多维度多尺度的轨道交通先导城市发展
Multidimensional and multiscale rail transport for urban development

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引言：国土视角下的TOD

Introduction: TOD in a territorial perspective
TOD研究背景与学科内涵：有TOD理论吗？
Background and disciplinary connotations of TOD research: Is there a TOD theory?

- 国际研究前沿：推动全球高质量发展
  - Frontiers in international research: promoting high quality global development
    - 在推动全球高质量发展的大部分国家中，城乡规划与交通发展结合越发紧密，共同促成了经济繁荣、城市活力，提升了交通公平。
    - In most of the countries driving quality development worldwide, urban and rural planning and transport development are increasingly integrated, together contributing to economic prosperity, urban vitality and improved transport equity.

- “交通强国”战略与“新型城镇化”战略
  - The "Stronger Transportation" Strategy and the "New Urbanisation" Strategy
    - 在建设交通强国的进程中，如何围绕综合交通体系进行高质量的城镇开发，成为我国新型城镇化发展过程中面临的挑战。In the process of building a strong transportation country, how to carry out high-quality town development around a comprehensive transportation system has become a challenge in the development of a new type of urbanisation in China.

- “双碳”目标：TOD模式促进公共交通发展
  - Double carbon objective: the TOD model favours the development of public transport
    - “碳达峰，碳中和”对交通运输来说既是机遇又是挑战。以公共交通为导向的城市开发，能够引导人们选择公交出行，从而实现碳排放的降低。
      - "Carbon peaking, carbon neutral" is both an opportunity and a challenge for transport. Public transport oriented urban development can lead to a reduction in carbon emissions by directing people towards public transport.
Status and development of TOD disciplines at home and abroad

Developments abroad: university settings for interdisciplinary research in transport and cities

- **Policy Interdisciplinary**
  - 加州大学洛杉矶分校（UCLA）在城市规划专业下设有“交通政策与规划（Transportation Policy and Planning）”方向；
  - 伊利诺伊大学芝加哥分校（UIC）在城市规划与政策专业下设有“公共交通规划与管理”方向；
  - 弗吉尼亚理工（VT）在城市事务与规划专业下设有“交通规划与政策”方向。
  - The University of California, Los Angeles (UCLA) has a "Transportation Policy and Planning" program under the Urban Planning program;
  - The University of Illinois at Chicago (UIC) has a "Public Transportation Planning and Management" track under the Urban Planning and Policy program;
  - Virginia Tech (VT) has a specialization in Urban Affairs and Planning with a concentration in Transportation Planning and Policy.

- **Technology and Smart Applications Direction**
  - 美国麻省理工大学（MIT）设立了中国未来城市实验室（MIT China Future City Lab）；
  - 欧洲伦敦大学学院（ULC）在交通运输专业下设有“交通与城市规划（Transport and City Planning）”专业；在建筑学院设有“智慧城市与城市分析（Smart Cities and Urban Analytics）”专业；
  - 亚洲新加坡管理学院与斯特朗特设计学院共同设置了“智能城市设计专业”。
  - The MIT China Future City Lab has been established at the Massachusetts Institute of Technology (MIT) in the USA;
  - University College London (ULC) has a Transport and City Planning programme under Transport and a Smart Cities and Urban Analytics programme in the School of Architecture;
  - Asia Singapore Management Institute (ASMI) and Strutt Institute of Design (SID) jointly set up the “Smart City Design Programme”.
国际组织对TOD关注密切
International organisations pay close attention to TOD

- 全球环境基金(GEF)在全球范围内发起“可持续城市综合方式项目”，世界银行为项目执行机构。该项目有11个国家参与实施，住房和城乡建设部为中国项目的国内管理机构。项目旨在通过TOD模式的试点和推广，引导城市可持续发展。

- The Global Environment Facility (GEF) launched the Integrated Approach to Sustainable Cities (IASSC) project globally, with the World Bank as the implementing agency. Eleven countries are involved in the project and the Ministry of Housing and Urban-Rural Development (MOHURD) is the domestic management agency for the project in China. The project aims to guide sustainable urban development through the piloting and promotion of the TOD model.

发展中国家建设对TOD需求迫切
There is an urgent need for TOD in the construction of developing countries

- 通过TOD建设，引导沿线国家的国际分工与互惠合作，建设公共交通系统服务地区发展；
- 通过TOD建设，满足沿线国家和区域的整体开发、土地建设。
- To guide the international division of labour and reciprocal cooperation of countries along the route through TOD construction, and to build public transport systems to serve regional development.
- To meet the overall development and land construction of countries and regions along the route through TOD construction.
图例
重要节点城市
古路上丝绸之路
今路上丝绸之路
古海上丝绸之路
今海上丝绸之路
交叉学科研究模式的国际高校

美国麻省理工学院（MIT）设立了中国未来城市实验室（MIT China Future City Lab），包括城市发展、经济、建筑、管理、计算机科学、人工智能、交通体系、土木与环境工程等学科，专注于中国城市的可持续发展。

亚洲新加坡管理学院与新加坡设计学院共同设置了“智能城市设计专业”，旨在解决能源、交通等问题，支撑新加坡“智慧城市2025”的目标计划。

加州大学洛杉矶分校（UCLA）在城市规划专业下设有“交通政策与规划（Transportation Policy and Planning）”方向，专注于交通政策与规划的跨学科的研究。

欧洲伦敦大学学院（UCL）在交通规划专业下设有“交通与城市规划（Transport and City Planning）”专业，在建筑学院设有“智慧城市与城市分析（Smart Cities and Urban Analytics）”专业，关注城市与交通的可持续发展。
中国高铁与区域发展
High-speed rail and regional development in China

铁路是影响区域经济发展的重要交通基础
Railways are an important transport infrastructure affecting regional economic development
- 铁路与城市化和都市发展紧密相关
  Railways are closely linked to urbanisation and urban development

铁路建设与城市化的发展历程
The history of railway construction and urbanisation
- “一五”规划，开启建设时代
- The "first five-year plan” opens the era of construction
- 文革时期：停滞不前
- The Cultural Revolution: stagnation
- 经济改革开放后的调整与发展
- Adjustment and development after economic reform and opening up
- 21世纪：高速铁路的黄金时期
- The 21st century: the golden age of high-speed rail

Before 2000: Miles issues
After 2000: Speed issues
高铁与城市空间发展
The relationship between high-speed rail and urban spatial development

轨道交通站与城市空间发展
The relationship between rail stations and urban spatial development

- 全国高铁铁路系统与城市轨道交通的交接
  The intersection of the national high-speed rail system with urban rail

![Maps showing the evolution of the high-speed rail system in China over different decades.](image)
The relationship between high-speed rail and urban spatial development

Current status of domestic and international research

The impact of transport infrastructures on urban development

(1) 线站点对城市空间影响，研究集中于：在城市中所处位置，对周边空间影响。

The impact of orbital stations on urban space, research focuses on: location in the city, impact on the surrounding space.

(2) 线网对城市空间的影响，研究集中于：城市交通设施，对缩小区域发展差异、提升劳动力就业，和转移交通模式的影响。

The impact of the rail network on urban space, focusing on the impact of urban transport facilities on reducing regional development disparities, enhancing labour force employment, and shifting transport patterns.

Research related to the integration of rail transport planning and urban planning integration

(1) 理念层面，国外研究，重大基础设施投入，需涉及多辖区、多系统间管制同意。

Conceptual level, foreign studies, major infrastructural inputs, need to involve multi-jurisdictional and multi-system control synergies.

(2) 方法和技术层面，国内外学者用软件建立“轨道-城市”模型。

Methodological and technical aspects, domestic and foreign scholars use software to build "rail-city" models.
The relationship between high-speed rail and urban spatial development

High speed railway stations connected with urban underground rail transit

1. **National High-speed Rail Layout**
   Development of the national high-speed railway station
   - High-speed railway stations have the potential to drive urban development
     Taking the distant suburban-type high-speed railway stations such as Shanghai Hongqiao, Hangzhou East, Xi’an North and Suzhou North as examples, the TOD construction of high-speed railway stations has contributed to the value-added and development of the surrounding urban space to varying degrees.
   - High-speed rail new cities have been actively built throughout China over the years
     According to incomplete statistics, there are more than 70 new high-speed railway new cities that have started or will be planned and built in China. Among them, the greatest density has been built on the Beijing-Shanghai and Beijing-Harbin lines.
高铁与城市空间发展的关系
The relationship between high-speed rail and urban spatial development

放射状交通网络系统与高铁站布局，对通过性客流形成影响，形成了地下空间与区域交通网络的复杂性。
The system of the radial traffic network and the design of the high-speed stations have an impact on the passenger flows in which it is built, forming the complexity of the underground space and the regional traffic network.

重点问题：纵向空间的可达性，“点—轴—网络”多层级的区域交通体系，引导区域产业、人口良性发展。
Key issues: accessibility of the vertical space, a multi-level regional transport system of “point-axis-network”, guiding the development of regional industries and population.

Figure Beijing high-speed railway stations and intercity railway plans, with urban rail distribution in the Beijing-Tianjin-Hebei region
经济维度：轨道交通与经济活力
The economic dimension: rail transport and economic dynamism

高铁与城市空间发展的关系
The relationship between high-speed rail and urban spatial development

轨道交通与城市空间的协同发展
Synergistic development of rail transport and urban space

天津西站的案例
The Case of Tianjin West Station
天津西站案例：TOD带动经济活力
The case of Tianjin West Station: TOD as a driver of economic vitality

天津西站定位及发展趋势

■ 上位规划
  • 天津是全国以及京津冀城市群的重要战略地区，与北京实现双城联动发展
  • 天津西站位于天津市重点发展区域，是一个连接多条线路的重要枢纽站，也是国内沟通南北和东西的十字路口

■ 在京津冀区域中的定位及发展趋势
  • 西站不仅是天津市重要的内部交通枢纽，对于京津冀而言也是众多高铁沿线重要客运枢纽之一
  • 区域会在借助周边城市的强势发展劲头，逐步成为进行各种交易的国际交易核心区域

■ 周边城市空间定位及站域空间定位

  • 天津西站南面服务范围较广，西北方向的服务范围有待发展
  • 天津城市中心区的轨道特征呈三足鼎立形势，地铁线路呈现出以天津站为中心的放射状，而天津西站则将会成为未来天津市交通进一步发展的着力点
  • 未来可以依托天津西站交通枢纽的资源优势，力争建设成为综合型城市副中心，进一步辐射带动天津市西北部经济快速发展。
The direction and development trend of Tianjin West Station

**Upstream planning**
- Tianjin is an important strategic area for the whole country as well as for the Beijing-Tianjin-Hebei urban agglomeration, with a twin-city development with Beijing.
- Tianjin West Station is located in a key development area of Tianjin, an important hub station connecting several lines and a crossroads between north and south and east and west in China.

**Positioning and development trends in the Beijing-Tianjin-Hebei region**
- The Western Railway Station is not only an important internal transport hub in Tianjin, but also one of the main passenger transport hubs along many high-speed railway lines for Beijing-Tianjin-Hebei.
- With the strong development dynamics of the surrounding cities, the area will gradually become the heart of international transactions for various deals.

**Spatial positioning of the surrounding city and spatial positioning of the station**
- The service area south of Tianjin West Station is relatively large and the service area in the northwest direction is to be developed.
- The railway features of Tianjin central area are three branches and the underground lines have a radial shape with Tianjin Station as the centre, while Tianjin West Station will become the centre of the future development of Tianjin transportation.
- In the future, relying on the resource advantages of Tianjin West Station transportation centre, we can strive to turn it into a complete urban sub-center, and further radiate and stimulate the rapid economic development of northwest Tianjin.
天津西站案例：TOD带动经济活力
The case of Tianjin West Station: TOD as a driver of economic vitality

**区域尺度 Regional scale**
- **优点**：作为京津冀协同发展的新中心，发展潜力巨大
  Advantages: Great potential for development as a new hub for the synergistic development of Beijing, Tianjin and Hebei.
- **缺点**：相关产业发展重心偏移，发展潜力后劲不足，需以商业开发为主
  Weaknesses: the focus of development of related industries is shifting, the industrial development is not strong enough, need to focus on commercial development.

**城市尺度 Urban Scale**
- **优点**：位于天津中心城区，也将是天津轨道交通及客运中心
  Advantages: Located in the heart of Tianjin, it will also be the centre of Tianjin’s rail and passenger transportation.
- **缺点**：天津轨道建设进度慢，开发与实际需求不配套
  Disadvantages: Slow progress of track construction in Tianjin, mismatch between development around stations and actual demand.

天津西站轨道枢纽TOD开发定位
Tianjin West Station Rail Hub TOD Development Positioning
天津市高铁商务办公区，多功能复合的集聚型商圈，京津冀区域面向商旅人士的高端公寓区
Tianjin’s high-speed railway business office district, a multi-functional complex of clustered business districts, and a high-end flat district for business travelers in the Beijing-Tianjin-Hebei region

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京津冀城市群高铁站枢纽客流量规模分布图

京津冀城市群全呮及市辖区人口密度与铁路交通联系频度图（含高铁、普速、和城际）
天津西站案例：TOD带动经济活力
The case of Tianjin West Station: TOD as a driver of economic vitality

轨道交通对土地价格的增值效应评价

- 轨道交通对土地价格的影响具有很强的时效性
  - 同一个轨道交通项目，在不同阶段对住宅价格的影响存在较大差异。
  - 从轨道交通项目宣布建设开始，有轨道交通的住宅价格 = 有轨道交通带来的住宅溢价 + 无轨道交通的住宅价格的自然增值。
  - 土地价格的增长是从轨道交通项目宣布建设开始就开始增加，在投入运营之后，相对于无轨道交通的土地价格增幅更大。
  - 商业和住宅的增值速度不同，商业的增值慢，但增幅大；住宅的增值快，保值高，同时良好设计可以增加轨道交通增值（图中红色虚线部分）。
  - 因此，项目地块未来的开发价值即为居住价值和商业价值之和。

轨道交通周边土地溢价的时间变化趋势
(Noreen, 2016)
The impact of rail transport on land prices is very time-sensitive

- The impact of the same rail transport project on residential prices at different stages varies greatly.
- As soon as the construction of the rail project is announced, the price of residential properties with rail transport = the premium of residential properties with rail transport + the natural appreciation of residential prices without rail transport.
- The increase in land prices started as soon as the announcement of the construction of the rail project was made. After the project was commissioned, the increase in land prices was higher than that of land without rail transport.
- Commercial and residential value added rates are different. Commercial value added is slow, but the growth rate is high; residential value added is fast and the preservation of value is high. At the same time, good design can increase the value added of rail transport (the red dotted line in the figure).
- Therefore, the future development value of the project land is the sum of the residential value and the commercial value.

Trend in the temporal variation of the land premium around rail transport (Noreen, 2016)
天津西站案例：TOD带动经济活力
The case of Tianjin West Station: TOD as a driver of economic vitality
轨道交通对商业溢价、商业活力的影响

区域对比——天津西站商圈发展不成熟
- 天津市商铺租金均价4.4元/m²·天，商业广场等集中分布在河东区、和平区，是较为发达的商业中心。
- 天津西站周边商圈现状仍然不十分成熟发达，商业溢价没有得到很好的体现，大型商业聚集点较少。同时，天津站附近商业发展规模较大，辐射范围较广，商圈较为成熟发达。
- 对比各个站点的商铺均价，直观对比：天津站>天津北站>天津西站>天津南站。

Regional Comparison - Immature Development of Tianjin West Station Business District
- The average shop rent in Tianjin is 4.4 yuan/m²·day, and shopping plazas are concentrated in Hedong and Heping districts, which are relatively developed commercial centres.
- The status quo of business districts around Tianjin West Station is not yet very mature and developed, the commercial premium has not been well reflected, and there are few large-scale commercial gathering points. At the same time, the scale of commercial development near Tianjin Station is relatively large, with a wide range of radii, and the business district is relatively mature and developed.
- Compare the average price of shops in each location: Tianjin Station>North Tianjin Station>West Tianjin Station>South Tianjin Station.

<table>
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<tr>
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<th>枢纽等级</th>
<th>站点周边1km商业租金</th>
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<tbody>
<tr>
<td>天津站</td>
<td>区域及都市圈枢纽</td>
<td>7.02元/m²·天</td>
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<tr>
<td>天津北站</td>
<td>城市核心枢纽</td>
<td>5.83元/m²·天</td>
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<td>天津西站</td>
<td>区域及都市圈枢纽</td>
<td>4.49元/m²·天</td>
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<tr>
<td>天津南站</td>
<td>区域核心枢纽</td>
<td>2.98元/m²·天</td>
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</tbody>
</table>
Community Level Commercial

Community level commercial.
As the name implies, community-level commercial functions mainly serve community residents within a certain range, have livelihood attributes, and are active on lower-grade streets or internal community roads. Typical examples are fresh vegetable supermarkets, small post stations, barber stores, sports lotteries, and outpatient pharmacies.
天津西站案例：TOD带动经济活力

The case of Tianjin West Station: TOD as a driver of economic vitality

轨道交通对商业溢价、商业活力的影响

<table>
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<tr>
<th>编号</th>
<th>天津商圈排名</th>
<th>商圈1km范围周边地铁站点</th>
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<tbody>
<tr>
<td>①</td>
<td>滨江道</td>
<td>和平路地铁站（237m）</td>
</tr>
<tr>
<td></td>
<td></td>
<td>津湾广场（641m）</td>
</tr>
<tr>
<td>②</td>
<td>天津古文化街</td>
<td>东南角（707m）</td>
</tr>
<tr>
<td></td>
<td></td>
<td>建国道（773m）</td>
</tr>
<tr>
<td>③</td>
<td>八里台新文化广场</td>
<td>天塔站（464m）</td>
</tr>
<tr>
<td></td>
<td></td>
<td>吴家湾（634m）</td>
</tr>
<tr>
<td>滨海区</td>
<td>洋货市场</td>
<td>塘沽站（847m）</td>
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<tr>
<td></td>
<td></td>
<td>鼓楼（514m）</td>
</tr>
<tr>
<td>④</td>
<td>南市食品街</td>
<td>东南角（709m）</td>
</tr>
<tr>
<td></td>
<td></td>
<td>金街站（289m）</td>
</tr>
<tr>
<td>⑤</td>
<td>天津百货大楼</td>
<td>东南角（817m）</td>
</tr>
</tbody>
</table>

天津市商圈和轨道交通枢纽人流密度分布图

商圈与轨道交通关系—天津西站与商圈未产生有机联系

- 天津市传统商圈的购物中心存量占据全市的43%，主要包括滨江道-和平路商圈、鼓楼商圈、友谊路商圈、小白楼商圈、解放路商圈，大多分布在以天津站为出发点，在传统商圈的基础上向西南方向蔓延。
- 其他站点由于远离传统的商业中心，站场区域和围绕站场能够发展起来的产业区域没有有机的联系，形成孤岛式站点，人流活力没有激发。
The case of Tianjin West Station: TOD as a driver of economic vitality

Impact of rail transit on business premiums and business vibrancy

<table>
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<tr>
<th>编号</th>
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Map of population density distribution in commercial districts and rail transit hubs in Tianjina

- The relationship between the business district and rail transport - there is no organic link between Tianjin West Station and the business district
  - The stock of shopping centres in Tianjin's traditional business districts accounts for 43% of the city's total, mainly comprising the Nanjing Road-Binjiang Road-Heping Road business district, the Gulou business district, the Youyi Road business district, the Xiaobailou business district and the Jiefang Road business district, most of which are spread out taking Tianjin Railway Station as a starting point and extending south-westwards based on the traditional business district.
  - As the other sites are far from the traditional shopping centres, there is no organic link between the station area and the industrial areas that may be developed around the station, forming an island site, and the vitality of people flows is not stimulated.
天津西站案例：TOD带动经济活力
The case of Tianjin West Station: TOD as a driver of economic vitality

轨道交通对商业溢价、商业活力的影响

商圈与站点相距200m

商圈与站点相距700m

商圈与轨道交通关系—天津西站与商圈未产生有机联系

根据研究发现天津市最受欢迎的前十商圈中，依靠百度热力图表示人流数据，滨江道、恒隆广场、银河国际购物中心商圈人流由轨道交通带动。

前十商圈在1km步行范围内都有1-2个地铁站，其中大悦城（2016年开业）、恒隆广场（2014年开业）、银河国际购物中心（2012年开业）作为新兴商圈与站点人流有很好的关联性；天津古文化街、远洋市场、南市食品街、百货大楼作传统商圈在与轨道交通枢纽的关联上弱于新兴商圈，这些站点依托传统商业中心发展，目前普遍面临面向为青年群体和轨道交通出行需求的转型问题。
The case of Tianjin West Station: TOD as a driver of economic vitality

The impact of rail transport on the commercial premium and commercial vitality

- The relationship between the business district and rail transport - there is no organic link between Tianjin West Station and the business district
  - According to the research, among the ten most popular business districts in Tianjin, the people flow data is represented by Baidu's heat map, and the people flow in Binjiang Road, 66 Plaza and Galaxy International Shopping Centre is driven by railway transportation
  - The top ten business districts have 1-2 underground stations within 1 km walking distance, among which Joy City (opened in 2016), Plaza 66 (opened in 2014) and Galaxy International Shopping Center (opened in 2012) are emerging business districts with good correlation between the flows of people on site; Tianjin Ancient Culture Street, Foreign Goods Market, Nanshi Food Street and department stores are weaker traditional business circles than emerging business circles compared to rail transit hubs. Although the city relies on traditional business centres to develop, it is now generally faced with the problem of transformation to meet the needs of youth groups and rail travel.
天津西站案例：TOD带动经济活力
The case of Tianjin West Station: TOD as a driver of economic vitality

轨道交通对商业溢价、商业活力的影响

**商圈与轨道交通关系—天津西站步行可达性较弱**
- 天津西站作为区域及都市圈枢纽，具有明显的人群聚集，但与周边商圈距离较远；同时西站周边道路复杂，步行性弱于其他站点。
- 由商业POI密度分析图可知，天津站>天津北站>天津西站>天津南站。
- 选取商圈较好的天津站、天津北站为研究对象，通过步行可达性分析可知，站点周围商圈往往分布在路网密集，可达性良好的方向，商圈往往分布在站点5分钟步行范围内。
The impact of rail transport on the commercial premium and commercial vitality

- The relationship between business districts and rail transport - Tianjin West Station is less accessible on foot
  - As a regional and metropolitan hub, Tianjin West Station has obvious crowd gatherings, but it is far from the surrounding business community; at the same time, the roads around West Station are complicated and the walk is weaker than other stations.
  - From the commercial point of interest density analysis table, we can see that Tianjin Station > Tianjin North Station > Tianjin West Station > Tianjin South Station.
  - Select Tianjin Railway Station and Tianjin North Railway Station with good business districts as search objects. From the walking accessibility analysis, we can see that the business districts around the railway stations are often distributed in the direction of a dense road network and good accessibility, and the business districts are often distributed within 5 minutes of the site.
天津西站案例：TOD带动经济活力
The case of Tianjin West Station: TOD as a driver of economic vitality

轨道交通对商业溢价、商业活力的影响
Impact of rail transit on business premiums and business vibrancy

- 项目周边—供给与需求脱节
- Around the project: disconnection between supply and demand

- 目前天津西站轨道交通周围仅存在少量的便利超市、餐饮，业态单一，与当下客流的多元化需求脱节，迫使人流在站点辐射范围停留的时间减少，活力无法被激发。
- At present, there are only a few supermarkets and convenient restaurants around Tianjin West Station, with a single commercial format, which does not meet the diversified needs of the current passenger flow, forcing the flow of people to spend less time in the station's outreach area, and their vitality cannot be stimulated.

- 天津西站以及站域周边以天津大悦城为首，引入更多的餐饮、文创、休闲、娱乐等体验式品牌和新兴品牌，同时打造文化创意主题街区，紧跟时尚热度，打造艺术IP等主题活动，提高商圈热度，吸引广大青年消费群体。建议地块规划商业业态时进行错位发展，丰富业态。
- Tianjin West Station and the surrounding area of the station domain, led by Tianjin Joy City, will introduce more experiential and emerging brands such as catering, cultural and creative, leisure and entertainment, as well as creating a cultural and creative theme block to keep up with the fashion heat and create thematic activities such as art IP to increase the heat of the business district and attract the majority of young consumers. It is suggested that the plot be planned for staggered development of commercial businesses to enrich the business format.

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高大上的TOD？实际接地气的TOD
The TOD that looks high and superior? Actually grounded
**Summary**

The project site construction needs are judged in five separate dimensions:

- **Development density**: The development density around the site is low, and the overall commercial atmosphere is insufficient. The project should introduce high-end commercial and business offices to increase the attractiveness of talents.

- **Public space**: There are few public spaces around the project and the environment is old, so we should build a "people-oriented" space, improve the landscape quality and shape the urban image.

- **Cultural nodes**: The site has a strong history, and how to stimulate the creation of cultural nodes and take advantage of the railroad museum and other advantages is one of the directions of the project development.

- **Transportation**: The site is surrounded by convenient transportation stations, but the utilization rate is low and needs to improve transportation accessibility and walkability.

- **Community**: A large amount of community-based food and beverage retail exists, but it cannot meet the positioning of the Tianjin West Station area and the hub of the metropolitan area. The site will establish a large shopping district to absorb new dynamic people and create station-city integration.
轨道交通住房价格的增值效应评价
Evaluation of the value-added effect of railroad housing prices

研究区域：天津市外环线以内

研究对象：轨道交通6号线

轨道交通6号线是天津市第5条建成运营的轨道交通线路，全线共设39座地铁站，连接了天津西站、天津北站等重要的区域性交通枢纽。

- 开工建设：2011年3月29日
- 开通运营：2016年8月6日，一期工程首通段（长虹公园站——南翠屏站）；2016年12月31日，一期工程北段（南孙庄站——长虹公园站）；2018年4月26日开通运营一期工程南段（南翠屏站——梅林路站）。

数据来源：

1. 住宅成交数据：贝壳网，2011-2019年的天津市117,885个住宅交易数据；
2. 住宅小区均价数据：链家网，2019年12月天津市6620个住宅小区均价数据；
3. 轨道交通站点数据：包含2019年12月天津市轨道交通站点数据、线路数据、站点施工时间、站点正式运营时间；
4. 其他公共服务设施GIS数据：包括公交站、大型商场、公园等矢量数据。
Evaluation of the value-added effect of railroad housing prices

Search area: in the outer ring road of Tianjin

Research object: Railway transport line 6

Railway Line 6 is the fifth completed and operational railroad line in Tianjin. There are 39 subway stations along the line, connecting important regional transportation centers such as Tianjin West Station and Tianjin North Station.

- Start of construction: March 29, 2011
- Opening and operation: On August 6, 2016, the first section of the first phase of the project (Changhong Park Station - Nancuiping Station); on December 31, 2016, the northern section of the first phase of the project (South Sunzhuang Station - Changhong Park Station); on April 26, 2018, the southern section of the first phase of the project (South Cuiping Station - Meilin Road Station) was opened.

Source of information:

1. Residential transaction data: shell.com, data on 117,885 residential transactions in Tianjin from 2011-2019. Average residential plot price data: Chain Home,
3. Rail transit station data: including rail transit station data, line data, station construction time and station official operation time in Tianjin, December 2019.
4. Other public service facilities GIS data: including vector data of bus stops, large shopping malls, parks, etc.
(1) 天津市住宅价格的空间分布：全市层面  
Spatial distribution of residential prices in Tianjin: citywide level

1. 天津市住房价格均价2.38元/m²;
2. 预判断：天津西站周边住房均价在2.6-3.4万元/m²;
3. 房价对比：天津站、天津西站>天津北站>天津南站

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天津市住宅小区的描述性统计表  
Descriptive statistics table of residential neighborhoods in Tianjin

天津市住房价格空间分布的Kriging插值（全市）
Kriging interpolation of the spatial distribution of housing prices in Tianjin (citywide)
Evaluation of the value-added effect of railroad housing prices

Housing prices around the project site: local level (26,000 to 34,000/m²)
Evaluation of the value-added effect of railroad housing prices

How much of a premium does rail transit place on housing? — Rail Transit Line 6

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<td>2016/6/6</td>
<td>换乘2号线</td>
</tr>
<tr>
<td>天津宾馆</td>
<td>地铁8号线(天津宾馆-梅林)</td>
<td>117.1010</td>
<td>30.1453</td>
<td>2011/3/29</td>
<td>2016/4/26</td>
<td>换乘2号线</td>
</tr>
</tbody>
</table>

轨道交通住房价格的增值效应评估

1. 开工建设时间一致；
2. 房价建设数据能支撑（2011-2019）
### Evaluation of the value-added effect of railroad housing prices

#### Direct comparison method

- ** Influence range of rail transportation:*** Domestic scholars mostly choose 2 km for first-tier cities such as Beijing and Shanghai; 1.5 km for non-first-tier cities such as Nanjing, Changchun, and Suzhou. Tianjin is a non-first-tier city, so 1.5 km is selected as the impact area of rail transportation, and 1.5-2 km is the non-impact area.**

- **Rail premium rate = (residential price in impact area - residential price in non-impact area) / residential price in non-impact area*100%**

**Advantage:** Simple, convenient and easy to understand;

**Disadvantage:** The influence of other factors cannot be removed from the comparison process, and thus only trend analysis can be performed.

### Characteristic price model method

\[
\ln(\text{Price}) = \alpha_0 + \alpha_1 \text{Subway500} + \alpha_2 \text{Subway500_1000} + \\
\alpha_3 \text{Subway1000_1500} + \beta_1 Y2012 + \beta_2 Y2013 + \cdots + \beta_8 Y2019 + \gamma X + \epsilon
\]

- \(\ln(\text{Price})\) is the logarithm of the residential transaction price per square meter, and Subway500, Subway500_1000, Subway1000_1500 are all dummy variables for the rail transit influence zone, indicating whether the residential transaction sample is located in the 500m, 500-1000m, and 1000-1500m influence of the rail transit station, respectively.
1) From the spatial effect, rail transit has a significant premium on residential prices along the line, but the degree of premium does not decrease with the increase of distance to the rail transit station, but shows an "inverted U-shaped" trend of rising first and then decreasing. Among them, the impact area of 500-1000m has the largest price premium, with a premium rate of 17.2%.

2) In terms of time effect, the impact of rail transit on residential prices is ahead of time, with premiums appearing during the construction period and peaking in the first year of operation, indicating that residential prices react strongly to the "landmark" event of operation.

3) Due to the psychological expectation effect, the premium effect of the full line of rail transit opening operation is significantly lower than the premium effect of the first opening operation year.

4) Considering the rail transportation, the estimated selling price of new housing on the Tianjin West Station project site is 30,000 - 38,000/m². The specific price depends on the housing quality, brand premium, etc.

The findings of the study provide decision support for the "premium recovery" strategy of urban mixed-use development and rail transit under the TOD (public transportation-oriented) model.
社会维度：TOD与职住平衡

Social dimension: TOD and work-life balance
轨道交通站与城市形态特征
Railway stations and urban morphological characteristics

轨道交通建设与TOD
不协同模式主要分为空间维度的不匹配、发展时序的错位和土地开发强度的不协调。

（1）城市形态与轨道交通建设空间维度不匹配
A. 城市轨道交通滞后于城市空间结构发展
B. 城市轨道交通发展过热，超过城市空间借口发展速度。
（2）城市形态发展与轨道交通发展时序错位
在城市发展和轨道建设的时间上存在时间维度的不匹配，即时间上异速，常常是城市形态已经在日益成熟，而轨道交通建设才逐渐起步。

以北京为例：
北京城市化发展在先，轨道交通建设在后，导致城市轨道交通为了适应“摊大饼式”扩张模式而建设，各类功能在中心城的叠加带来的交通拥堵问题日趋严重。从东京、纽约、伦敦等国际城市来看，城市中心区都构建了密度高达1～2公里/平方公里的轨道网络体系，而北京五环内轨道网密度仅为0.51公里/平方公里，远低于国际城市水平。此外，目前城市建设区已逐渐蔓延到四到六环的城乡结合部地区，中心城呈现“均质式”蔓延特征，与以轨道交通为主导的公共交通系统的“集中式”供给之间存在巨大矛盾。

北京南站是后期修建的一座综合性交通枢纽，由于南站周围已经是开发较为成熟的区域，以住宅用地为主。南站的轨道交通建设无法实现TOD的优势，一方面由于拆除成本高无法推广TOD模式；另一方面南站建设远滞后于周边住宅区建设，周边用地强度与应有的开发强度不匹配。
**Construction of rail transport and TOD**

The uncoordinated mode is mainly divided into the mismatch of spatial dimensions, the dislocation of development schedule and the incoordination of land development intensity.

(1) **Mismatch between urban form and the spatial dimension of rail transit construction**

A. Urban rail transportation lags behind the development of urban spatial structure.
B. The development of urban rail transit is overheated and outpaces the development of urban space excuses.

(2) **Timing mismatch between urban form development and rail transit development**

There is a time dimension mismatch in the timing of urban development and rail construction, i.e. the time isochronism, often the urban form is already maturing while the rail construction is only gradually starting.

**Take Beijing as an example:**

Beijing's urbanization development comes first, but the construction of rail transit comes later, which leads to the construction of urban rail transit in order to adapt to Beijing's "pie-spreading" expansion mode, and the traffic congestion problem brought by the superposition of various functions in the central city becomes more and more serious. From the perspective of international cities such as Tokyo, New York, London, etc., the central area of the city has built a rail network system with a density of 1 to 2 km/square kilometer, while the density of the rail network within the fifth ring in Beijing is only 0.51 km/square kilometer, far below the level of international cities. In addition, the city's construction area has gradually spread to the fourth to sixth ring roads in the urban and rural areas, and the central city has a "homogeneous" spreading characteristic, which is in great contradiction with the "centralized" supply of public transportation system led by rail transit.

Beijing South Station is a comprehensive transportation hub built in the later stage, as the area around the South Station is already a more mature area for development, mainly residential land. The rail transit construction of the South Station cannot realize the advantages of TOD, on the one hand, due to the high cost of demolition cannot promote the TOD model; on the other hand, the construction of the South Station lags far behind the construction of the surrounding residential areas, and the intensity of the surrounding land does not match the intensity of development as it should.
均质化与极化：Homogenization and polarization:
- 相比人口变化，在就业空间分布中，极化的力量起到主导作用。
- In contrast to demographic changes, the forces of polarization play a dominant role in the spatial distribution of employment.
- 区位差异更加突出，城市就业空间不再均质化。
- Location differences are more prominent, urban employment space is no longer homogeneous.

图 北京市2000年（左）和2010年（右）分街道的就业变化
Figure Changes in employment by street in Beijing in 2000 (left) and 2010 (right)
Urban rail transit construction and the changing employment space within cities

Decentralization and centralization:
- Stronger concentration trend: Compared with population distribution, the improved accessibility after rail transit construction has led to further concentration of economic factors, with CBDs appearing in rail transit node locations.

Weak dispersion: Although urban rail transit provides easier access, few employment centers are found in suburban zones (the two exceptions are the Shangdi area and Dashanzi area).

The power of concentration is greater than the power of dispersion.

Figure Changes in employment by street in Beijing in 2000 (top) and 2010 (bottom) (Photo credit: Author's own drawing)
Urban Spatial and Transportation Synergy in a Social Dimensional Perspective

- Social Dimension:
The mirror image relationship between commuter quality and housing prices

"Live in Beijing, work in Hebei" Wading across the river?

Figure Distribution of First Mile Satisfaction of around Beijing Subway Station
Spatial manifestation of job-living mismatch: long-distance commuting

The main destination for commuters is Chaoyang District. It mainly reaches stations such as Sihui, Dawanglu and Guomao, which are located in the CBD and along the Third Ring Road. Chaoyang District has a huge magnetic effect on Tongzhou.

The majority of Tongzhou residents still prefer employment in places with high employment opportunities and convenient commutes.

In terms of commuting range, employment centers farther apart such as Fengtai Science and Technology Park, Xi'erqi and Wukesong also have a large number of people living in Tongzhou employed precisely because there are no competitive industrial clusters with them within Tongzhou.
Spatial manifestation of job-living mismatch: long-distance commuting

(3) OD contact from outside the morning peak to Tongzhou

Commuting direction: outside the district - sub-center

A total of 7599 one-to-one OD contacts are counted (red dots indicate sites with OD counts greater than 100)
职住不匹配的功能影响：弱势群体
Functional impact of the job-living mismatch: vulnerable groups

Figure 9  Distribution of food and beverage POL in the eastern transportation corridor

Figure 10  Eastern transportation corridor hotel POL distribution

Figure 10  Eastern transportation corridor traffic coverage
职住不匹配的功能影响：生活品质
Functional impact of job-living mismatch: quality of life

4.3.1 轨道交通沿线POI串珠式集聚

数据来源：2011年的POI数据下载自BCL城市实验室官网，总共选取11327个；2019年POI数据源于高德API接口爬取的数据，总共选取28450个；地铁线路数据更新时间是2019年12月，选取副中心范围内2条线路的12座站点。

数据的分类：原始的2019年高德数据分为20大类，包括所有通州地区的餐饮服务、购物服务、生活服务、体育休闲服务、医疗保健类、政府机构与社会团体类、教育文化类，居住类共八类。

站点影响区：本文以地铁站点为中心，将800米的缓冲区范围（10分钟步行路程）结合泰森多边形分析界定的地铁站点影响区。

图4-14 副中心地铁站影响区示意图

4.3.1 POI string clustering along rail transit lines

**Data sources:** 2011 POI data were downloaded from the official website of BCL City Lab, with a total of 11,327 selected; 2019 POI data originated from data crawled by the API interface of Gaode, with a total of 28,450 selected; metro line data were updated in December 2019, with 12 stations selected from 2 lines within the sub-center.

**Classification of data:** The original 2019 Gaode data is divided into 20 categories, extracting all Tongzhou area food services, shopping services, living services, sports and leisure, health care, government agencies and social organizations, science, education and culture, and residence in a total of eight categories.

**Site impact zone:** In this paper, the 800-meter buffer zone range (10-minute walking distance) combined with the Tyson polygon analysis defined by the metro site impact zone is centered on the metro site.

图4-14 Sub-center subway station impact area diagram

### Table 4-3 POI classification criteria in this paper

<table>
<thead>
<tr>
<th>Serial number</th>
<th>Major Categories</th>
<th>Minor Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Business</td>
<td>Includes three categories of food service, shopping service and accommodation service</td>
</tr>
<tr>
<td>2</td>
<td>Life Services</td>
<td>Post office, intermediaries, telecommunication business offices</td>
</tr>
<tr>
<td>3</td>
<td>Sports and leisure services</td>
<td>Such as sports stadiums, entertainment venues, theaters</td>
</tr>
<tr>
<td>4</td>
<td>Healthcare Services</td>
<td>Such as general hospitals, clinics, pharmacies, pet clinics</td>
</tr>
<tr>
<td>5</td>
<td>Science, Education and Culture Services</td>
<td>Such as schools, training institutions, exhibition centers, museums</td>
</tr>
<tr>
<td>6</td>
<td>Residence</td>
<td>Such as villas, residential communities, dormitories</td>
</tr>
<tr>
<td>7</td>
<td>Office class</td>
<td>Including government agencies and social organizations, financial and insurance companies, companies and enterprises in three categories</td>
</tr>
<tr>
<td>8</td>
<td>Transportation Facilities Services</td>
<td>Such as bus stops, parking lots, subway stations, shuttle stops</td>
</tr>
</tbody>
</table>

### 表4-3 本文中POI分类标准

<table>
<thead>
<tr>
<th>序号</th>
<th>大类</th>
<th>小类</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>商业类</td>
<td>包含餐饮服务、购物服务、住宿服务三大类</td>
</tr>
<tr>
<td>2</td>
<td>生活服务</td>
<td>邮局、中介机构、电讯营业厅</td>
</tr>
<tr>
<td>3</td>
<td>体育休闲服务</td>
<td>如运动场馆、娱乐场所、影剧院</td>
</tr>
<tr>
<td>4</td>
<td>医疗保健服务</td>
<td>如综合医院、诊所、药店、宠物诊所</td>
</tr>
<tr>
<td>5</td>
<td>科教文化服务</td>
<td>如学校、培训机构、会展中心、博物馆</td>
</tr>
<tr>
<td>6</td>
<td>居住类</td>
<td>如别墅、住宅小区、宿舍</td>
</tr>
<tr>
<td>7</td>
<td>办公类</td>
<td>包含政府机构及社会团体、金融保险公司、公司企业三大类</td>
</tr>
<tr>
<td>8</td>
<td>交通设施服务</td>
<td>如公交车站、停车场、地铁站、班车站</td>
</tr>
</tbody>
</table>
5.3.2 通勤时间与受教育程度的关系
5.3.2 The relationship between commuting time and educational attainment

5.3.3 通勤时间与房屋产权的关系
5.3.3 The relationship between commuting time and home ownership

在房屋产权方面，产权类型为员工宿舍的通勤时间最短，其次为公租房，自有住房，租住房因为其选址大多在租金廉价的位置，远离就业中心，其通勤时间最长。

In terms of housing ownership, the shortest commute time is for the ownership type of employee dormitories, followed by public rental housing, owned housing, and rental housing, which has the longest commute time because it is mostly located in locations where rents are cheap and far from employment centers.

5.3.4 通勤时间与交通工具的关系

在交通工具选择方面，不同通勤方式的受访者其通勤时长有差异，步行的通勤时间最短，单位班车、出租车或网约车、公交车、私家车、地铁的通勤时间依次递增；而地铁的通勤时长0.5-1小时占比较多，说明在距离相等的情况下，缩短了通勤时间、提升了可达性，提供了大运量快速的交通方式。

In terms of choice of transportation, respondents with different commuting modes have differences in their commuting time, with walking having the shortest commuting time, followed by unit shuttles, cabs or online cars, buses, private cars and subways in increasing order; while subways have a higher commuting time of 0.5-1 hour, indicating that they shorten commuting time, improve accessibility and provide high-capacity and fast transportation at equal distances. The subway is the most popular mode of transportation.
探究极端通勤人员满意度影响因素与解决思路

2.3 极端通勤人员画像

基本情况：姓名：唐先生
年龄：39岁
工作类型：白领
单程通勤时长：3h

画像：通勤越来越难了，出门时间提前，但到公司总是迟到。

痛点：1. 防控检查站堵车时间长，运力差。
2. 进京站进京时间长，影响正常工作。
3. 进京材料繁琐，忘记带材料。

基本情况：姓名：许先生
年龄：28岁
工作类型：企业员工
单程通勤时长：2h

画像：为了能够积攒一定的资金，只能忍受远距离通勤。

痛点：1. 每天排队等公交，遇到雨雪天气更加严重。
2. 公交地铁太拥挤了，人多网络就不行，每天在路上花费的时间什么都做不了。

基本情况：姓名：刘女士
年龄：35岁
工作类型：创业者
单程通勤时长：2h

画像：为了梦想能接受远距离通勤，目前正在燕郊开店。

痛点：1. 上下班道路拥堵严重。
2. 进京关卡浪费时间太久了。

基本情况：姓名：王女士
年龄：33岁
工作类型：公务员
单程通勤时长：2h

画像：比起上班的劳累，通勤的疲惫才是我不能忍受的。

痛点：1. 经常买不到车票，下班时间晚上晚点，就赶不上地铁。
2. 每天的时间除了上班都在路上，陪伴孩子的时间只有晚上2小时。

基本情况：姓名：赵女士
年龄：32岁
工作类型：家庭主妇
单程通勤时长：2h

画像：为了孩子和家庭，只能承受远距离通勤。

痛点：1. 每天的通勤时间太长，影响孩子的学习和成长。
2. 家庭的负担大，通勤的疲惫让我无法忍受。

基本情况：姓名：钱先生
年龄：36岁
工作类型：自由职业者
单程通勤时长：2h

画像：为了梦想，忍受远距离通勤。

痛点：1. 每天的通勤时间太长，影响家庭的和谐。
2. 家庭的负担大，通勤的疲惫让我无法忍受。

基本情况：姓名：孙女士
年龄：34岁
工作类型：企业员工
单程通勤时长：2h

画像：为了梦想，忍受远距离通勤。

痛点：1. 每天的通勤时间太长，影响家庭的和谐。
2. 家庭的负担大，通勤的疲惫让我无法忍受。

基本情况：姓名：李女士
年龄：35岁
工作类型：创业者
单程通勤时长：2h

画像：为了梦想，忍受远距离通勤。

痛点：1. 每天的通勤时间太长，影响家庭的和谐。
2. 家庭的负担大，通勤的疲惫让我无法忍受。

基本情况：姓名：周女士
年龄：36岁
工作类型：公务员
单程通勤时长：2h

画像：为了梦想，忍受远距离通勤。

痛点：1. 每天的通勤时间太长，影响家庭的和谐。
2. 家庭的负担大，通勤的疲惫让我无法忍受。

基本情况：姓名：郑女士
年龄：37岁
工作类型：自由职业者
单程通勤时长：2h

画像：为了梦想，忍受远距离通勤。

痛点：1. 每天的通勤时间太长，影响家庭的和谐。
2. 家庭的负担大，通勤的疲惫让我无法忍受。
2.3 Portrait of an extreme commuter

**Basic information:**
Name: Mr. Tang  
Age: 39 years old  
Work type: White collar  
One-way commuting time: 3h

**Portrait:**
Commuting is getting more and more difficult, the time to leave home is constantly in advance, but in special circumstances will still be late.

**Pain Points:**
1. After the prevention and control into Beijing is more difficult, a checkpoint blocked half an hour, good luck to reach the company on time.
2. Cumbersome materials to enter Beijing, forget to bring materials can only take half a day off with the leadership.

**Basic information:**
Name: Mr. Xu  
Age: 26 years old  
Work type: Corporate employees  
One-way commuting time: 2 hours and a half

**Portrait:**
In order to accumulate a certain amount of capital, I can only endure the long-distance commute and will not stay in Beijing in the future.

**Pain Points:**
1. Waiting in line for public transportation every day until the collapse, the situation is even worse when it comes to rain and snow
2. The bus and subway are too crowded, the network does not work when there are many people, spending time on the road every day can not do anything.

**Basic information:**
Name: Ms. Liu  
Age: 35 years old  
Work type: Entrepreneurs  
One-way commuting time: 2h

**Portrait:**
For the dream of being able to accept long-distance commuting, I am currently looking at houses in Yanjiao and hope to settle down soon.

**Pain Points:**
1. Heavy congestion on the roads to and from work, wasting too much time at the Beijing gates
2. Lack of direct public transportation into Beijing, and a lot of time wasted on interchanges.

**Basic information:**
Name: Ms. Gu  
Age: 33 years old  
Work type: Public Service  
One-way commuting time: 2h

**Portrait:**
Compared to the labor of going to work, the exhaustion of commuting is what I can not stand.

**Pain Points:**
1. Often worry about not being able to buy a ticket, a little later after work, you can not catch the subway bus
2. In addition to going to work every day are on the road, accompanied by the children's time only 2 hours at night.
TOD + BRT对于乌鲁木齐低收入群体就业的影响
Impact of TOD + BRT on employment of low-income groups in Urumqi

四条BRT线路已经建成，七条规划中的地铁线路覆盖整个城市。
Four BRT lines are constructed, seven planned subway lines covering the whole city.

乌鲁木齐市平均每天的出行次数为2.47次/人*天
The average number of trips per day in Urumqi City is 2.47 times / person * day

在旅行时间方面，非机动车的最短旅行时间为：22分钟；机动车的最长时间为42.3分钟。
In terms of travel time, the minimum travel time of non-motor vehicles is: 22min; the longest motor vehicle time is 42.3min.

从旅行方式来看，慢速旅行所占比例最大，而出租车所占比例最小。
In terms of travel modes, slow travel accounts for the largest proportion, and taxis account for the smallest proportion.
BRT沿线职住空间关系的变化
Job-housing Ratio Changes along BRT Lines

- 考察BRT沿线，以TAZ为基本单元的职住比从2010年到2014年的变化。
- Taking TAZ as the basic unit, this paper investigates the JHB index changes of BRT from 2010 to 2014.

- 总体趋势显示，BRT沿线的职住比提升。
- Overall trends indicate that the increase in JHB index along the BRT.

- 这反映了快速公交系统将为沿线的那些受时间和出行费用所限的人群带来更多的工作机会。
- It reflects the fact that the BRT system would bring more job opportunities to those people who live near by BRT.

- 然而，BRT对于边远城郊地区的影响有限。However, BRT lines had limited impact on the far suburban area.

图 2010-2014年乌鲁木齐BRT沿线职住比变化
Figure the change of JHB ratio along BRT in Urumqi city from 2010 to 2014
低收入群体集中区
The Low-income Groups Concentrated Area

（1）按照就业行业划分，潜在的低收入行业如采矿、建筑、制造业等大多分布在城市北部的郊区。
According to the employment sector, the potential for low-income industries such as mining, construction, manufacturing, mostly in the northern suburbs of the city.

（2）按照民族来划分，维吾尔族集中的区域主要分布在城市中心区的东部和南部。
According to the division of ethnic groups, the concentration of the Uighur region is mainly distributed in the eastern and southern part of the city center.

（3）按照流动人口比例来划分，高外来人口比例的地区也集中在城市郊区，特别是东北、西北和南部。
According to the proportion of floating population, the proportion of high proportion of foreign population is concentrated in the suburbs, especially in the northeast, northwest and south.

（4）将这些因素进行交叉分析，结果显示结合行业、少数民
族、流动人口因素的潜在低收入社区，可能更多的分布在城
市郊区和远郊地区，尤其是北部和东南部地区。
These factors will cross analysis, the results show the potential for low income community with industry, minority, floating population factors, may be more distributed in the outskirts of the city and suburban areas, especially in the north and southeast regions.
• The survey data consists of a travel behavior survey in Urumqi. It used the 2010 standard trip questionnaire, and the survey is done in 2014. In the questionnaire, there are three level of data, family level, individual level and trip level.
对就业状况的影响因素
Impact Factors on Employment Status

- 在一些情况下影响因素显著相关，即性别（X7）为男性的全职在业可能性更高（β6=-0.014，Sig5=0.000）。
- The influence of factors showed significant relevance in some cases, namely gender (X7) for men, the higher the likelihood of full-time employment (β=-0.014, Sig=0.000).

- 在住房和（X9）方面，不拥有产权的居民全职就业率的可能性更大（β9=0.21, Sig9=0.035），这与传统理论并不相符，可能是由于不拥有产权的居民只占到了11%，他们的就业状态全职的比率更大所致。
- There was a greater likelihood of property owners (X9) (β=0.21, Sig=0.035), which was not consistent with the traditional theory and may be due to property ownership account for only 11% and their full-time employment rate was higher.

- 家庭人均收入（X10）越高，全职在业可能性越高（β8=0.008, Sig8=0.000），这与传统理论假设是相同的。
- The higher average household income (X10) of the family, the higher the likelihood of full time employment (β=0.008, Sig8=0.000), which was the same as the traditional theoretical hypothesis.

### 表 乌鲁木齐市总体被调查者工作状态回归模型
Table The regression model of the employment status of the respondents in Urumqi

<table>
<thead>
<tr>
<th>Variable</th>
<th>Unit</th>
<th>Working status model</th>
<th>β</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>R²</td>
<td></td>
<td></td>
<td>.666</td>
<td></td>
</tr>
<tr>
<td>Durbin-Watson</td>
<td></td>
<td></td>
<td>1.403</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td></td>
<td></td>
<td>.607</td>
<td>.000</td>
</tr>
<tr>
<td>Explanatory variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X1 commuting time</td>
<td>min</td>
<td></td>
<td>4.025E-005</td>
<td>.568</td>
</tr>
<tr>
<td>X1 commuting mode</td>
<td>Bus and other=1, Car=0</td>
<td></td>
<td>-0.28</td>
<td>.111</td>
</tr>
<tr>
<td>X1 average Monthly Income*bus and other</td>
<td>Cross variable</td>
<td></td>
<td>.009</td>
<td>.050</td>
</tr>
<tr>
<td>X1 commuting time*bus and other</td>
<td>Cross variable</td>
<td></td>
<td>-2.253E-005</td>
<td>.784</td>
</tr>
<tr>
<td>X1 age</td>
<td>Year</td>
<td></td>
<td>.024</td>
<td>.000</td>
</tr>
<tr>
<td>X1 square of the age</td>
<td>Year</td>
<td></td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td>X1 gender</td>
<td>Male=1, Female=2</td>
<td></td>
<td>-0.14</td>
<td>.000</td>
</tr>
<tr>
<td>X1 family population</td>
<td>Person</td>
<td></td>
<td>-0.10</td>
<td>.000</td>
</tr>
<tr>
<td>X1 property ownership</td>
<td>Yes=1, No=0</td>
<td></td>
<td>.021</td>
<td>.000</td>
</tr>
<tr>
<td>X10 Average household income</td>
<td>Below 2000=1, 2000-5000=2, 5001-10000=3, 10001-20000=4, More than 20000=5</td>
<td></td>
<td>.008</td>
<td>.040</td>
</tr>
<tr>
<td>X11 distance to the nearest BRT bus station</td>
<td>Meter</td>
<td></td>
<td>-0.001</td>
<td>.481</td>
</tr>
<tr>
<td>Dependent variable</td>
<td>Employment status</td>
<td>Full-time=1, Others=0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


环境维度：TOD与碳排放

Environmental Dimension: TOD and Carbon Emissions
以轨道交通站点为中心，以400-800米（约5-10分钟步行路程）为半径，进行高密度开发，打造集工作、商业、文化、教育、居住等为一体的混合功能区，使公共交通的使用最大化的一种开发方式。

A development method that maximizes the use of public transportation by creating a mixed functional area that integrates work, commerce, culture, education, and housing with a 400-800 meter (about a 5-10 minute walk) radius centered on a rail transit station for high-density development.
**TOD与低碳**
**TOD and Low Carbon**

**紧凑开发，减少扩张**
TOD的设计开发理念可以帮助城市摆脱“摊大饼”式的无序蔓延发展，减少能源消耗

**Compact development, less sprawl**
The TOD design and development concept can help cities get rid of the "pie" type of sprawl and reduce energy consumption.

**低碳出行，公交导向**
以公共交通为导向的发展，鼓励使用公共交通+步行，减少小汽车出行

**Low carbon travel, transit oriented**
Public transport oriented development to encourage the use of public transport + walking and reduce car trips.

**功能混合，就近通勤**
打造集工作、商业、文化、教育、居住等为一体的混合功能区，缩小职住分离程度，就近通勤

**Mixed functions, commuting close to home**
Create a mixed functional area that integrates work, business, culture, education, and residence to reduce the separation of work and residence and to provide a close commute.
TOD与低碳
TOD and Low Carbon

TOD规划开发通过城市交通设施与用地布局的结合，能够促进人们在TOD周边的就业、购物和餐饮行为，从而对交通方式的选择产生显著影响，整体上促进了步行、自行车及公交方式的发展，对小汽车方式有一定的抑制作用。

Through the combination of urban transportation facilities and site layout, TOD planned development can promote people's employment, shopping and dining behaviors around the TOD, thus significantly influencing the choice of transportation modes, and overall promoting the development of walking, bicycling and transit modes, with some inhibiting effect on the small car mode.
以香港为例：
• 45%的人口居住在距离地铁站仅500米的范围内
• 新界内大约78%的就业岗位集中在铁路车站附近
• 商务中心高度集中在各类公共交通的大型枢纽处

Take Hong Kong as an example:
• 45% of the population lives within 500 meters of a metro station
• Approximately 78% of jobs in the new sector are concentrated near railroad stations
• High concentration of business centers at large hubs for various types of public transportation

资料来源：《城市交通与城市空间演化相互作用机制研究》
Source: Study on the Mechanism of Interaction between Urban Transportation and Urban Spatial Evolution
TOD with Low Carbon

TOD development mode can bring benign changes in transportation activities from optimizing urban structure, guiding passengers to rail transit and other public transportation fields, so as to achieve the purpose of ecological balance, energy conservation and emission reduction.

Source: The Role of Transit Oriented Development in constructing urban environment sustainability, the case of Jabodetabek, Indonesia(9)
According to the historical data, the simulation analysis of Jakarta is carried out, and the following conclusions are drawn:

**TOD引入后**

- 降低油耗20%
- 预计二氧化碳排放量降低350万吨
- 降低碳排放26%

Source: The Role of Transit Oriented Development in constructing urban environment sustainability, the case of Jabodetabek, Indonesia(9)
TOD与低碳
TOD and Low Carbon

通过结合可持续的建筑、能源和废物处理方法与高质量的运输通道，可以在城市改造中实现有效的融合，带来可持续发展和节能减排的效果。
By combining sustainable building, energy and waste treatment methods with high-quality transportation corridors, effective integration can be achieved in urban transformation, so as to achieve sustainable development, energy conservation and emission reduction.

协同效应
Synergies

增加建筑和人员密度，匹配商业和住宅的不同热量和能源需求，节约供暖/制冷费用，并引入废物再利用技术，实现废热的最大化再利用。
Increase the density of buildings and personnel, match the different heat and energy needs of commercial and residential buildings, reduce heating / cooling costs, and introduce waste recycling technology to maximize the recovery of waste heat.

利用铁路站台顶棚和远程停车场结构的光伏发电，为建筑物提供太阳能。
Solar energy is provided to the building by generating photovoltaic power from the roof of the railway platform and the structure of the remote parking lot.

利用建筑环境产生的可再生能源/燃料为交通车辆提供动力。
Use renewable energy / fuels generated by the built environment to power transport vehicles.

促进非机动车交通的使用，减少不透水的停车场表面，代之以更多的开放空间和社区花园。
Encourage the use of non motorized transportation, reduce impervious parking spaces, and replace them with more open spaces and community gardens.

碳排放测算
Carbon emission measurement

各国交通运输范围差异：部分国家采用大口径，中国为小口径
Differences in transportation scope among countries: some countries use large caliber, while China uses small caliber

经过整理，目前的测算方法主要有十种，其中在国际和国内使用最多的是自上而下法和自下而上法
After sorting, there are mainly ten calculation methods, of which the top-down method and the bottom-up method are most widely used internationally and domestically.
碳排放测算
Carbon emission measurement

交通运输碳排放: Transport related carbon emissions

交通运输业碳排放主要分为固定源碳排放和移动源碳排放。影响交通运输碳排放因素很多，根据交通主体的不同，可以分为供给因素、需求因素和环境因素三大类。TOD模式主要影响交通供-需关系。

The carbon emissions of the transportation industry are mainly divided into fixed carbon emissions and mobile carbon emissions. There are many factors affecting transport carbon emissions, which can be divided into supply factors, demand factors and environmental factors according to different transport entities. TOD mode mainly affects the relationship between transportation supply and demand.
碳排放测算
Carbon emission measurement

交通运输碳排放影响因素:
Facteurs influant sur les émissions de carbone provenant des transports:

Traffic supply factors can be divided into traffic management factors, traffic technology factors and traffic energy factors.

- 交通管理因素从政府管理的角度反映出行的便利性和效率性，影响出行方式和出行效率。
  Traffic supply factors can be divided into traffic management factors, traffic technology factors and traffic energy factors.
- 科学的道路规划改善交叉口的连通性，缓解拥堵，减少碳排放
  Scientific road planning improves intersection connectivity, alleviates congestion and reduces carbon emissions Urban development planning, urban spatial structure, transportation planning, operation management planning
- 交通技术因素包括车辆技术、能源技术等，对一定的出行需求产生直接的碳排放影响。
  Transportation technology factors include vehicle technology, energy technology, etc., which have a direct impact on the carbon emissions of certain travel needs.
- 汽车的生产要求轻设计、超低阻力和更高的燃料效率
  Automobile production requires lightweight design, ultra-low resistance and higher fuel efficiency
  - 汽车能源设计及其配套设施设计
  - Design of automobile power and its supporting facilities
- 能源消耗是交通碳排放的前提。
  Energy consumption is the premise of transportation carbon emissions.
  - 能源结构 energy-resource structure
  - 能源效率 energy efficiency
碳排放测算
Carbon emission measurement

交通运输碳排放影响因素:
Factors affecting transport carbon emissions:

交通需求因素从直接消耗主体出发，包括出行结构、出行成本、出行方式、出行距离等。
Traffic demand factors start from the direct consumer, including travel structure, travel cost, travel mode, travel distance, etc.

非机动车与公共交通能源消耗强度原低于小汽车
The energy consumption intensity of non-motorised vehicles and public transport was originally lower than that of small cars

经济性政策（税收、补贴）成为控制需求的常见手段
Economic policies (taxes, subsidies) have become a common means of controlling demand

交通需求增加刺激车辆拥有量与能耗增加
Increased transport demand stimulates increased vehicle ownership and energy consumption

- 3亿辆汽车
- 6亿吨燃油
- 7亿吨原油
碳排放测算

Carbon emission measurement

交通运输碳排放影响因素 Factors affecting transport carbon emissions:

Environmental factors reflect the external environment on which transportation depends, including population and economic development, and there is also a correlation between transportation carbon emissions.

- **Demographic factors**
  - 主要包括人口密度与人口增长率
    Mainly including population density and growth rate
  - 研究表明，人口的增长必然导致交通周转率的增加，直接扩大交通需求，导致碳源的增加
    With the increase of urban population density and the continuous expansion of urban agglomeration, the travel distance of urban residents in China is increasing, and the carbon emissions are increasing.
  - 随着城市人口密度增加，城市建成区面积不断扩大，导致我国城市居民出行距离增加，碳排放激增
    Research shows that population growth will inevitably lead to an increase in traffic volume, directly increase traffic demand, and lead to an increase in carbon sources

- **Economic development factors**
  - 经济发展促进了交通需求，增加了道路运输碳排放
    Economic development drives traffic demand and increases carbon emissions from road transportation
  - 发展经济与城市道路交通碳减排并不是矛盾的目标。有研究
    shows that the increase of China’s per capita GDP growth rate in the previous period has greatly increased the current carbon emissions, but the long-term effect of per capita GDP growth is conducive to carbon emission reduction.
    There is no contradiction between economic development and the carbon emission reduction target of urban road transportation. The research shows that the increase of China’s per capita GDP growth rate in the previous period has greatly increased the current carbon emissions, but the long-term effect of per capita GDP growth is conducive to carbon emission reduction.
碳排放测算
Carbon emission measurement

交通运输碳排放影响因素 Factors affecting transport carbon emissions:

根据(IPCC)国家温室气体清单指南，移动源碳排放计算方法可以分为自上而下和自下而上两种模式。这两种估计模型可以用于计算不同研究

目标下交通总排放量和不同交通方式的排放量。

According to the IPCC guidelines for the preparation of national greenhouse gas inventories, the methods for calculating carbon emissions from mobile sources can be divided into top-down and bottom-up models. These two estimation models can be used to calculate the total emissions of transportation under different research objectives and emissions of different transportation modes.

自下而上模式
Top-down model

\[ E = \sum_i E F_i \times V_i \]

式中，\( E \)表示交通碳排放；
\( i \)表示燃料类型；
\( E F_i \)表示碳排放因子
\( V_i \)表示\( i \)类型的燃料消耗量

- 该模型计算简单，具有较大的测量范围，可以计算不同尺度，不同燃料类型的空间的碳排放情况，并进行区域间的比较。
- 该方法依赖于交通能源消耗的准确数据，然后乘以相应的碳排放因子来估计最终的交通碳排放。
- 能源碳排放系数的确定没有统一的标准，限制了自上而下模型估算碳排放的准确性。
- The model has simple calculation and wide measurement range, and can calculate the carbon emissions of different scales and different fuel types, and make regional comparison. This method relies on accurate transportation energy consumption data, and then multiplies it by the corresponding carbon emission coefficient to estimate the final transportation carbon emission. There is no unified standard for the determination of energy carbon emission coefficient, which limits the accuracy of the top-down model to estimate carbon emissions.
Carbon emission measurement

Factors affecting transport carbon emissions:

According to the IPCC guidelines for the preparation of national greenhouse gas inventories, the methods for calculating carbon emissions from mobile sources can be divided into top-down and bottom-up models. These two estimation models can be used to calculate the total emissions of transportation under different research objectives and emissions of different transportation modes.

Bottom-up model

\[
T = \sum_{ij} V_{ij} \times D_{ij} \times C_{ij} \times F_{ij}
\]

- \(T\) 表示交通碳排放；
- \(i\) 表示车辆类型（小汽车、公共汽车等）；
- \(j\) 表示能源类型（汽油、柴油、天然气等）；
- \(V_{ij}\) 表示使用能源\(i\)的车辆数；
- \(D_{ij}\) 表示使用能源\(i\)的车辆\(i\)一段时间内行驶距离；
- \(C_{ij}\) 表示使用能源\(i\)的车辆\(i\)的平均能耗；
- \(F_{ij}\) 表示使用能源\(i\)的车辆\(i\)碳排放因子。

- 自下而上模型考虑出行方式、车辆类型、保有量、行驶距离、单位燃料消耗等因素影响，理论上准确反映移动源排放的特点。
- 这种方法对数据要求很高。这些数据一般是通过调查获得，研究区域局限，这增加了计算的不确定性，导致区域之间的可比性较差。
- The bottom-up model considers the influence of driving mode, vehicle type, performance, driving distance, unit fuel consumption and other factors, and theoretically accurately reflects the emission characteristics of mobile sources. This method requires high data. These data are usually obtained through investigation, and the research area is limited, which increases the uncertainty of calculation, resulting in poor comparability between regions.
TOD模式与交通出行方式
TOD mode and transmission mode

TOD模式与交通方式选择的互动机理：
Interaction mechanism between TOD mode and transmission mode selection:

表 不同开发强度下的城市日常通勤交通方式构成
Table 2-1 composition of daily commuting traffic modes in cities with different development intensity

<table>
<thead>
<tr>
<th>城市</th>
<th>开发强度</th>
<th>步行与自行车</th>
<th>摩托车</th>
<th>公共交通</th>
<th>私家车</th>
<th>其他</th>
</tr>
</thead>
<tbody>
<tr>
<td>莫里斯</td>
<td>低</td>
<td>1.4</td>
<td>0.9</td>
<td>3.9</td>
<td>92.2</td>
<td>1.6</td>
</tr>
<tr>
<td>伦敦</td>
<td>中</td>
<td>11.5</td>
<td>1.9</td>
<td>17.0</td>
<td>70.6</td>
<td>-</td>
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<tr>
<td>香港</td>
<td>高(TOD)</td>
<td>2.9</td>
<td>3.8</td>
<td>84.8</td>
<td>6.3</td>
<td>2.2</td>
</tr>
</tbody>
</table>

TOD开发模式
Transit-oriented development

开发强度大、密度高且布局集中
High development intensity, high density and centralized layout

交通需求集中分布
Centralized traffic demand scheduling

密度（density）

多样性（diversity）

城市设计（design）

地价上升
Land price rise

停车费用上涨
Parking fee increase

限制私家车使用
Restrict the use of private cars

匹配完善的高运力公交系统
Suitable for full capacity bus system

公交出行比例上升
Increase the proportion of bus trips
The implementation of public transport priority policy will improve the sharing rate of public transport, reduce the sharing rate of private cars, and correspondingly reduce the number of cars, so as to reduce the full life cycle carbon emissions of cars in the process of production, use, maintenance and scrapping.
人才培养：自主设置交叉学科
——国土空间与交通协同（TOD）
Talent training: independent setting of Interdisciplinary-Space and territorial transport coordination (TOD)
TOD的理论基础——学科交叉
Tod interdisciplinary theoretical basis

城乡规划学：城市交通规划理论、城市生态理论、人居环境科学理论，可持续发展理论等。
Urban and rural planning: urban transportation planning theory, urban ecology theory, scientific human settlement theory, sustainable development theory, etc.

交通运输工程：交通基础设施规划基本理论、交通可持续发展理论、交通运输系统规划与决策管理的理论与方法。
Transportation Engineering: the basic theory of transportation infrastructure planning, transportation sustainable development theory, transportation system planning and design and decision-making management theory and method.

应用经济学：土地经济学、区域经济学、城市经济学。
Applied Economics: land economics, regional economics, urban economics.

土木工程：土木工程材料学、土木工程建造与管理学、绿色规划与设计、智慧建造与运维。
Civil Engineering: civil engineering material science, civil engineering construction management, green planning and design, intelligent construction and operation and maintenance.

系统科学：复杂适应系统理论、整体性理论。
System science: complex adaptive system theory, whole theory.
TOD's interdisciplinary theoretical basis

Purpose of TOD independent interdisciplinary framework

- 城乡规划学
Urban and Rural Planning
- 一级学科硕士点
First class master's degree
- 交通运输工程
Traffic and Transport Engineering
- 土木工程
Civil Engineering
- 应用经济学
Applied Economics
- 系统科学
Systems Science
- 一级学科博士点
First Class Doctorate

本学科以城乡和区域多要素协同规划理论为基础，强化大数据与前沿信息技术运用，突出综合交通系统对区域产业协同和城乡发展的引领作用，着力培养国际化、复合型城乡规划行业领军人才和引领未来智慧城市发展的人才。

Based on the theory of urban-rural and regional multi factor collaborative planning, this discipline strengthens the application of big data and advanced information technology, and highlights the leading role of integrated transportation system in regional industrial coordination and urban-rural development. We will strive to cultivate international and composite urban and rural planning industry leaders and innovative leaders who will lead the development of smart cities in the future.
TOD工程人才的主要研究方向及研究内容

国土空间与交通协同

交叉学科

城乡规划学

交通运输工程

土木工程

应用经济学

系统科学

交叉学科研究方向

城市群与交通区域一体化理论与方法

城市空间与交通协同理论与方法

低碳与可持续TOD理论与方法

基于TOD的大数据分析技术

交叉学科研究内容

城市群空间结构与交通网络

都市圈发展与交通一体化

城市群资源配置与交通布局

城市交通与土地利用协同的理论与方法研究

交通走廊沿线的城市开发研究

交通站点周边的城市设计

低碳城市与绿色交通研究

基于TOD的土地价值捕获研究

TOD开发模式的经济可行性研究

基于复杂系统的TOD大数据时空演化研究

交通网络系统与城市发展的模拟与预测

智慧城市建设与智慧交通
TOD国际人才培养与国际TOD需求
International talent development and international demand of TOD

商务部在北京交通大学设有针对国际官员的“城乡规划学”与“交通运输工程”两个全英文硕士项目，两个班成建制并行招生。在培养方案上课程交叉，以交通带动城乡发展，以城镇化引导交通布局。目前为“一带一路”沿线培养3届共74名城乡规划硕士，成为发展中国家培养重要骨干人才。

The Ministry of Commerce opened two master's degree courses in English for international civil servants at Beijing Jiaotong University, namely "urban and rural planning" and "Transportation Engineering". These two classes will be registered in parallel. In the training plan, the courses are cross cutting, urban and rural development is driven by transportation, and urbanization is the guidance of transportation routes. At present, 74 urban and rural planning masters have been trained for three periods along the "the Belt and Road", and have become important talents in developing countries.
TOD交叉工程人才培养目标
Objectifs de formation des talents inter-ingénieurs TOD

培养学生在国土空间与交通协同学科领域具有较强的知识获取能力、学术鉴别能力、科学研究能力、学术创新能力、学术交流能力以及合作能力、组织协调能力的拔尖创新人才。Cultivate students with strong knowledge acquisition ability, academic insight, scientific research ability, academic innovation ability, academic communication ability and the ability of cooperation, organization and coordination in the field of indoor space and transportation synergy.

系统专业知识，良好科研素养，丰富实践能力
Systematic expertise, good scientific knowledge and extensive practical skills

具有良好的科学素养和独立从事科学研究工作和解决工程技术问题的能力，在科学或专门技术上做出创造性的成果。Have good scientific literacy and the ability to independently engage in scientific research and solve engineering and technical problems, and make creative achievements in science or specialty.

卓越国际视野，实际工程经验
Excellent international exposure, practical engineering experience

掌握坚实宽广的基础理论和系统深入的专门知识，全面深入了解本学科有关研究领域的现状，发展方向及国际学术前沿。毕业后，成为能够胜任工程实践工作，以及实际部门的技术与管理工作的高级复合型人才。

Master solid and extensive basic theories and systematic and in-depth professional knowledge, and have a comprehensive and in-depth understanding of the current situation, development direction and international academic frontier of the relevant research fields of this discipline. After graduation, he will become a senior compound talent, who can work in engineering practice and engage in technical and management work in the practice department.
Thank You

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