Urban Area

Drawing from the experiences of Tokyo, Singapore, and Chengdu, the Shijiazhuang GEF-6 China TOD project augments the existing urban rail network with suburban railway routes to establish a radial pattern, creating 14 nodes on the periphery of the main urban area. These jobs-rich nodes make the new towns a "counter-magnetic center" closely connected to the city center through rail transit (figure 6).

Figure 6: Layout of Rail Transit Serving TOD New Towns



Source: China Urban Planning and Design Research Institute, 05-Outcome 5-1: *Shijiazhuang Rail Transit TOD Development Strategy and Connection Transportation Study*, 2022.

This approach guides the restructuring of urban functions and facilitates population decongestion within the Second Ring Road. The 14 nodes for the new towns will serve a housing population of 660,000. This implementation of TOD creates a land layout that is efficient, intensive, and diverse, with the rail transit stations as hubs. Beginning with the development of housing, the towns gradually achieve a balanced distribution of housing, commercial, business, park, and green space functions. The layout ensures a balance between jobs and housing areas, comprehensive public services, and pleasant living environments. Each with an average size of about 1 to 2 square kilometers, these new towns conform to the cluster structure determined in the *Shijiazhuang Territorial and Spatial Master Plan (2021–2035)*.

The Case of Jiahua New Town

The Shijiazhuang GEF-6 China TOD project is guided by the goal of creating net economic benefits. In the case of Jiahua and its rail station, the costs of rail construction and operation yielded an allocation of 31.8 hectares of land for integrated development. The allocation, which includes 472,000 square meters of housing space and 226,000 square meters of commercial and office space, creates an economic balance between housing sales and commercial leasing on one hand and the costs of rail construction and operation on the other.

The area surrounding the Jiahua station contains three concentric zones at distances of 100 meters, 400 meters, and 800 meters from the station. The closest zone focuses on commercial and business functions; the 400-meter zone emphasizes public services; the outer zone primarily consists of housing.

Gradients of development intensity also vary by concentric zone. The most intensive development is concentrated around the stations, with a focus on supplying jobs opportunities. Currently, the uses of land in Jiahua mainly consist of agriculture and forestry, industry, and logistics and warehousing. The land also includes a 28.3-hectare rolling-stock depot. To eliminate the fragmentation caused by the depot and improve land intensification, construction is carried out on top of the depot. The preliminary work for the building to be placed above the rail station has been completed (figure 7).

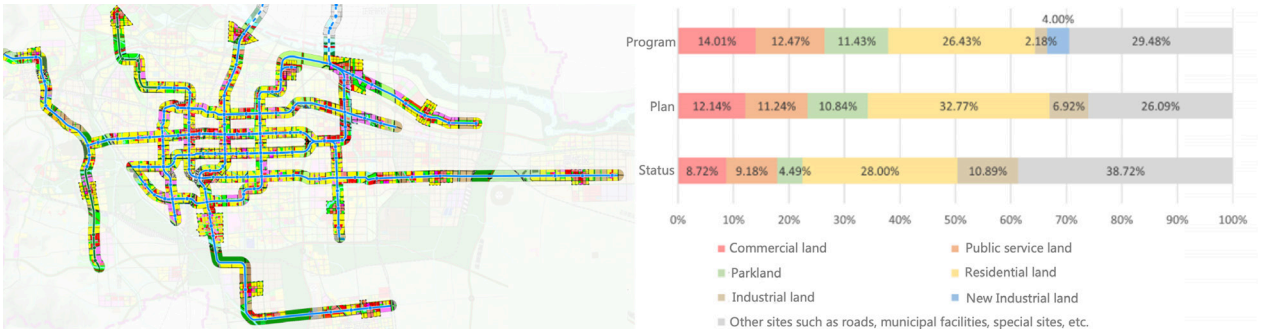
Figure 7: Current Situation of Overhead Development at Jiahua Depot

Source: Beijing Jiaotong University.

Restructuring the Layout of Land Use along Rail Lines

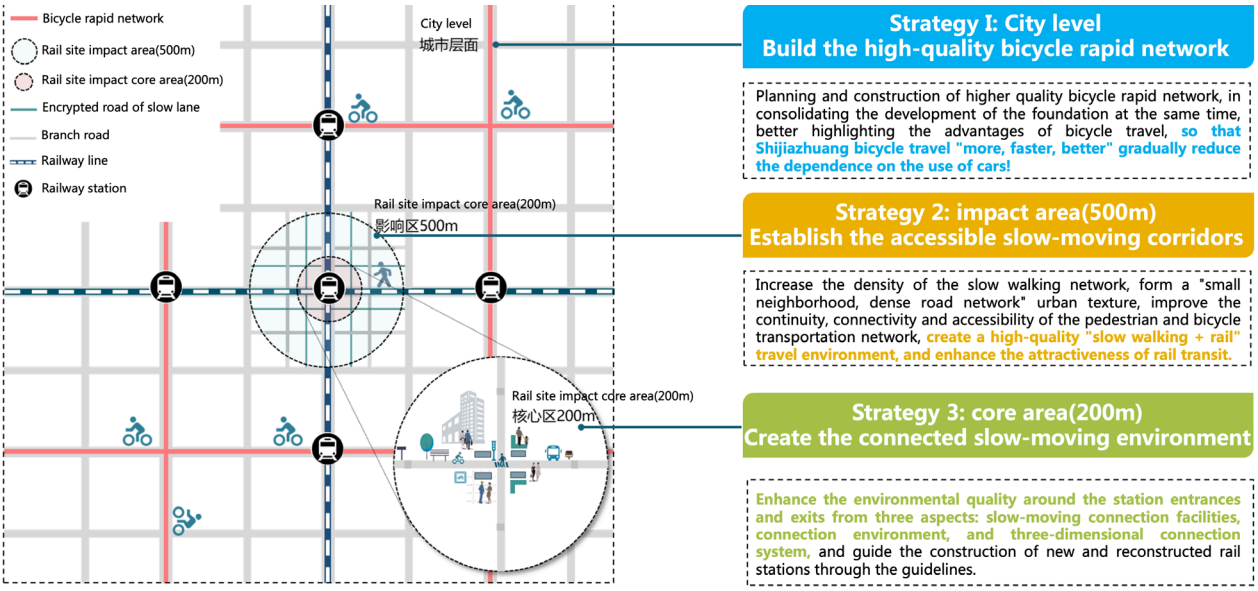
The Shijiazhuang GEF-6 China TOD project adjusts the land layout along a rail line by examining the land use and optimizing its configuration (figure 8). First, TOD optimizes the allocation of public service facilities along the line on the basis of linked trips ("trip chains") that combine errands. Inefficient uses of land are upgraded by concentrating administrative offices; commercial, business, and industrial facilities; and public services along the rail line. Second, the TOD plan for Shijiazhuang aims to concentrate 60 percent of jobs and housing within 800 meters of rail stations. Last, the plan reduces high-density, and homogeneous development and promotes diversified functions along the rail corridor.

Figure 8: Land Layout and Comparison along the Entire Rail Line



Source: China Urban Planning and Design Research Institute, 05-Outcome 5-1: *Shijiazhuang Rail Transit TOD Development Strategy and Intermodal Transport Study*, 2022.

Figure 9: Slow Mobility Facilities Planning around Rail Transit Stations



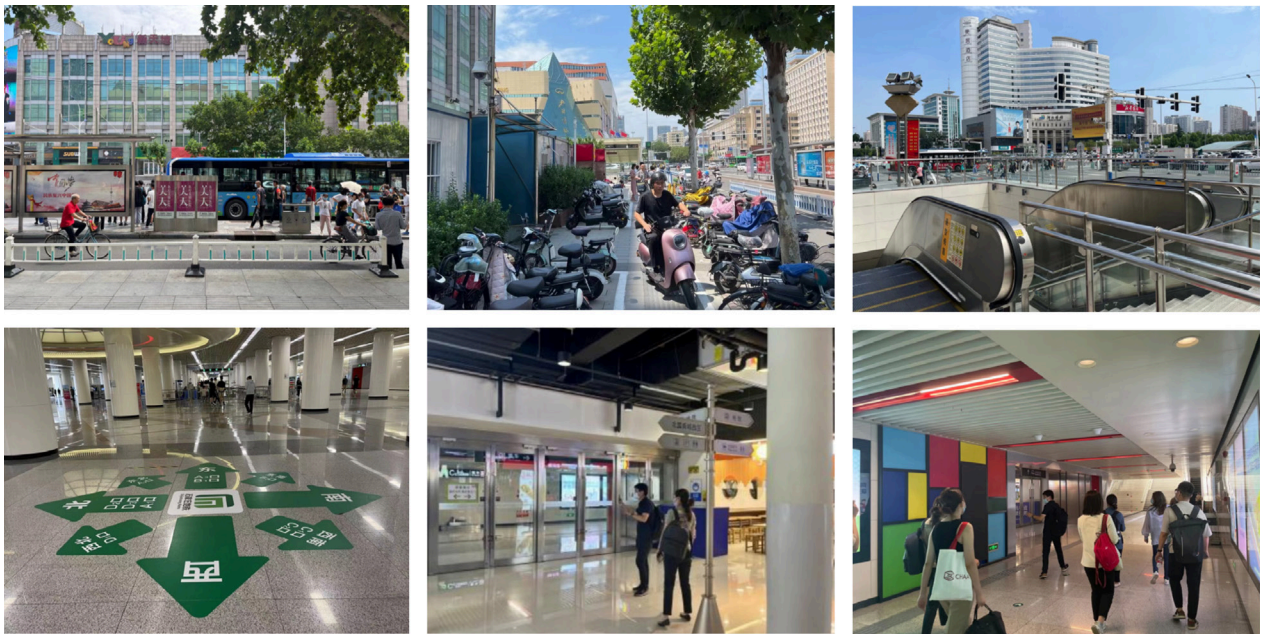
Source: China Urban Planning and Design Institute, Report 5-2: Study on Improving the Quality of Slow Mobility in Shijiazhuang, 2022.

Rail Transit and Slow Mobility

Given the extensive use of slow mobility in Shijiazhuang, its potential for growth, and its well-established connection with rail transit, the Shijiazhuang GEF-6 China TOD project aims to further integrate and co-build both modes. The project strives to create safe, continuous, accessible, and comfortable slow mobility districts around stations, establish a high-quality environment for cycling, and actively promote "Rail + Slow Mobility" as the integration of the two modes. The scale of integration varies by distance from a rail station (figure 9):

- At the city level, the broadest, a high-quality backbone bicycle network will provide reliable, convenient, and safe travel options for fast commuting, rail connections, and leisure fitness.
- Within 500 meters of stations, the project encourages the formation of "small blocks" and a dense road network. The length of supporting roads would increase by more than 90 kilometers, add 150 kilometers of dedicated slow lanes, and expand the open street network by about 70 kilometers. This expands the walkable range around stations, enhances the coverage and service level of stations for employment and housing purposes, and establishes a high-quality slow mobility network.
- Within 200 meters of rail stations, the project focuses on three conditions that together create a high-quality transfer environment for slow mobility: connection facilities, connection environments, and multilevel transfer systems. Particularly at centrally located stations with a concentration of commercial and office buildings, it encourages the integration of urban renewal and underground space development. This includes adding rail entrances/exits, forming a coordinated system of underground pedestrian walkways, ground-level public spaces, and elevated pedestrian corridors. The goal is to create a high-quality pedestrian street district with multidirectional connections (figure 10).

Figure 10: Slow-Traffic Facilities around North Country Mall Station



Source: Beijing Jiaotong University.

SHIJIAZHUANG

Part 2: TOD Strategy at the Corridor Level

Transportation corridors under the TOD development model tightly couple public transportation with land use. Shijiazhuang's Metro Line 4 will connect the old city area with the eastern industrial new zone, passing through multiple functional areas and important nodes. Its construction, which began in 2022, serves as an opportunity for revitalizing and renovating the old city while also driving the development of new areas. Guided by the development direction and planning strategies of TOD at the city level, the Shijiazhuang GEF-6 China TOD project has selected Shijiazhuang Metro Line 4 for research and planning at the corridor level to maximize the potential of Line 4 to support the development strategies for Shijiazhuang. It will be particularly important for the implementation of river-oriented development within the Second Ring Road and multiplication outside the Second Ring Road.

The Shijiazhuang GEF-6 China TOD project has analyzed the current issues in urban construction along Line 4 and makes specific proposals to address the still-fragmented development between the old city and new areas, improve the efficiency of construction, improve the colocation of jobs and housing and public services, enhance market performance, optimize water and green resources, and improve connectivity along the rail line. The proposals include differentiated development along the corridor, balancing the investment returns through the model of Rail + Property, promoting environmental benefits through TOD + EOD (Transit-Oriented Development + Environment-Oriented Development), and comprehensive integration design for connectivity.

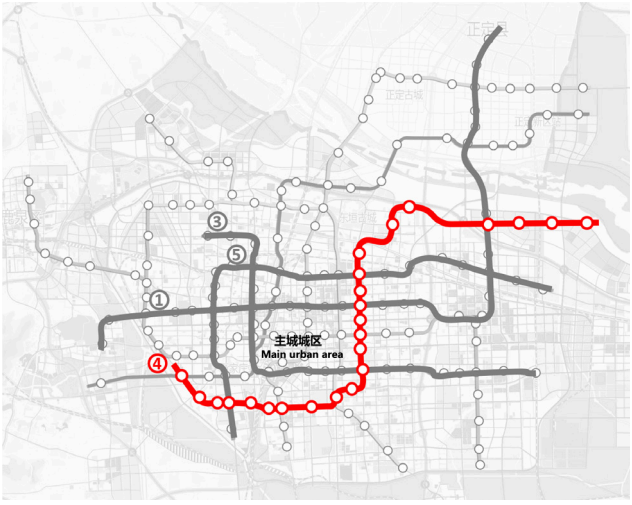
These strategies will ensure that the construction of Line 4 will yield a vibrant eastern new city outside the Second Ring Road and optimally renovated old city inside the Second Ring Road, promote the coordinated development of the old and new areas, and significantly enhance the urban functions and multiple benefits along the rail line.

1. Overview of Metro Line 4

Shijiazhuang Metro Line 4 began construction in early 2022 and is expected to be operational by the end of 2026. The line has 19 stations and spans approximately 22.4 kilometers between Yucun South Road and Gaoyingqiao West (figure 11). Line 4 has six interchange stations that provide direct connections to railways and highways and facilitate regional transportation. Line 4 and Line 5 are planned to form a loop in the city center, helping to alleviate traffic congestion within the city. Line 4 passes through the main urban area and will traverse different functional zones from southwest to northeast, including the higher education district, the Wanda commercial area, the northeast cultural and industrial area, the Dongyuan ancient city, the international trade zone, the innovation and entrepreneurship center, and the sports and entertainment district.

Shijiazhuang Line 4 connects important nodes in the city and can play a significant role in improving the urban spatial structure. On one hand, it can effectively promote the "subtraction" of the old city: The construction of Line 4 in the old city is an opportunity for urban renewal, supporting emerging business activities while helping relocate warehousing and wholesale businesses. On the other hand, it effectively contributes to the "multiplication" in the eastern industrial area, driving the development of the peripheral areas of the city. It will connect the biopharmaceutical base, technology innovation center, and producer services industries.[3] Doing so will guide industrial agglomeration, promote interaction between production and research, enhance the functions of life services, and achieve a balance between work and housing areas.

Figure 11: Shijiazhuang Metro Line 4



Source: Beijing Municipal Institute of Municipal Engineering Design and Research and Shenzhen Peking University Planning and Design Research Center, *Task 4 - Comprehensive Development Research on the Along-Line Area and Stations*, 2022.

3 Producer services primarily consist of transportation, logistics, banking and insurance, research and development, industrial design, management consulting, business services, human resource services, testing and certification, and legal services.

2. Challenges of TOD in the Line 4 Corridor

The Eastern Industrial New Area of Shijiazhuang represents an important opportunity for urban-rural integration. However, the current situation is characterized by slow and haphazard development and lacks spatial synergy with the old city. The main reason is the lack of rail connections, preventing the smooth relocation of economic activities from the old city to the new area. Although Line 4 is currently under construction, prominent issues remain to be resolved concerning land use and functional layout along the corridor. In the old city, the distribution of land use around the stations requires improved integration. At the same time, the eastern extension section has been planned for a significant number of innovative and creative industries but needs more adequate public service facilities and amenities to attract the population relocating from the old city.

Structural Adjustment: Changing Inefficient Development along Line 4

The current uses of the land along Line 4 are mainly for housing and industry, with insufficient public service facilities and a significant amount of undeveloped land, especially in the areas outside the second ring road where urban development still needs to be completed. Within 500 meters of Line 4 stations, housing accounts for 29 percent of land use, followed by industry, at about 15 percent. A significant proportion—more than 20 percent—is inefficient use such as nondevelopment land, village settlements, and warehousing and logistics (table 1). Unless corrected, the high proportion of inefficient uses along Line 4 will result in dispersal of much new housing and jobs beyond the service range of the rail stations, thereby degrading the living environments of residents along the corridor and suppressing rail passenger volume.

Table 1: Land-Use Balance around Stations along Line 4

Land-Use Type		500-Meter Radius (Square Meters)	Percentage of Land Use within 500 meters
Development land	Administration and public services	1,727,255	12.3
	Commercial and business facilities	1,537,663	10.9
	Railway	81,634	0.6
	Road, street, and transportation	221,191	1.6
	Residential	409,1910	29.0
	Industrial, manufacturing	216,3661	15.4
	Municipal, utilities	189,094	1.3
	Logistics and warehouse	598,745	4.2
	Green space and station plazas	1,127,720	8.0
	Villages and urban villages	720,213	5.0
Nondevelopment land		1,715,424	12.2
Total		**14,092,877**	**100.00**

Source: Beijing Municipal Engineering Design and Research Institute and Shenzhen PKU Planning and Design Institute, *Comprehensive Development Study of Corridor Areas and Stations*, 2022

Ecological Upgrading: Reorganizing Blue-Green Resources along Line 4

Line 4 has abundant water and green resources along its route, but they are not interconnected enough to form a comprehensive system. A peripheral water system has been established in Shijiazhuang, but the connection with internal rivers and channels, such as Minxin River and Mingqu, still needs to be completed. Also, the water bodies along Line 4 are mostly rigid channels, which reduces their ecological value. As for green space along the line, its quantity, variety, and scale must be increased to enhance its appeal—for example, the current green belts along the water channels are relatively monotonous. The distribution of parks along the line is scattered, and most of them, apart from Century Park, need more facilities if they are to form well-integrated ecological-landscape-leisure nodes.

Transportation Accessibility: Improving the Connection Capacity along Line 4

In terms of passenger flow during peak hours, the modes of transportation for connecting to Line 4 stations (given current usage in Shijiazhuang) would be, from most used to least, walking (53 percent), bus (24 percent), nonmotorized vehicles (21 percent), and taxis/private cars (2 percent). At 3.2 km/km^2, the average road network density within 500 meters of the stations is relatively low, which affects the walkability of the stations. Within the second ring road, slow-mobility facilities are relatively sufficient, including dedicated bicycle lanes and pedestrian paths; but outside the second ring road, road facilities are inadequate, and the slow-mobility system is incomplete. A total of 79 bus routes cross Line 4, with seven bus routes overlapping with the rail line for more than three stations, but these are concentrated in the middle section. In general, the low concentration of connecting transportation at each end of Line 4 creates complex connectivity issues.

3. Corridor TOD Planning Strategies for Line 4

Line 4 connects the old city area with the new eastern area, strengthening the link between them, enhancing urban quality, promoting industrial collaboration, attracting talent mobility, and driving overall urban development. The GEF6-TOD project in Shijiazhuang divides the areas along Line 4 into seven functional zones that are intended to guide the spatial layout of distinctive industries (figure 12, panel a). From west to east, these zones, with their primary functions, are as follows:

1. Ecological Living Zone (housing and leisure commercial functions)
2. Education and Research Zone (education and housing functions)
3. Headquarters Research and Development Zone (headquarters base, scientific research and development, and education functions)
4. Ecological Leisure Zone (medical, education, housing, and leisure functions)
5. Vibrant Development Zone (on commercial, trade logistics, and housing functions)
6. Cultural and Leisure Zone (cultural creativity, tourism, and housing functions)
7. Emerging Industries Zone (scientific research and productive service functions)

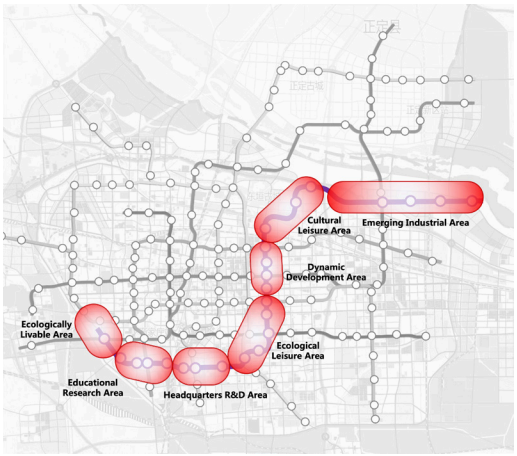
Specialized zones will create a balanced and diversified development pattern along the Line 4 corridor. The GEF6-TOD project in Shijiazhuang also aims to optimize and adjust the land layout of public facilities along the line to enhance the quality of urban life and improve the overall development of the city.

In the old city area, the project applies the principle of "subtracting within the second ring road," which involves vacating inefficient land and optimizing industrial, logistics, storage, agricultural, and forestry land in the main urban area. Simultaneously, the plan aims to increase the availability of public service facilities within 500 meters of the stations.

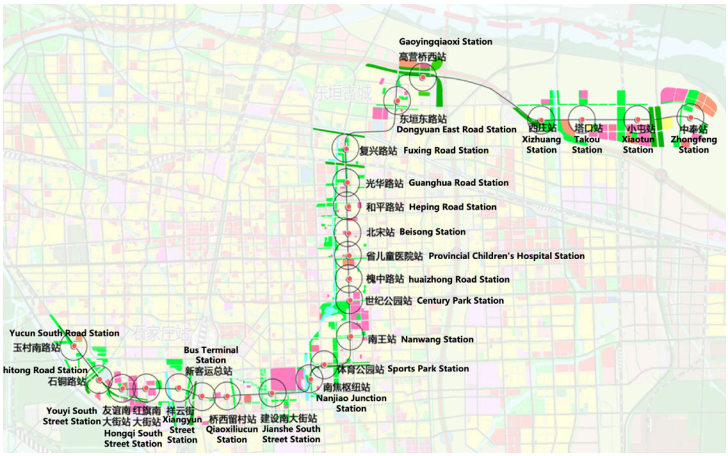
The plan follows the principle of "multiplying beyond the second ring road" in the eastern extension area. Existing facilities that are difficult to demolish are retained, with adjustments to areas with inefficient layouts, and housing is added. The areas surrounding the stations are planned to accommodate public service facilities, as well as productive service industries and innovative industrial land. This dual approach of accommodating both jobs and housing needs aims to facilitate the population redistribution from the main urban area (figure 12, panel b).

Figure 12: Planning Strategies for Line 4

a. Functional areas



b. Optimization of public facilities layout

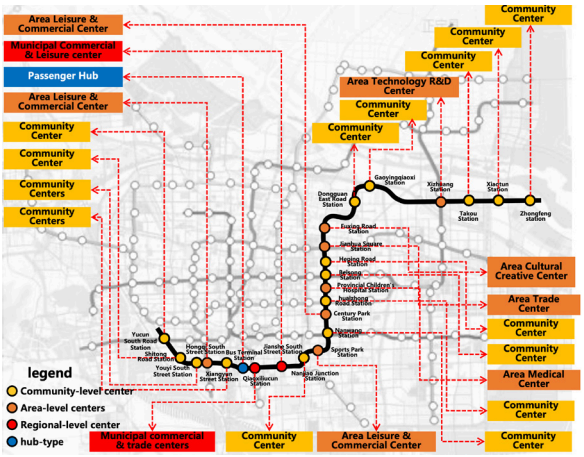


Source: Beijing Municipal Institute of Civil Engineering and Architecture Research and Shenzhen Beijing University Planning and Design Research Center Consortium, *Task 6 - Research on Public Space and Urban Quality Improvement*, 2023.

Differential Development along the Line, Optimizing Resource Allocation

TOD along Line 4 will promote the integration of transportation, space, and industry, and create heterogeneous developments at stations along the line. Different functions, intensities, and densities are arranged to form an "ecosystem" with a balance between work and living (figure 13). Surrounding each station is a core area, then a "direct influence" area, and, farther out, a "secondary influence" area, with different dominant functions assigned accordingly. This layering optimizes resource allocation around the stations, increases job opportunities, and balances the relationship between work and living spaces. One hub station on Line 4 is established in conjunction with the Shijiazhuang High-speed Railway Station. Two regional-level stations serve mixed-use areas. Seven district-level stations serve as general transfer points, forming housing and mixed-use areas with attractive landscapes. Areas around 14 community-level stations primarily focus on housing functions and basic commercial and public service facilities.

Figure 13: Classification of Station Levels along Line 4



Source: Beijing Municipal Institute of Urban Planning and Design and Shenzhen Beijing University Planning and Design Research Center, Task 4 - *Joint research report on comprehensive development of areas and stations along Metro Line 4*, 2022.

Operation and Maintenance of "Rail + Property" to Balance Investment Returns

A sustainable balance of investment returns for Line 4 will be gradually realized through application of the "Rail + Property" model in Hong Kong. The city, residents, developers, and rail companies will benefit from a policy and mechanism designed to channel the gains that Line 4 confers on land and property values back into rail construction and operation. Specifically, the plan includes 19 stations along the line, with a total track length of 22.4 kilometers. The estimated total construction cost of Line 4 is approximately CNY 25 billion, and the annual operating cost of the line is CNY 186 million. The total land area used for TOD comprehensive development of housing is about 171 hectares, with a total residential floor area of about 4 million square meters. About 38.5 hectares is devoted to commercial development. The total retail floor area will be about 2.5 million square meters, of which about 13 percent will be leased and the rest for sale. The expected housing development profit is CNY 6.1 billion, which accounts for about 40 percent of the CNY 15 billion construction investment; and the self-owned commercial profit is CNY 238 million per year.

TOD + EOD Synergy for Environmental Benefits

The eastern extension of Line 4 is in the Hutuo River area, and it requires the implementation of the river-oriented development concept. The Shijiazhuang GEF-6 TOD plan for the eastern extension draws inspiration from Chengdu's TOD + EOD concept. TOD represents the coordinated development of transportation, space, and industry with a people-centered approach, and EOD (Environment-Oriented Development) is based on ecological protection and environmental governance. In the eastern extension, TOD + EOD incorporates more residential housing functions. It also gathers productive service industries around the stations and intersperses green space to create a harmonious, blue-green landscape with the Hutuo River. This approach will contribute to Shijiazhuang's goal of constructing a garden city.

Integrated Interconnection Design to Improve Transportation Efficiency

The stations along Line 4 are divided into four types: two urban transportation hub stations, seven rail transfer stations, 13 nontransfer rail stations, and two rail terminal stations. Each type has specific requirements for interconnectivity with other transportation modes.

All the stations will connect with conventional buses, taxis, private cars, nonmotorized vehicles, and pedestrians. The transfer stations and hubs will need to accommodate sudden surges in passenger flow. And the hubs must also serve connections with railways and long-distance buses.

Walking Connectivity

The pedestrian system along Metro Line 4 suffers from inconsistent progress in its construction, inadequate accessibility, and poor quality of the pedestrian environment. The TOD plan aims to correct those problems by building a well-connected and comfortable pedestrian network, including well-planned parking facilities. Public spaces will be expanded in the old city and built up in the new peripheral areas.

Pedestrian connectivity with the subway will mainly be achieved through station squares—plazas in front of the stations—and with pedestrian crossings. Station squares serve as the basic interchange for all modes of connectivity. Pedestrian crossings can include crosswalks, pedestrian bridges, and underground passages. The designs will vary according to the nature of the land use and transit use surrounding each station. For example, within 500 meters of the Nanwang, Huaizhong Road, and Heping Road stations, the width of pedestrian walkways should be at least 2.5 meters, whereas for the rest of the stations, the width should be at least 2 meters.

Bus Connectivity

With land adjustments and development, the bus supply should be gradually increased to serve the passenger flow of Line 4. However, so that buses can contribute to the overall efficiency of the public transportation system, the relative positioning of buses and railways in different areas must be carefully executed to reduce route duplication and leverage the respective strengths of the two modes. First, the feeder bus routes to the remote end of Line 4 need to be increased.

Second, existing bus routes such as 65, 73, 89, 90, 290, and Sightseeing Route 1 need to be altered to reduce overlap with Line 4 and instead intersect perpendicularly to it. Route 57, which largely parallels Line 4, should be moved to East Second Ring Road, becoming another north-south trunk route to alleviate passenger pressure on Line 4. Finally, the bus routes connecting to cluster stations can be adjusted to intersect with the rail loop, which will involve more feeder bus routes and create larger bus capacity.

Bus terminals are set at rail stations with high traffic volumes. The stations at Yucun South Road, New Passenger Transportation Hub, Xiangyun Street, and Nanjiao Hub have bus connection flows exceeding 1,000 passengers per hour (the Nanjiao Hub is already equipped with a bus terminal station). Bus stops, designed as bay platforms, are placed at the rail stations with lower flow. The North Song, Provincial Children's Hospital, and Gaoyingqiao West stations have two platforms, while bus stops at the rest of the stations have one platform.

Nonmotorized Vehicle Connectivity

Nonmotorized vehicle connectivity is primarily achieved through dedicated bicycle lanes and parking facilities. Within 500 meters of stations, the width of bicycle lanes on main roads, secondary roads, and side roads should be at least 2.5 meters. The width of unidirectional bicycle lanes should be at least 2.5 meters, and that of bidirectional lanes should be at least 3 meters.

Nonmotorized vehicle parking facilities include parking spaces and parking lots. For rail stations with fewer connecting vehicles, flexible arrangements can be made to use spaces under tree pits, elevated pedestrian crossings, and other suitable locations. A vertical design can serve stations with limited land area but high parking demand. Bicycle parking facilities at rail stations can be connected to nearby buildings via pedestrian walkways.

Taxi/Private Vehicle Connectivity

The relatively low use of taxis and private vehicles to connect to Line 4 means that, for many stations, a single bay-style pick-up and drop-off areas can be set up without the need to establish park-and-ride or dedicated taxi facilities. Busier stations with two pick-up and drop-off spots include Yucun South Road, Hongqi South Street, Xiangyun Street, New Passenger Transportation Center, Nanjiao Hub, Beisong, and Dongheng East Road.


SHIJIAZHUANG

Part 3: TOD Strategy at the Station Level

After determining the TOD planning requirements at the city and corridor levels, the Shijiazhuang GEF6-TOD project delved into the potential for development at the station level. TOD station area planning focuses on developing an integrated spatial pattern for industry, housing, leisure, and tourism; constructing ecologically resilient spaces that blend blue and green elements; designing three-dimensional mixed-use urban spaces; and organizing comprehensive transportation combining both fast and slow modes.

The station-level research for Shijiazhuang focused on four stations currently under construction along Metro Line 1 in the area north of Shijiazhuang East Railway Station (a station on the Shijiazhuang – Jinan High Speed Railway). This stretch of Line 1 serves as a crucial node for connecting the old city with the Zhengding New City and for promoting urban development along the Hutuo River. The area served by the four Line 1 stations currently faces various challenges, such as limited development and construction, weak infrastructure, monotonous living environment, and risks of flooding along the river. But it possesses significant advantages for promoting regional transportation connections, innovative industrial development, and the integration of blue and green resources. The goal is that TOD of the four stations on Line 1 will become a model for all TOD station area development in Shijiazhuang.

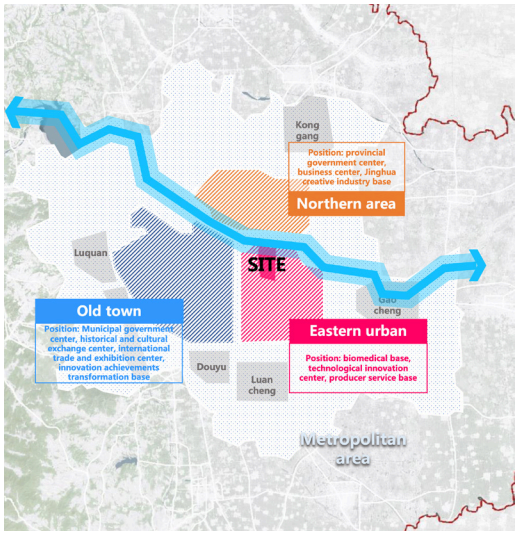
1. Overview of the Four-Station Area

Metro Line 1 serves as the east-west backbone of the Shijiazhuang subway system, primarily alleviating traffic congestion in the east-west direction of the city and guiding urban development. The four Line 1 metro stations chosen for the TOD station-level study— Dongzhuang, Xizhuang, Daohe Avenue, and Nancun—are north of the Shijiazhuang East Railway Station. The study area covers about 20 square kilometers and includes the northeastern junction of Phase 1 and Phase 2 of Metro Line 1, which extends northward from the junction to the Hutuo River. The northern section of Phase 2 runs along Qinling Street and New City Street, connecting the High-tech Zone and Zhengding New City.

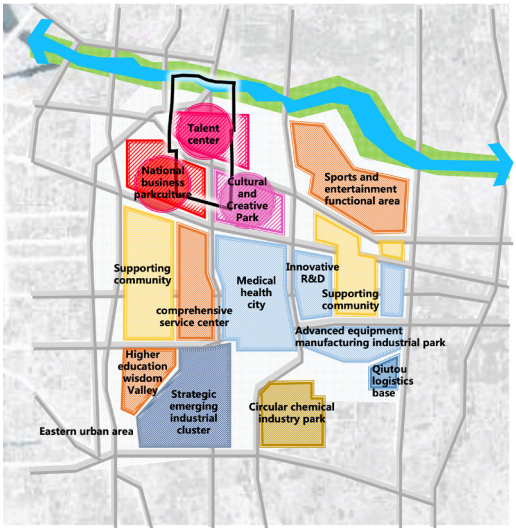
The area chosen for the TOD station-level study plays a strategic role in linking the main urban area of Shijiazhuang to Zhengding New City. It encompasses several villages and towns, including Dianshang, Xizhuangtun, Xitakou, Dongjiazhuang, Dongduzhuang, and Nancun. The study area includes the Heihu Mountain Temple, Dongzhaotong Memorial Hall, and Sanxiao Temple, which hold historical and cultural preservation value.

Figure 14: Industrial Positioning in Shijiazhuang

a. Overall development pattern



b. Functional clusters in the eastern urban area



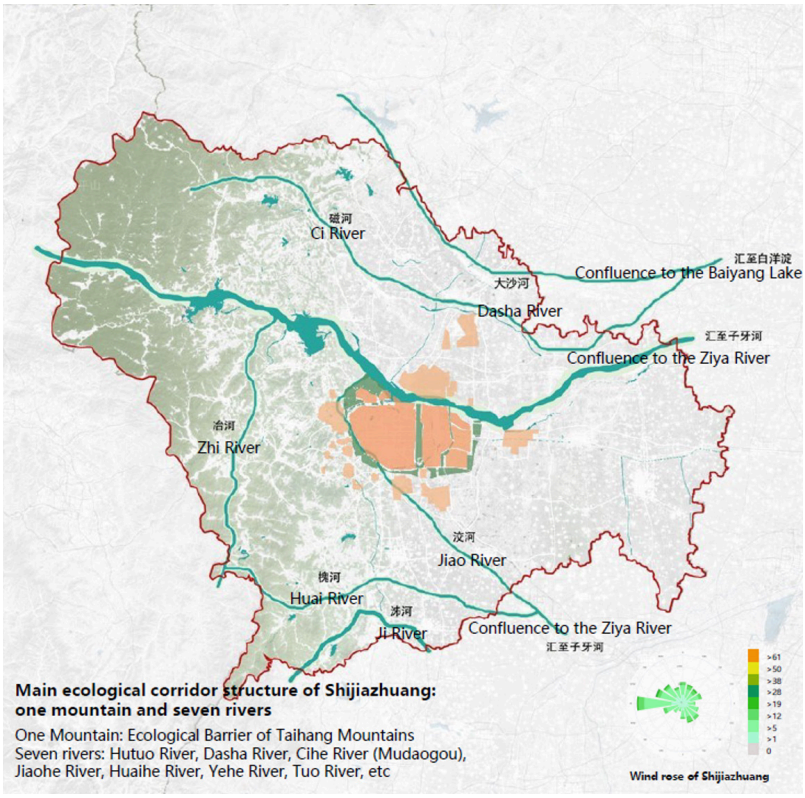
Source: Shenzhen General Comprehensive Transportation and Municipal Engineering Design Research Institute and Shenzhen Urban Planning and Design Institute, *Task 2 - Current Diagnosis and Assessment Research Report*, 2022.

Industrial Positioning: Innovation Center in the Eastern Urban Area

In the terminology of the national land-use plan, the main urban area of Shijiazhuang presents a cluster-based layout, which can be divided into the old city area, the eastern urban area, and the northern urban area. These three sections form the core space for the aggregation of urban functions (figure 14, panel a). The study area is in the central part of the eastern urban area, with Zhengding New City to the north and Shijiazhuang High-·tech Zone and Economic Development Zone to the south. Multiple highways radiate out from the study area. Within the study area, Line 1 connects the old city area and the Zhengding New City, serving as the core node for efficient linkage between the two.

The eastern urban area, positioned as a technological innovation center for productive service industries and biopharmaceuticals, is highly developed and has significant advantages as an industrial location. The Shijiazhuang International Trade City has taken initial shape to the west, and to the north is the Hutuo River Natural Ecological Scenic Area. The Shijiazhuang East Railway Station, on the south side, serves both external railway transportation and internal metro transportation, effectively relieving passenger flow. The comprehensive advantages of industry, transportation, services, and landscape provide the study area with great potential for coordinated development in the future, including becoming an innovation center, cultural and creative hub, and international trade hub (figure 14, panel b).

Figure 15: Distribution of Major Ecological Landscapes in Shijiazhuang City



Source: Shenzhen General Institute of Comprehensive Transportation and Municipal Engineering Design Research and Shenzhen Urban Planning and Design Research Institute, *Task 2 - Current Situation Diagnosis and Evaluation Research Report*, 2022.

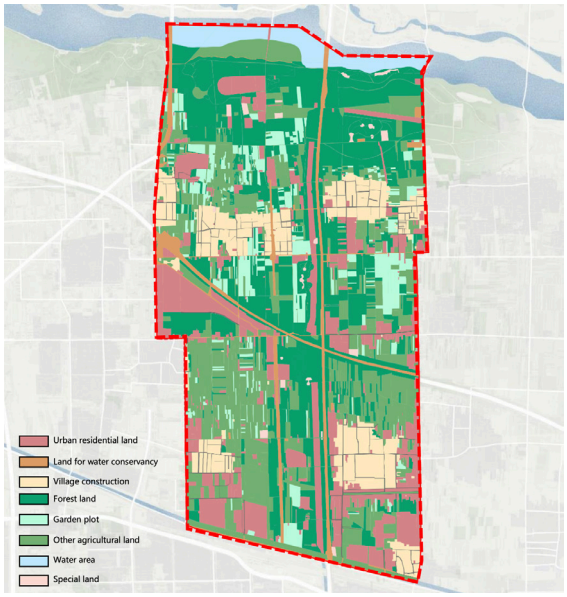
Ecological Landscape: Core Node with Blue-Green Integration

The Taihang Mountains border Shijiazhuang to the west, and the Hutuo River flows through the city. The city is surrounded by a green belt primarily composed of forests and farmland, and several green corridors connect the north and south along the Hutuo River (figure 15). In 2017, Shijiazhuang officially approved the *Hutuo River Ecological Restoration Project and Comprehensive Improvement Plan for the Surrounding Areas*, which integrates regional cultural characteristics along the Hutuo River to create themed landscape parks. The study area is located between the urban green corridors on the southern bank of the Hutuo River, in the eastern part of the main urban area. The river channel is approximately 80 meters wide. It connects southward to the Shijin Main Canal, with various landscapes such as flower fields, grasslands, and forests on the northern side, offering superior ecological and scenic resources.

2. Challenges of TOD in the Four-Station Area

The area's current state is characterized as a preliminary urbanization zone, primarily consisting of rural and agricultural land. The land-use types are monotonous, and the efficiency of land utilization is low (figure 16). The area includes several villages with poor living environments, which hinder industrial development. According to the data from the land survey (table 2), the total land area is 19.5 square kilometers, with forestland, orchards, and other agricultural land accounting for about 51 percent of the total land, and urban construction land accounting for about 19 percent. Within 500 meters of each of the four Line 1 stations, most of the land remains farmland and forestland, with only a few scattered industrial and storage buildings. Large commercial buildings within the vicinity of Nancun Station are currently vacant.

Figure 16: Current Land Use in the Area



Source: Shenzhen General Institute of Comprehensive Transportation and Municipal Engineering Design and Shenzhen Urban Planning and Design Research Institute, *Task 2 - Current Status Diagnosis and Evaluation Research Report*, 2022.

Table 2: Land Types and Their Proportions in the Four-Station Area

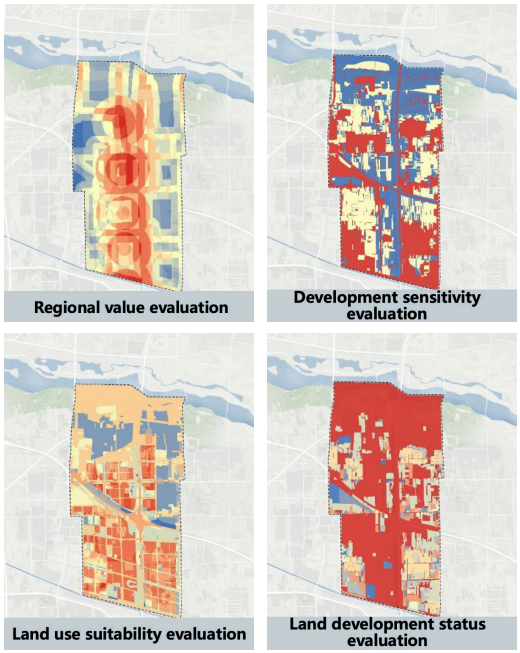
Land Type	Area (km^2)	Percentage
Urban Construction Land	3.7	18.8
Transportation and Water Conservancy Land	2.4	12.4
Forestland	6.4	32.9
Orchards	2.1	10.7
Other Agricultural Land	1.4	7.1
Village Construction Land	2.1	10.7
Water Areas	1.3	6.9
Special Use Land	0.1	0.6
Total	**19.5**	**100.0**

Note: Based on land survey data.

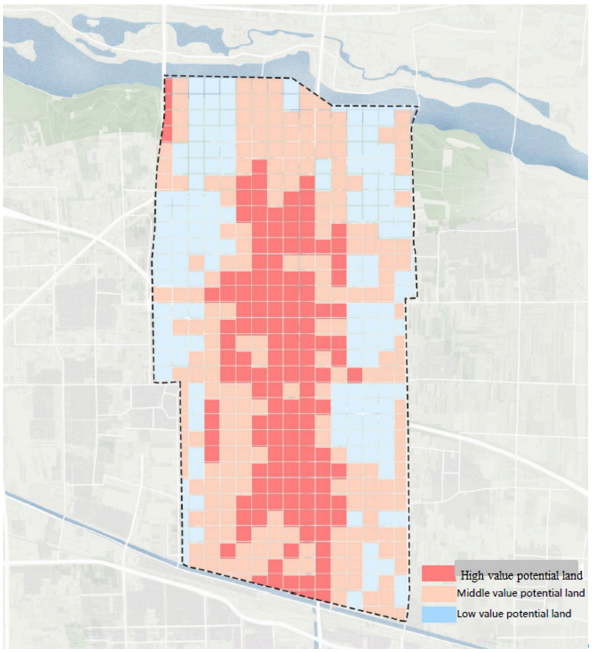
The GEF-6 China TOD project station-level study selected four evaluation factors: location value, development sensitivity, land suitability, and land development status (figure 17, panel a). It also considered 13 indicator elements such as land use, floor area ratio, building density, building quality, distance to rail transit stations, and distance to water bodies and green spaces. Based on these factors, high, medium, and low development-potential zones within the project area were identified (figure 17, panel b). Overall, the high potential areas align with the locations of the Line 1 metro stations, and the development potential decreases gradually as the distance from each side of the line increases, which is in line with the expectations of TOD development.

Figure 17: Land-Use Evaluation

a. Evaluation factors



b. Zones of development potential

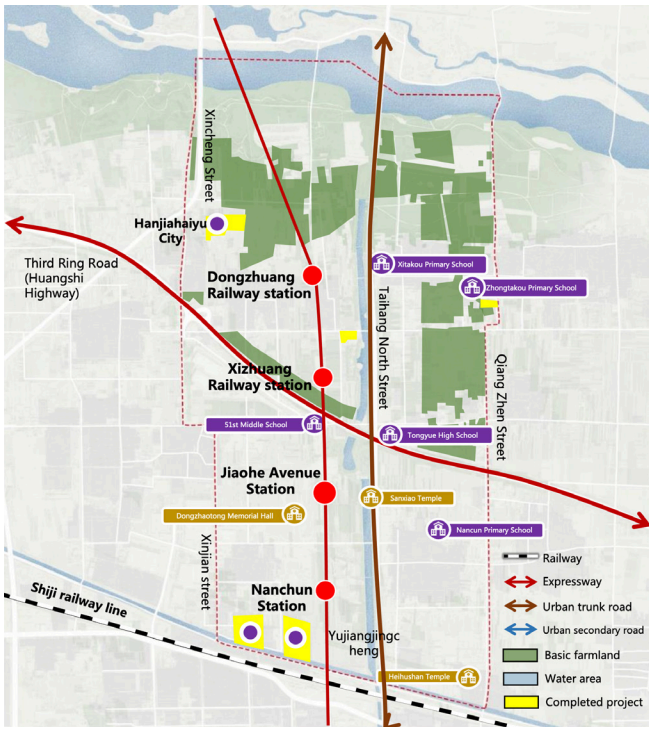


Source: Shenzhen Institute of Comprehensive Transportation and Municipal Engineering Design, Shenzhen; and Institute of Urban Planning and Design, Shenzhen, *Task 2 - Diagnosis and Evaluation Research Report*, 2022.

Infrastructure Still in Early Stage

Although the external road network framework of the area has started to take shape, and the regional transportation advantages are evident, and the local road network consists mainly of village roads (figure 18). Metro Line 1 has been completed and opened, but urban development along the line is still in need of development, and the integration of people, industry, city, and transportation has not been effectively achieved. The construction of the four metro stations is still underway along Qinling Street, and facilities such as pedestrian pathways and public transportation are lacking. Various infrastructure components are in urgent need of completion.

Figure 18: Current Status of Road Infrastructure in the Area



Source: Comprehensive Transportation and Municipal Engineering Design Research Institute and Urban Planning and Design Research Institute of Shenzhen, *Task 2 - Current Situation Diagnosis and Evaluation Research Report*, 2022.

Monotonous and Lackluster Living Environment

In contrast to the urban development of Zhengding New Town on the northern bank of the Hutuo River, the space within the area on the southern bank of the river is monotonous and lacks vitality. Currently, many buildings within the area are clustered village houses, scattered storage and industrial buildings along the roads, and a small-scale commercial street formed in the southeastern part of the study area in the Nancun community. Among them, village houses, commercial buildings, storage and industrial land are mostly one or two stories tall, while transportation facilities have four stories, and a few have six stories. Two residential buildings, Run Du Yu Garden and Yu Jiang Jing Cheng, are 33 stories tall. The housing complexes and transportation facilities have a floor-area ratio (FAR—the ratio of gross floor area to the total area of the lot on which the building sits) greater than 2, while the remaining village, industrial, commercial, and storage areas have higher site coverage ratio but a FAR lower than 1. Furthermore, there is a significant amount of agricultural land separating the Hutuo River Landscape Park from the urbanizable land.

Hazard Risks along the River

The terrain of the study area is flat, with an average slope of less than 5 degrees, making it mostly suitable for construction. However, the land along both banks of the Hutuo River is composed of alluvial deposits, which have loose soil structure and poor stability, making it prone to uneven ground subsidence.

3. Station Area TOD Planning Strategies

The study area has significant advantages in transportation, industry, and ecology. The transit-oriented development of these functions and features, along with housing and recreation, should yield a living environment of vitality, attractiveness, and efficiency.

Figure 19: Area Spatial Structure Planning

Source: Shenzhen Comprehensive Transportation and Municipal Engineering Design and Research Institute and Shenzhen Urban Planning and Design Research Institute, *Task 4 - Integrated Development Research: Results of the Area*, 2022.

The Shijiazhuang GEF-6 China TOD project aims to create a spatial structure of "One Axis, Two Belts, Four Clusters" within the study area (figure 19). One Axis refers to the TOD integration axis along Line 1. The Two Belts are the ecological landscape belt along the Hutuo River and the vibrant waterfront belt along the internal water system. The Four Clusters consist of the northwest scientific research and development cluster, the northeast science and technology service cluster, the southwest trade and service cluster, and the southeast cultural and creative cluster. The study area is divided into a northern and southern area by the east-west green corridor. The northern part is referred to as the "North Garden," focusing on scientific research and development, cultural tourism, and eco-housing functions. The southern part is referred to as the "South City," focusing on trade and service, cultural creativity, and quality housing functions.nd.

Designing Hierarchical TOD Living Circles

With the metro stations as the core, the Shijiazhuang GEF-6 China TOD project has created "living circles" consisting of four concentric bands progressively more distant from the stations in terms of travel time. The circles are Unit (5-minute walking range), Block (8-minute walking range), Community (20-minute walking range), and City (within 10 minutes by rail).

Within each of the living circles, the project establishes a green walking system combining leisure paths and elevated corridors. This creates pedestrian-friendly, open, and vibrant neighborhoods. The public spaces are age-friendly and connect with nature, providing residents with diverse leisure options. At the same time, relying on main roads and water systems, a central green valley is created, and multiple waterfront parks and neighborhood parks are incorporated into the functional layout. Public activity areas and circulation paths are designed to ensure that, in each circle, a park is reachable within a 5-minute walk.

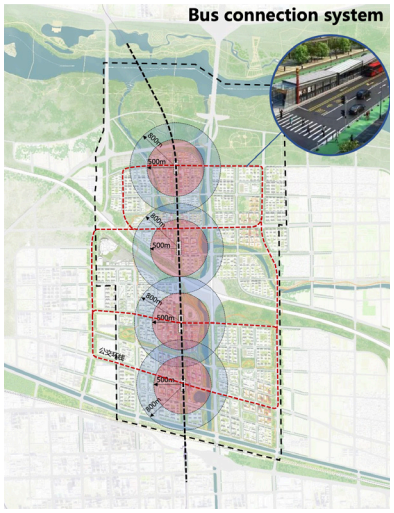
Building a Comprehensive Transportation System that Combines Fast and Slow Modes

Different levels of transportation-network density radiate from the four metro stations. Landmark buildings are set up around the subway stations to create a well-structured, intensive, and compact urban form. The design includes a compressed secondary road and branch road network with a density of 2.8 km/km² as part of a well-defined hierarchical transportation network. By improving accessibility and reducing travel time, a high-density road network can support the following objectives: first, expanding the construction of the bus transfer system (figure 20, panel a); second, supporting pedestrian and nonmotorized vehicle travel by increasing walking and nonmotorized road rights; and third, constructing underground entrances and exits for multiple plots to alleviate surface traffic pressure and jointly solve the last-mile problem of the subway.

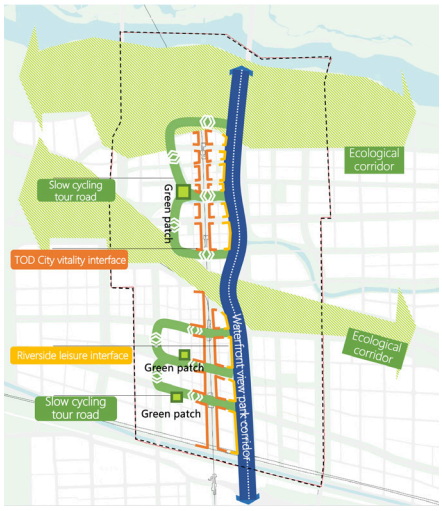
The combination of rail transit stations and slow transportation systems enhances the accessibility and service vitality of public facilities, providing convenient access to a variety of recreational activities and community living spaces for residents. A "main corridor + pocket" green slow travel scheme creates four pocket-shaped walking and cycling paths that connect waterfront landscape park corridors with the urban living interface (figure 20, panel b).

Figure 20: Plans for Fast and Slow Transportation Modes

a. Bus system



b. Pedestrian system



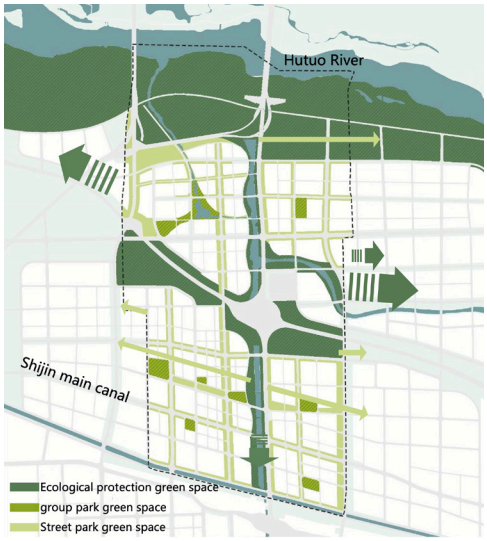
Source: Shenzhen General Institute of Transportation and Municipal Engineering Design and Research and Shenzhen Urban Planning and Design Research Institute, *Task 4 - Integrated Development Research: Results of the Area*, 2022.

Constructing an Environmentally Resilient City with a Blue-Green Interweaving

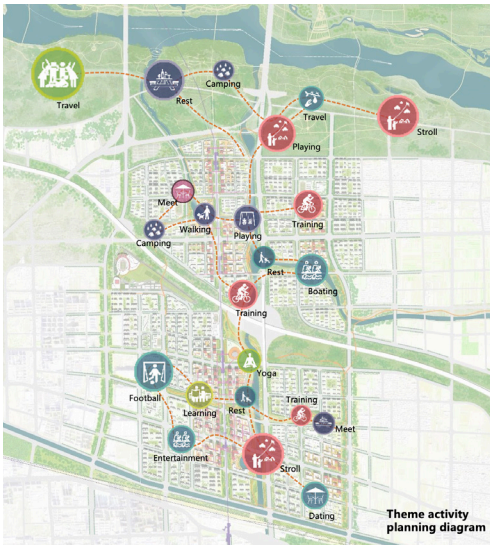
The project uses the Hu River green corridor and the protective green corridor of the Shihuang Expressway as the foundation for the growth of blue-green space outside the study area. Within the four-station area, the plan employs an array of protective green spaces (figure 21, panel a). It increases forest coverage and establishes ecological barriers on the edge of the urban area by promoting the development of protective forests and commercially viable forests along the banks of the Hutuo River. Making minor modifications to the terrain and setting up multilevel rainwater gardens in low-lying areas also promotes low-impact development. Introducing more varied vegetation and cultivating diverse forests helps improve the microclimate of the area. Other approaches include constructing a water-conserving corridor with the central green valley as the core and creating three-level landscape corridors, creating attractive ecological experiential spaces, actively developing eco-tourism and urban agricultural areas, and constructing ecologically oriented theme parks (figure 21, panel b).

Figure 21: Plans for Resilient Ecological Facilities

a. Green spaces



b. Activity planning



Source: Shenzhen General Institute of Comprehensive Transportation and Municipal Engineering Design Research Institute and Shenzhen Urban Planning and Design Research Institute, *Task 4 - Comprehensive Development Research: Results of the Project*, 2022.


SHIJIAZHUANG

Part 4: Summary of Achievements

Through benchmarking international TOD experiences and combining them with the characteristics and trends of Shijiazhuang's development, the Shijiazhuang GEF-6 China TOD project conducted an in-depth analysis of the development issues and potential at the city, corridor, and station levels in Shijiazhuang. Based on this analysis, TOD planning response strategies and relevant support measures were proposed to support the sustainable development goals of the Shijiazhuang Municipal Government. These strategies provide direction for sustainable future development. The technical achievements and unique experiences of the project are presented here by the summary team of Beijing Jiaotong University.

1. Unique Experiences

As a city on a plain, Shijiazhuang has historically followed a development pattern of expanding from a central area. Over time, the process has led to environmental problems and inefficient land use, which has hindered the continued expansion of the city. Therefore, the Shijiazhuang Municipal Government proposed a fundamental change in the city's spatial development framework to guide the improvement of urban functions. The initiative included establishing four new city clusters in the periphery of the main urban area, development along rivers, and the concept of "subtraction within the second ring road and multiplication outside the second ring road."

The Shijiazhuang GEF-6 China TOD project has identified TOD as a powerful means to implement these strategies. It combines the delineation of urban development boundaries with the coverage of the rail transit network to create new towns resembling a string of pearls. At the same time, the TOD project focused on the renewal and transformation of the areas around metro stations to optimize urban structure, enhance urban functions, and improve urban quality.

Specifically, to expand the urban framework outward, a radial structure was established on the basis of the existing rail transit network, forming hub nodes outside of the main urban area. To guide the renewal of the old city inward, low-efficiency land along the rail transit lines would be replaced, and the proportion of commercial and business areas, public services, parks, green spaces, and new industrial land along the lines would be increased. The goal is to concentrate 60 percent of jobs and housing functions within 800 meters of the rail stations. Ultimately, the vibrant core area of the city will be connected with the peripheral areas, meeting the commuting, entertainment, and business transportation needs of both. This ensures passenger flow for rail transit development and promotes synergistic industrial development, convenient talent mobility, and overall urban development and enhancement.

Reversing the Role of Rail Transit in Urban Development

Shijiazhuang needs to reverse the role of transportation in the development of the city, from being a result of that development to being its instrument. This means that rail and related transportation projects should be arranged ahead of urban development, guiding the future development of surrounding areas.

The TOD strategies are aimed at three geographic scales—city, corridor, and station. At the city scale, the layout of new towns coordinates rail construction and industrial development, thereby adjusting the urban spatial structure and optimizing the layout of industrial spaces. At the corridor scale, development along rail transit lines is aligned with the level and format of the stations, driving the sustainable development of the corridor in terms of economy, ecology, and society. At the station level, multiple spatial approaches, such as integrating blue and green elements, creating three-dimensional mixed-use spaces, combining fast and slow transit modes, and implementing zoning and gradation, are employed to construct TOD living circles.

Criteria for Defining Development Needs

The Shijiazhuang GEF-6 China TOD project not only focuses on achieving a balanced return on investment for rail transit in Shijiazhuang but also aims to increase social and environmental benefits along the rail lines through TOD, ensuring the vitality of the real estate market in the "post-real estate era."

First, to achieve a sustainable balance in rail transit investment returns, the project proposed comprehensive land development based on the rail transit system's construction and operation costs. Through policy and mechanism design, the integrated development of TOD and the station-city connection increases the value of land and property. The higher value in turn is used to support the construction and operation of the rail transit system, creating a win-win situation for the city, residents, developers, and rail transit companies.

Second, the project adjusted the land use and functional structure along the rail lines. It optimized the allocation of economic, social, and ecological resources to ensure economic benefits and significantly enhance social and environmental benefits. For example, the homogeneous development pattern is reversed by finely dividing the functional zones along the rail lines, classifying the scale of rail stations, and determining the radiation zones. The combination of zone, class, and layer factors guides the control of land use, development capacity, and spatial form. High-efficiency land for administrative offices, commercial activities, public services, and innovative industries is concentrated along the rail lines to achieve the goal of having 60 percent of jobs and housing functions concentrated within 800 meters of the rail stations.

Finally, the project established an indicator system for TOD environmental and social assessments safeguard social and environmental benefits. The system assesses the positive and negative impacts on the environment and society at all stages of developing station areas, from planning, to design, construction, and operation.

From Development Strategy to Spatial Design with "TOD + EOD"

As the "mother river" of Shijiazhuang, the Hutuo River possesses significant ecological and environmental resource advantages. Long-term ecological restoration and comprehensive improvement projects have formed a green corridor that integrates functions such as protection, sightseeing, leisure, fitness, and education. The urban development pattern of "embracing the river" in Shijiazhuang is a prerequisite for enhancing environmental benefits and creating simultaneous ecological benefits through the aggregation of TOD.

The Shijiazhuang GEF-6 China TOD project proposes the construction mode of transit-oriented and environmentally oriented development (TOD + EOD), which forms a multi-level transmission of tasks from the city level to the corridor level and then to the station level. At the city level, the strategic pattern of "embracing the river" is implemented, with the rail transit network extending toward the Hutuo River, and five out of the 14 TOD new towns are distributed along both banks of the Hutuo River.

Integrating rail transit development with the blue-green resource layout at the corridor level emphasizes ecological protection and environmental governance to create a garden city. At the station area level, theme parks and neighborhood parks are set up along the flow lines of public activity areas to put green landscapes and ecological experiences within a 5-minute walk of transit stations. The project also implements low-impact development to reduce and prevent rainwater floods, regulate microclimates, and promote low-carbon development.

"Rail + Slow Mobility"

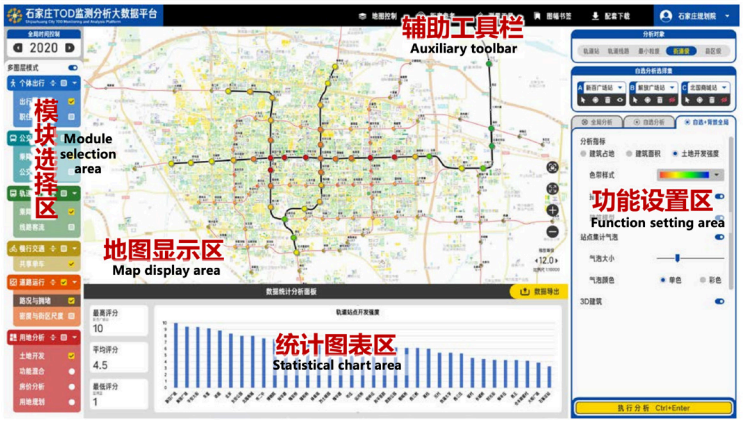
Shijiazhuang's relatively flat landscape provides excellent conditions for slow transportation modes (walking and cycling), and it does already have a high level of nonmotorized travel. The integration of slow mode transportation with rail transit will greatly improve the accessibility of rail transit stations in the "last mile," increasing rail passenger flow and coverage of jobs-housing areas, thereby significantly enhancing social benefits. However, rail transit stations in Shijiazhuang are marked by thin road networks and inadequate entrances, exits, and surrounding environments for slow modes of travel. The Shijiazhuang GEF-6 China TOD project focuses on promoting the simultaneous development of rail transit systems and slow mode systems, improving their connectivity in rail transit station areas, and thus creating more opportunities for green travel in Shijiazhuang.

At the city scale, the project proposes the construction of a high-quality bicycle network. Along the corridor, pocket-shaped cycling paths connect parks with urban living areas. At the station level, slow-mobility neighborhoods are established, introducing more secondary roads, bike lanes, and pedestrian pathways, and encouraging the opening of previously closed courtyards in certain areas.

Evaluation and Monitoring of TOD

Employing spatiotemporal big data and visualization simulation, the Shijiazhuang GEF-6 China TOD project has adopted a powerful tool to promote the integration of TOD and urban development in Shijiazhuang—a TOD evaluation and monitoring platform (figure 22) covering the entire city. The platform is a localized version of the national TOD platform developed by the Ministry of Housing and Urban-Rural Development (MoHURD) and directly connects to it.[4] While it has all the functionality of the national platform, the local platform aligns with the development characteristics of Shijiazhuang. Using artificial intelligence and big-data analysis, it dynamically monitors the level of the city's TOD, diagnoses current issues, and predicts future development directions.

Figure 22: Shijiazhuang City TOD Evaluation and Monitoring Platform



Source: China Academy of Urban Planning and Design, *Report 04: Platform Development and Shijiazhuang TOD Development Level Evaluation*, 2022.

Like the national platform, the Shijiazhuang platform has four main functions—data aggregation, monitoring, evaluation, and decision-making—plus national linkage.

- *The aggregated data* include rail infrastructure, fare collection, mobile signaling, buildings, POIs (points of interest), property prices, road network density, shared bicycles, buses, road conditions, and more.
- Continuous dynamic *monitoring* and timely updates of the data will be carried out in the future. *Evaluation* is performed with an indicator system including variables such as rail utilization, jobs-housing balance, land development, functional mix, living costs, connectivity convenience, and integration efficiency.
- Statistical analysis provides a scientific basis for planning and *decision-making*. For example, the project has calculated the future jobs-housing rate under different development scenarios for Metro Lines 4, 5, and 6, and made corresponding recommendations on the timing of construction. In addition, with the platform, the project determines the TOD development potential of rail transit stations, which supports subsequent planning and classification of station types more accurately.

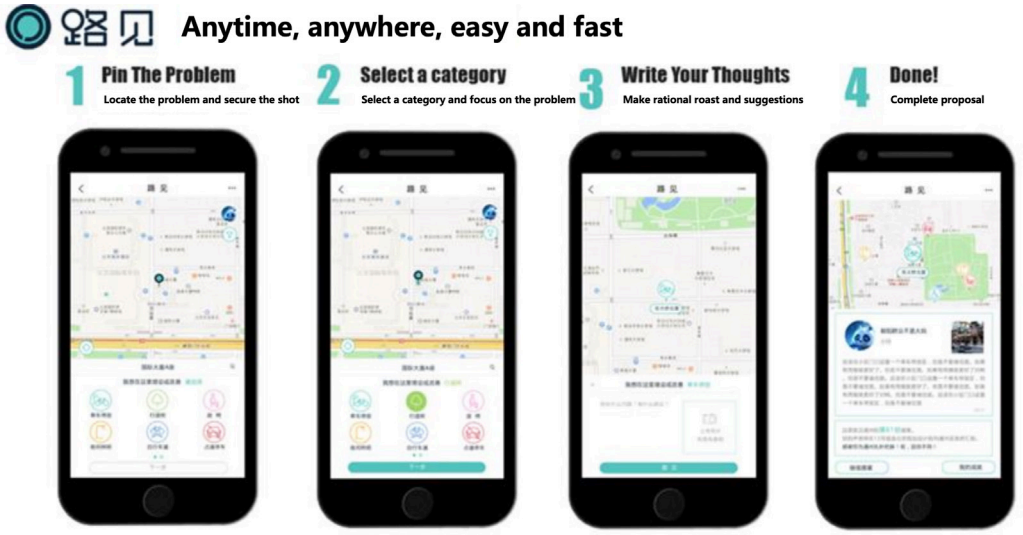
4 See GEF6 China Sustainable Cities Integrated Approach Pilot Project, *The National TOD Platform: Technical Summary Report.*

Interactive Environment for Public Participation

Testing ways of promoting TOD to stakeholders and the general public was an important function of the Shijiazhuang GEF-6 China TOD project. The project obtained public input through a survey application designed by the technical team for mobile devices (the "PinStreet" application); and the project used an "Internet Plus" approach to advocacy and public education via online promotion, offline advertising, and community visits. The combination of the mobile application and the Internet Plus program established a learning environment in which advocacy is informed by public participation.

The "PinStreet" program serves as a one-stop online public survey platform. It collects basic information about respondents, their use of transportation, plus TOD-related and slow-mobility information, all of which includes real-time data on the location of the respondent. Then, through open proposals, PinStreet gathers public demands and suggestions across 12 dimensions, including pedestrian environment, cycling environment, pedestrian crossings and traffic lights, motor vehicle encroachments, nonmotorized vehicle parking, subway systems, road potholes and water accumulation, greening and beautification, nighttime lighting, seating areas, accessibility facilities, and customization. These data help identify the main problems faced in rail travel from the general public's perspective (figure 23). To application includes a number of features to ensure user-friendliness and maintain data quality control.

Figure 23: Display of the Interactive Interface of "Roads as PinStreet" Miniprogram



Source: China Academy of Urban Planning and Design, *Report 01-Phase 1-1: Preliminary Report on World Bank TOD in Shijiazhuang*, 2022.

The Internet Plus strategy involved promotion—online information and advocacy, subway advertisements and promotions at key stations—as well as community visits for the further solicitation of proposals. The project's technical team also organized an "I Am a Planner" online activity, inviting the public to participate in visual design.

Currently, with the support of the Shijiazhuang Project Management Office, PinStreet has received more than 4,200 proposals from more than 3,800 people in five administrative districts and 18 subdistrcits of Shijiazhuang. Respondents included students, urban workers, farmers, and retired individuals. And through Internet Plus, the project has issued special reports on Shijiazhuang TOD through national and local media outlets such as *China Urban News*, *People's Daily Online*, *China Times*, and *Shijiazhuang Daily*, generating wide-ranging social impact (figure 24).

Figure 24: News Promotions of Shijiazhuang TOD Project

Source: China Academy of Urban Planning and Design, *02-Outcome 2-2: Institutionalized Strategy for Citizen Participation*, 2022.

The team from Beijing Jiaotong University conducted tracking surveys on the effectiveness of the PinStreet and Internet Plus methods. The team found that the public in general had gained awareness and acceptance of TOD concepts. Citizens felt that their concerns were effectively collected and considered in the project's technical outcomes and thus had confidence in the future development of TOD in Shijiazhuang.

For example, most citizens believed that TOD, through the coordinated development of metro, pedestrian, and motor vehicle transport, could facilitate travel for childcare, education, and training.

Many working professionals approved of the time-saving benefits of commuting by metro and supported the optimization of pedestrian and nonmotorized transport connections. They hoped to enjoy the convenience of walking, cycling, electric vehicles, and seamless integration with the bus network. Residents living in the outskirts of the city expressed their desire for nearby metro stations and hoped that the metro network would extend to more housing areas, with longer, broader, and interconnected routes.

Young people expressed their appreciation for the convenience and diverse activities brought by metro-based commercial complexes and looked forward to more integration between stations and commercial establishments, making life a seamless part of travel. Commuters and nonlocal residents believe that one-stop transfers and the diverse uses of interior spaces in high-speed rail stations have improved travel efficiency and overall quality of life.

Together, the PinStreet application and the "Internet Plus" approach allowed ordinary people to understand TOD while providing their own opinions and suggestions on urban construction issues along the rail line. By putting the project's technical achievements on a solid foundation of public opinion, the outreach contributed significantly to anchoring TOD to social benefits and generating public confidence in the future development of TOD in Shijiazhuang.

2. Future Improvements

Currently, all rail lines in Shijiazhuang are subway systems. TOD will accelerate development of urban (suburban) railways that connect with the subway systems in the central city. Improving the urban (suburban) rail transportation and its connecting road networks will drive the development of modern agriculture and leisure agriculture as well as lay a foundation for industrial and tourism service development. Furthermore, improving rail infrastructure and nearby public services will encourage rural residents to concentrate in the towns and communities along the rail lines and boost rail travel. Some important pathways to advancing TOD in Shijiazhuang are described below, including leveraging, through the internet, the cultural appeal of certain rail stations; improving the execution of TOD through better documentation of the city's TOD process; and investing to bolster the long-term viability of the city's platform for TOD information, data, monitoring, and assessment.

Activating the Internet Celebrity Economy

With the growing popularity of live streaming and innovative e-commerce formats, the nationwide "internet celebrity economy" has entered a fast lane of development. In Shijiazhuang, the emergence of "internet-famous subway stations" has generated significant economic value and positive urban vitality. The phenomenon can attract more passenger flow, promote the development of commercial and service industries along the rail lines, invigorate the real estate market, and become a new calling card for Shijiazhuang that reflects the city's economic vitality and potential.

For example, Beisong Station on Line 1 of the subway has become an internet sensation due to its cultural value (including the fact that the site was once home to the Beiyue Temple and a grand theater in the Song Dynasty). Large numbers of people come here to take photos, leading to spontaneous "subway time travel" costume shows that are showcased on the internet and social media platforms. Other subway stations along the Hutuo River and stations like Dongzhuang Station near the Hutuo Flower Sea are associated with their ecologically attractive environment and are likely to also become internet famous.

Improving the Guide to TOD Planning and Implementation

The Shijiazhuang GEF-6 China TOD project has created extensive documentation of the TOD plan and its processes. However, follow-up visits to administrative departments and the city's rail transit group indicated that a more comprehensive and refined TOD development work guide was needed. Such a guide should be based on the implementation of the *Shijiazhuang Rail Transit Construction Management Measures and the Implementation Measures for Comprehensive Development and Utilization of Land along Shijiazhuang Rail Transit Lines*. It will serve as a standard reference for government, other stakeholders, and the general public to participate in the formulation of TOD plans.

Investing in the TOD Evaluation and Monitoring Platform

The Shijiazhuang TOD evaluation and monitoring platform plays a crucial role in accurately understanding the status of Shijiazhuang's rail transit and in fashioning further development strategies. For example, the Shijiazhuang platform revealed the lingering issues in the placement of certain Shijiazhuang metro stations that degraded train speed and passenger flow. As Shijiazhuang's TOD continues, the TOD platform will be a key to assessing and managing new problems and new opportunities. Its continued ability to perform will require ongoing and strong organizational coordination as well as substantial investments in data acquisition, updates, and the maintenance of technical procedures.

3. Conclusion

Anchoring land-use planning to transit requires close coordination and continuous advancement in research, planning, and implementation at the city, corridor, and station levels to achieve the desired development outcomes. The implementation of urban-rail-based TOD in China, including the experiences of Shijiazhuang, will become an important aspect of theoretical and practical urban development efforts throughout the world.

Bibliography

Beijing Municipal Engineering Design and Research Institute and Shenzhen PKU-HKUST Urban China Research Center Joint Venture. 2022. *Comprehensive Development Study of Corridor Areas and Stations.* GEF Shijiazhuang Project Management Office.

Beijing Municipal Engineering Design and Research Institute and Shenzhen PKU-HKUST Urban China Research Center Joint Venture. 2022. *Public Space and Urban Quality Enhancement Study.* GEF Shijiazhuang Project Management Office.

China Academy of Urban Planning and Design. 2022. *Institutionalization Strategy for Citizen Participation.* GEF Shijiazhuang Project Management Office.

China Academy of Urban Planning and Design. 2022. *Platform Development and Evaluation of Shijiazhuang TOD Development Level.* GEF Shijiazhuang Project Management Office.

China Academy of Urban Planning and Design. 2022. *Shijiazhuang World Bank TOD Preliminary Report.* GEF Shijiazhuang Project Management Office.

China Academy of Urban Planning and Design. 2022. Study on Improvement of *Shijiazhuang Slow Traffic Quality.* GEF Shijiazhuang Project Management Office.

China Academy of Urban Planning and Design. 2022. *Urban TOD Strategy General Report.* GEF Shijiazhuang Project Management Office.

Shenzhen Comprehensive Transportation Planning and Design Institute and Shenzhen Urban Planning and Design Research Institute. 2022. *Current Diagnosis and Evaluation Research Report.* GEF Shijiazhuang Project Management Office.

Shenzhen Comprehensive Transportation Planning and Design Institute and Shenzhen Urban Planning and Design Research Institute. 2022. *Research Results on Area Comprehensive Development.* GEF Shijiazhuang Project Management Office.