

Policy and practice of urban Tod localization in China: A perspective of policy tools

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Absrtact: in the background of transit priority changing to Transit City and transit power, in order to deal with the problems of construction land shortage and traffic jam brought by rapid urbanization, bus-oriented development (Tod) has become a key path for local governments to lead high-quality urbanization. Most local governments have put into practice a lot of locally-rooted Tod policies in the light of urban rail transit planning, construction and operation. Based on the characteristics of multi-level planning and multi-sector coordination, understanding the policy tools and practice mechanism of Tod will help improve the effectiveness of Tod. Based on 135 Tod policies in 35 cities, using NVIVO text analysis and case study methods, focusing on planning and overall planning, transfer of land development rights, development design and index control, investment and financing model, this paper analyzes the policy tools and practical characteristics of Tod, it is helpful to understand the implementation path of the localization of Tod. The research shows that in China, the most policy tools for Tod are environmental ones (68.09%) , supply ones (27.99%) and demand ones (3.92%) , it gradually presents the characteristics of government-led and market-oriented operation, establishes a more mature top-level design and overall planning mechanism, and forms innovations in financing structure, land development right transfer, index control and adjustment, etc. . In the future, the practice of Tod of local government should combine its own advantages, promote multi-financing, efficient overall planning, density management and other optimization paths to enhance the comprehensive benefits of Tod.

Foundation: National Natural Science Foundation of China (NSFC) project“Study on intercity transportation evolution, housing cost difference and cross-regional job-housing selection mechanism in metropolitan area”(No. 42271201) ; National Natural Science Foundation of China Youth Project“Research on land development structure, price evolution and premium capture mechanism along urban rail transit”(No. 42001174) ; The key project of Zhejiang Philosophy and social science planning, “Research on cross-border transportation coordination mechanism and spatial governance in the perspective of common prosperity”(No. 23NDJC015Z) ; The project“Pattern, process and mechanism of interaction between traffic and space in metropolitan area: Multi-source data simulation”(no. : 2023QL016) was supported by Ningbo Young Innovative Talents Project

Key words: transit-oriented development (Tod) ; policy tools; planning; development and utilization; investment and financing reform

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Localization of Tod Strategies and Practice in China: The Perspective of Policy Tools

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Abstract: Amidst urban transportation policy shifts from prioritizing transit to focusing on building transit metropolises and strengthening China's position as a nation with advanced transportation networks, transit-oriented development (Tod) emerges as a pivotal strategy for local governments to shape high-quality urbanization in the context of limited constructive-land supply and aggravating traffic congestion. Currently, most local governments in China have introduced a plethora of locally rooted Tod policies and practices. Given the necessity for multi-level planning and multidepartmental coordination in effectively achieving Tod goals, understanding the policy tools, their evolution, and implementation mechanism of localized TOD strategies is imperative. Based on 135 Tod policies utilizing textual analysis and case studies, the paper delves into four important aspects of TOD-planning coordination, transfer of development rights, planning and design standards, and investment and financing models. The study shows that China's Tod policy tools predominantly focus on the environmental and supply aspects, accounting for 68.09% and 27.99% respectively in the sample, while tools addressing the demand side are least represented, accounting for only 3.92%. Additionally, China's localized Tod approaches are government-led and market-oriented, with local governments establishing a mature policy framework and coordination mechanism. Innovations are mainly made in the financing structure, practice of transfer of development of rights, and control indicators and their adjustment. In the future, local governments should strengthen their strength in Tod policy making and implementation and promote diversification of financing, high-efficiency coordination, and density management to achieve comprehensive social benefits of Tod Strategies.

Keywords: transit-oriented development (Tod) ; policy tools; planning coordination; development and utilization; investment and financing reforms

In the context of rapid urbanization and limited land supply for construction, urban traffic congestion has brought about long commutes, high energy consumption and high pollution, therefore, various regions are actively exploring the spatial optimization strategy with the integration of transportation and land use as the core. Urban rail transit has become an important way to relieve traffic pressure and improve land use efficiency with the advantages of large volume, green, safety and punctuality, and provide new opportunities for transit-oriented development (Tod) policies and practices ^[1]. Up to 2022, 55 cities in our country have opened multi-standard urban rail transit (including subway, light rail, urban fast rail, tram, etc.) , which has 308 lines with a total length of 10287.45 km ^[2]. As a core concept of new urbanism, Tod can lead to high-density, mixed-use development of urban land, build diverse, compact and dynamic communities, and produce significant economic, social and environmental effects, such as increasing the share of land value and public transport ^[4], promoting sites, communities and urban vitality ^[5-6], reducing carbon emissions ^[7].

Tod plays an increasingly important role in urban territorial planning and governance. In 2015, the Ministry of Housing and Housing issued the guidelines for the planning and design of areas along urban rail lines, explicitly focusing on rail stations to build an intensive, efficient and user-friendly urban environment and activity space, we will give full play to the guiding role of rail transit in urban space. In 2016, the guidelines for further strengthening the management of urban planning and construction incorporated some of the core concepts of Tod into national guidance. Based on this, cities actively try out and promulgate a series of policies to encourage

and strengthen the exploration of Tod model through localized policy tools, and form a localized top-level design and action framework, define the content of the work, the mechanism of the work and the division of responsibilities. Among them, the localization of Tod has two connotations, one is the localization of international Tod Policy Practice in the mainland, the other is the localization of each place in the process of localization. A good Tod has the complex characteristics of multi-subject, multi-process and multi-policy, and its optimal implementation depends on local government's innovation and comprehensive and effective policy tools^[8-10]. At present, there are many researches on the principle of Tod, planning and design, and spatial effect, but few studies on the localization of Tod Policy and practice in China from the perspective of policy tools. By collecting and analyzing a total of 135 TOD policy documents in 35 cities in China, with the help of the theory of supply-based, environmental-based and demand-based policy instruments^[11], this paper reviews the characteristics of Tod policy in four aspects: planning and coordinating mechanism, land supply and utilization, design and index control, and investment and financing mode mechanism, this paper analyzes the practical mechanism of Tod policy in the process of localization in our country.

The rise and practice of Tod

1.1 Tod Concepts and developments

The Tod focuses on high-volume public transport to guide the development of mixed-use land-use patterns and community development adapted to Green Transport^[12], it has the characteristics of density, design, diversity, distance, accessibility, traffic demand management and rapid transit service^[13-15], and there are multi-scale and multi-type classification systems^[16]. Urban-scale TOD emphasizes the use of urban stock space to increase public transport use and achieve sustainable urban development through planning guidance; 17 community-scale Tod emphasizes encouraging public transport travel, building mixed-use, dynamic spaces near sites^[18]. Tod research also forms different schools of thought with different emphases on urban economy, urban planning and travel behavior. For example, the urban economics school focuses on the socio-economic impact of Tod, for example, the spillover effect on land price and urban economy, the urban planning school pays attention to multi-scale Tod Planning and design, it emphasizes the guiding and controlling role of planning and design strategies such as height, density, distance and mixing degree^[20-21], and travel behavior school emphasizes the multiple influences of Tod on travel mode choice^[22].

1.2 Tod Policy and practice

At present, global metropolises emphasize Tod as a comprehensive path to optimize urban development, such as reducing traffic congestion, guiding urban renewal and promoting urban vitality. For example, urban land and transport integration in Europe emphasizes the role of Tod in Sustainable Development and urban renewal and promotes the substitution of public transport for cars^[23-24]. In Hong Kong, China and Tokyo, Japan, "Track + property" Tod to help solve the land shortage and financial difficulties^[25]. In Curitiba, Brazil, high concentration of transport corridors can promote urban renewal, forming a new vitality of urban regeneration^[26]. In India, Tod links the various densely populated centres of Mumbai, mitigating job-housing

imbalances ^[27] . In Rio de Janeiro, Brazil, Tod has strengthened the construction of housing and employment centres along the transport corridor ^[28] .

The policy and practice of Tod involves multi-stakeholder and multi-level planning. The implementation will of the government and the ability of planning and development are the important factors that affect the practice. For example: the establishment of Planning Vision has a guiding role in the development of Tod ^[29] ; Laws, regulations and guidelines provide institutional safeguards for the integrated development of Tod ^[31] ; flexible adjustment of planning and design standards improves the feasibility of Tod ^[32] ; and policy consistency benefits the long-term implementation of Tod ^[33] . With the rapid development of urbanization in our country, the local government has made a series of Tod policies and promoted practical innovation by using rail transit construction. Therefore, analyzing the policy tools and practice mechanism of local governments to promote Tod is helpful to understand the practice mechanism and effect of urban Tod localization in China.

2 research ideas and design

2.1 research ideas

To collect and further select Tod Policy documents issued by major cities in China to reveal the policy tools and practices of urban Tod localization in China. First, a total of 173 comprehensive policies related to rail transit were selected and classified according to the text type and the signature of the document. Among them, the document type was divided into regulations, regulations, plans, methods, opinions, etc. , the signatories were divided into local government offices, natural resources and Planning Departments. Then, a further reading of the full text of the document, excluding the documents with little relevance to Tod, resulted in 135 valid policy documents for analysis.

The choice and application of these policies are typical, which can fully reflect the characteristics of Tod localization policy and practice. First, the 135 policy documents cover many important aspects such as Tod Integrated Development Planning and coordination, land supply and utilization, integrated development design and index control, and investment and financing model reform, by 2022, a total of 55 cities had opened multiple urban rail transit systems, excluding 10 cities with only trams, and the selected policy covered 77.8 per cent of the urban area, the policy systems used for textual analysis also take into account the evolution of Tod policies and practices in different cities. Taking Dongguan as an example, in 2011, the policies of Special Land Reserve and joint development of land around rail transit stations in Dongguan and the management measures of investment and financing of rail transit construction in Dongguan made corresponding explanations on land reserve and rail construction investment and financing mechanism within the scope of Tod Development Detailed rules for the comprehensive development of land around railway stations and the construction of station complexes in Dongguan, the leading group of urban rail transit construction and TOD development was established, and the management requirements of Land Reserve and supply, Tod spatial development and investment and financing mechanism were put forward Regulations on the management of land and space composite utilization in the Tod area of Dongguan urban rail

transit, it forms the guidelines for the complex utilization of space, transportation facilities and connection, public space and service facilities within the scope of Tod.

Based on the policy tool theory and analysis method, the policy terms are analyzed and coded by NVIVO software. Coding refers to the conversion of policy provisions into figures for quantitative processing such as statistical classification of policies. The coding of policy text analysis adopts the node coding of "Policy sequence-chapter sequence-clause sequence" (Table 1), and the basic unit of coding is the specific clause of the policy text, for example, 1-5-3 represents the point of Article 3 of Article 5 of the first policy, and then categorizes the coding results into policy tools and specific TOD development links.

2.2 study design

Constructing a two-or three-dimensional analytical framework with policy tools is a common approach to policy analysis ^[34]. According to the content of policy texts, a two-dimensional analysis framework for the comprehensive development of local government policy tools and Tod is constructed (Figure 1). According to the characteristics of Tod policy and its implementation process, Tod policy tools are classified into supply-oriented, environmental-oriented and demand-oriented, which can be applied to the connotation and classification of Tod Policy to a large extent. Among them: the supply-oriented tool refers to the government through infrastructure and investment to expand the supply of TOD-related factors, showing as the driving force of Tod Policy; Environmental tools provide a favorable environment for the implementation of Tod through financial and regulatory policies, which shows as the influence of Tod policies Demand tool refers to the government through procurement and (de-) regulation to reduce market uncertainty, formulate a characteristic of the integrated development policy of Tod, Tod policy differences. On the specific nomenclature of policy instruments, focusing on the policy and practice processes of Tod localisation, combined with the way the literature has been compartmentalised ^[35-36], 11 policy instruments were selected as units of analysis in the X dimension, as shown in Table 2.

In addition, combined with the main links involved in the development of Tod, the policy object is divided into the planning and coordinating mechanism of Tod Comprehensive Development, land supply and utilization, design and index control, investment and financing mode mechanism as the analysis unit of Y dimension. The research process is mainly divided into two steps: first, quantifying policy terms and word frequency statistics, discussing the time series characteristics of Tod Policy, analyzing the quantitative characteristics of different policy tools in each link of Tod Development, focusing on the "Overall analysis" at the national level. Secondly, based on the typical cases of Tod practice, this paper analyzes the local policy and practice characteristics in the process of Tod practice in our country, focusing on the local level "Case analysis". Through the "Whole-case" analysis of the combination of our comprehensive analysis of the characteristics of Tod Policy and practice.

3 policy tools for the integrated development of urban Tod in China

3.1 time series analysis of Tod Integrated Development Policy

Tod plays an important role in coordinating urban functions, perfecting land use layout and guiding urban development and renewal. By collecting and screening 135 policies of promoting the development and utilization of the railway stations and land along the railway from 2004 to 2022 in 35 cities, the characteristics of the stages of Tod comprehensive development policy are analyzed systematically. According to the number of policy documents and the word frequency of Tod policy, the urbanization process in our country can be divided into three stages: incubation stage, rapid development stage and steady development stage (Figure 2) . (1) incubation period (2004-2010) : this period is divided on the basis that the number of policies in each year is less than 5, and the number of policies in subsequent years does not have this characteristic. Word frequency analysis shows that key words such as“Construction”, “Planning” and“Operation” are given higher weights at this stage, and policy tools are mainly environmental and supply-oriented, with infrastructure and target planning in the majority, this indicates that rail transit construction is the dominant policy tool in this phase, while Tod has not been widely considered. (2) period of rapid development (2011-2018) : this period has a high number of policies, totaling 79, and 2018 was the year with the highest number of policies promulgated. Word frequency analysis shows that the weighted percentage of“Construction” and“Planning” in this period totalled 4.28% , and“Development” accounted for 1.20% , up 0.56% from the first period. The weight of“Tod” is 0.34% , which is the highest in the three periods. The reason is that the rapid urbanization promotes the construction of urban subway. Demand-based policy instruments decreased by 6.82% and environmental policy instruments increased by 6.59% during this period, which fully illustrates the importance of top-level design of Tod Policies, regulations and action plans to practice. (3) period of steady development (2019-present) : with the introduction of a new round of administrative measures for urban rail transit construction in 2018, China will continue to raise the threshold for urban rail transit construction and promote the transition of rail transit Tod to high-quality development. There was a decrease in the number of TOD-related policy documents, totalling 48 during the period, with“Development” and“Tod” weightings of 1.37% and 0.23% , respectively. The proportion of demand-based policy tools continues to decline, while the proportion of environment-based tools is steadily increasing, which shows that Tod is still an important tool for government to develop sites and regions, and is committed to creating a policy environment suitable for TOD implementation. Through the comparison of the three periods, it is found that the current Tod policy tools in our country are environment-oriented, supply-oriented and demand-oriented, in the early stage, the infrastructure investment and the improvement of laws and regulations are the main ways to promote the development of Tod in order to achieve the unity of social effect and economic benefit.

Fig. 1 two-dimensional analysis framework of Tod policy of local government

Fig. 1 Two-dimensional analysis framework of local TOD policies

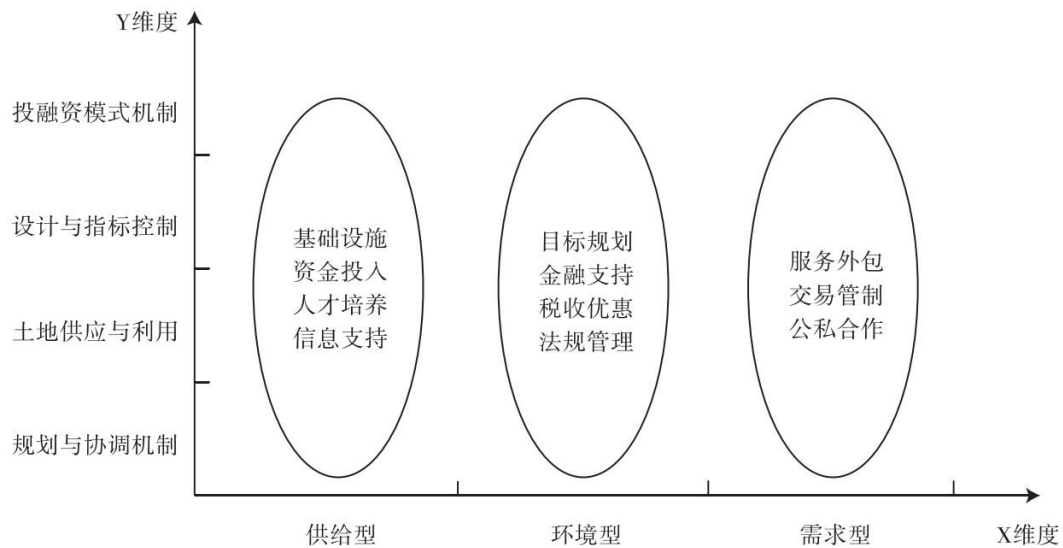


Table 1 code table of content unit of local government Tod development policy text

Tab. 1 Text-oriented coding of local Tod policies

政策编号	政策名称	内容分析单元	编码
1	南京市轨道交通发展专项基金管理办法	第二条 轨道基金实行财政专户管理,并作为市政府对地铁的项目资金投入	1—2
		第五条 轨道基金的来源构成 (三)市土地储备中心运作划拨地铁土地所取得的净收益	1—5—3
	
135	嘉兴市轨道交通站点及车辆基地综合开发的暂行意见	二、(一)加强规划引导。充分发挥规划的先导性作用促进轨道交通规划和综合开发协同发展。在轨道交通线网及建设规划阶段,同步开展站点及车辆基地综合开发规划研究,站点及车辆基地选址原则上应符合功能要求并有利于综合开发	135—2—1

Table 2 policy tools and their implications of Tod for local governments

TAB.2 Policy tools and interpretations of local Tod policies and practices

工具类型	工具名称	工具释义
供给型	基础设施	政府依托行政手段推动TOD落地,如优化行政审批
	资金投入	政府设立轨道交通专项资金等财政补贴保障开发建设
	人才培养	政府综合利用行政手段和经济手段促进专业培养、学科建设人才吸引
	信息支持	政府部门加强宣传引导,建立良好的舆论氛围,争取民众支持
环境型	目标规划	政府结合城市规划、土地利用规划等制定不同层次的TOD开发规划
	金融支持	政府给予TOD开发过程中金融优惠,如专项债券、专项基金等
	税收优惠	政府给予TOD建设开发过程的税费减免等
	法规管理	政府利用行政手段规范TOD开发,如出台轨道交通条例
需求型	服务外包	政府将业务外包给其他服务商来完成开发任务
	交易管制	政府利用行政手段对TOD涉及的交易过程进行有效管理
	公私合作	鼓励社会资本参与,引导民间资本投资

Data sources: Based on references ^[11], ^[35-36]

Due to the difference between urban rail construction and land development, Tod policy also has spatial differentiation. From the perspective of policy space, Shanghai, Hangzhou, Chengdu, Dongguan and other large cities to promote the development and construction of Tod Policy is more comprehensive. Taking Hangzhou as an example, the concept of "Track + property" was put forward in 2009, emphasizing the importance of Tod to urban development, and clarifying the key work of Tod Development and construction. In 2014, the Hangzhou Municipal People's government issued several opinions on further accelerating the construction and development of urban rail transit, putting forward more detailed requirements in terms of leadership and coordination system, management mode and fund-raising. In 2015 and 2018, Tod supporting policies were improved in terms of management mechanisms and land supply. In 2022, the Tod Special Plan was issued, and the planning plan and future vision of each grade station were put forward in detail. In contrast, the rail transit construction starts later, the city of the lower level of the number of fewer policies, involving a narrower scope. From the perspective of time and space changes, it can be found that local governments are in the different stages of rail transit construction and Tod Development, overall, the number of TOD-related policies is increasing, the scope of Tod involved is expanding.

3.2 the X-Y dimension analysis of TOD development policies of local governments

On the basis of coding the policy clauses, this paper classifies them according to the important links involved in the comprehensive development of Tod. Overall, these 135 documents cover three types of tools: supply-based, environmental-based and demand-based. They cover policy targets in four dimensions of Tod Development. In terms of the number and proportion of nodes counted (table 3), environment-based tools had the most (416 nodes), supply-based tools had the least (171 nodes), and demand-based tools had the least (24 nodes). Among the environmental tools, target planning (116 nodes) and regulation management (251 nodes) account for 88.22% of the total, with a quantitative advantage. This reflects the strong willingness of local governments to implement Tod. Among the supply tools, infrastructure (121 nodes) and capital investment (27 nodes) have attracted much attention, accounting for a total

of 86.55% , while talent investment and information support are less. To some extent, Tod development and construction in our country is still in the stage of active exploration, mainly in infrastructure investment, and the importance of land supply and investment and financing innovation is constantly enhanced. The most frequently used requirement-based tool was a public-private partnership (20 nodes) , accounting for 83.33% . In practice, the government expands financing channels and introduces social investment, while transaction control and service outsourcing are seldom involved.

Figure 2. Tod policy of local governments in three stages

Fig. 2 Word frequency analysis of local Tod policies in different phases



(a) 词频分析图 (2000—2010年) (b) 词频分析图 (2011—2018年) (c) 词频分析图 (2019—2022年)

Table 3 TOD policy tools by type and quantity

TAB.3 Types and number of local Tod policy tools

类型	工具名称	2000—2010年				2011—2018年				2019年至今			
		规划与协调机制	土地供应与利用	设计与指标控制	投融资模式机制	规划与协调机制	土地供应与利用	设计与指标控制	投融资模式机制	规划与协调机制	土地供应与利用	设计与指标控制	投融资模式机制
供给型	基础设施	6▲	1△	1△	5▲	54★	12□	10□	16□	11□	1△	0△	4△
	资金投入	3△	0△	0△	7▲	1△	2△	3△	6▲	0△	0△	0△	5▲
	人才培养	1△	0△	0△	0△	0△	0△	8▲	3△	0△	0△	2△	0△
	信息支持	1△	0△	0△	0△	1△	0△	5▲	1△	1△	0△	0△	0△
环境型	目标规划	6▲	2△	4△	3△	19□	18□	37■	11□	11□	0△	4△	1△
	金融支持	2△	0△	0△	5▲	0△	0△	0△	17□	0△	0△	0△	2△
	税收优惠	3△	0△	0△	7▲	0△	0△	0△	8▲	0△	0△	4△	1△
	法规管理	4△	5▲	3△	1△	5▲	46■	41■	41■	13□	0△	82★	10□
需求型	服务外包	0△	0△	0△	0△	0△	0△	0△	1△	0△	0△	0△	0△
	交易管制	0△	0△	0△	3△	0△	0△	0△	0△	0△	0△	0△	0△
	公私合作	0△	1△	0△	4△	0△	0△	0△	12□	0△	0△	0△	3△

Remarks: (1)△ : number of policy instruments < 5 times; (2)(5 times ≤ number of policy instruments < 10 times; (3)(10 times ≤ number of policy instruments < 20 times; (4)(20 times ≤ number of policy instruments < 50 times; (5)★ : number of policy tools ≥50 times.

From the development link dimension, the selected policy text includes the complete TOD development phase. According to statistics, the number of development planning and coordination mechanisms is relatively large in the period of cultivation and rapid development, totaling 62 nodes, and relatively small in the period of steady development, this reflects the fact that local governments have gradually developed local leadership and coordination mechanisms. The quantity and proportion of land development and utilization in the period of rapid development and the period of steady development are prominent, with a total of 88 nodes, indicating that the local government gradually adjusts the relevant policies of land use in the process of practice, to provide more policy support for TOD development. The development design and index control also present the similar characteristic, the quantity promotes steadily, promotes the TOD high quality development. The reform and evolution of investment and financing model are involved in three kinds of policy tools, especially in tax preference, financial support, regulation management, service facilities and so on.

4 the practice mechanism of localizing Tod comprehensive development in Chinese cities

4.1 planning and coordination mechanism

From 2004 to 2010, with the acceleration of the urbanization process, our country ushered in the upsurge of subway construction, by guiding the orderly and healthy expansion of urban space and the implementation of urban master planning through rail transit, the backbone role of rail transit in the urban public transport network is continuously promoted ^[37]. During this period, other big cities such as Hangzhou, Qingdao, Suzhou actively planned Tod comprehensive development of the early exploration work. With transport powerhouses and public transport priority strategies receiving high priority from national and local governments, rail transport has become an important pillar of inclusive growth and new urbanisation ^[38-39]. In addition, rail transit plays an indispensable role in urban spatial structure with its good economic and social benefits. The emphasis and depth of different levels of planning are different, and the Tod concept gradually permeates into the multi-level planning system ^[40-41], which is shown by the quantitative advantage of target planning in policy tools. At the macro level, it is emphasized that rail transit planning should be coordinated with urban master planning and land use master planning, and should link up with regional and urban functions, cities such as Hangzhou, Shanghai and Guangzhou have incorporated Tod into their territorial and spatial plans. At the meso-level, combined with urban density zoning and public service facilities layout, further determine the site function positioning and indicators adjustment. At the micro-level, specific route planning and detailed plot design were used to guide.

The process of rail transit planning, construction and development involves multi-party stakeholders, and the establishment of an efficient and coordinated leadership and coordination mechanism can coordinate all parties, policy tools include government efforts to promote the development of supply-side policy tools for Tod. At present, "Leading Group + office" is the main form of co-ordination in all localities. The members of the group include the main leaders of the city, the main heads of various departments, and the district governments, Hangzhou, Guangzhou, Nantong, Nanjing, Zhengzhou, Ningbo, Chengdu and other cities to rail transport construction Operation Group into the leading group, co-ordinate land development, planning and approval processes. At the same time, regular meetings or special working groups will be set up to discuss and coordinate Tod comprehensive development matters. In addition, improve the efficiency of relevant projects, optimize the approval process to promote Tod development, such as Jinan proposed rail transit project construction approval documents can be issued in stages and layers (code 78-3). Zhengzhou opened up a "Green channel" for the approval of rail transit projects, according to the project project time points, the time limit to complete the approval work (code 87 -4 -11). The practice shows that the government attaches importance to the use of environmental policy tools for the development of Tod to create a convenient government environment.

4.2 land supply and use

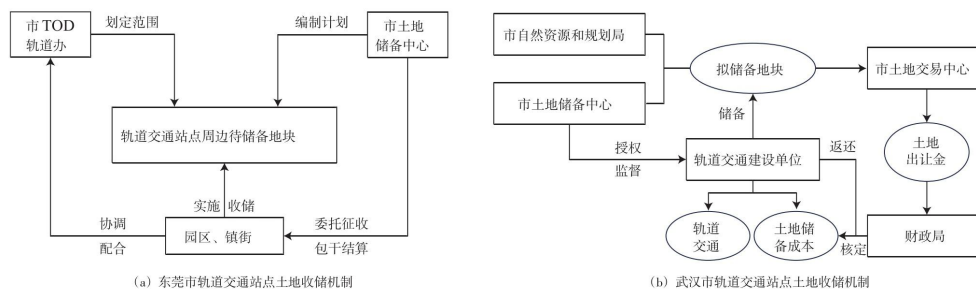
4.2.1 mode of Land Reserve and supply

As a necessary link of Tod Comprehensive Development, Land Reserve is the key factor to realize land value-added income and promote comprehensive development in an orderly way. Through the policy carding found that around the rail stations around the land reserve presented the following two mechanisms (Figure 3) : (1) city-level co-ordination, district-level responsible for

the specific collection and storage work. Taking Dongguan City as an example, after the Tod Office of the city coordinated with local towns and cities to define the scope of land reserve, the Municipal Land Reserve Center is responsible for the preparation of the plan for the collection and storage, the consultation of the compensation for the collection and storage, and the work of entering and leaving the storage around the rail transit stations, then by the park, the town (Street) is responsible for involving in the area of rail transit stations around the specific land storage work. In this kind of reserve mechanism, the rail transit construction unit does not undertake the main work, but cooperates with other departments to carry on the land ownership investigation, the land requisition demolition and so on work, Hangzhou, Shanghai also belongs to this kind of way. (2) the mechanism of directional land reserve. After determining the scope of the reserve, the Municipal Land Reserve Center shall grant the right of collection and reserve to the rail transit construction unit, which shall undertake the work of track construction and Land Reserve, transfer to the land transaction center to complete the land transaction, after the transaction of land transfer money back to rail transit construction company, Nanjing, Wuhan, Guangzhou, Qingdao have adopted this reserve model [42].

Fig. 3 the land reserve mechanism around the rail transit station

Fig. 3 Mechanism of land reservation for rail transit station areas



Source: Figure (B) is adapted from reference [42]

Tod practice needs to adapt to the innovation of land use system. According to the land remising system of our country, the land exploration beneficial to Tod development has been carried out in practice, which shows the trend of policy evolution (table 4) . Preliminary exploration of the transfer of more by agreement and “With conditions of auction hanging” way of transfer, the scope of land mostly for the vehicle section cover, project reserved land and does not have a separate planning and construction conditions of the land. In this way, the use right of the land to be developed can be guaranteed by agreement or precondition. Metro can set up property companies with development qualifications to develop independently, or jointly develop with other developers by means of joint stock, such as Shanghai explicitly encourages joint development, nanjing encourages metro companies to develop or own part of their properties. However, there are such problems as complicated procedures, difficult supervision, weak capital and lack of development experience. Cities such as Shenzhen, Guiyang, Nanning and Lanzhou have started to explore land pricing, whereby the government values land tenure for a certain

number of years at the pre-subway market price or takes a stake in a subway group to be developed by it, the government enjoyed shareholder benefits. Shenzhen, an early adopter, in 2012 and 2013, they issued the circular on implementing the overall plan for the reform of the land management system of Shenzhen Municipality, and the interim measures of Shenzhen Municipality on financing the pricing of state-owned land tenure, respectively, to support the granting of land-pricing financing, it was also implemented in the construction and operation of the third phase of the Metro, providing a model for other cities to follow. This way not only ensures the metro group to obtain the right to use the land within the scope of Tod, but also enables the land development to feed back the construction of rail transit.

4.2.2 three-dimensional development, mixed use

The layered establishment of construction land use right is one of the feasible ways of intensive land use under land saving strategy, and it is also an important move under Tod Comprehensive Development Strategy. The traditional right to the use of construction land is flat, in 2007 issued the implementation of the “Property Law” proposed that the right to the use of construction land can be established on the surface of the land, above or below the ground. Combined with the development trend of the property above the subway, a large number of cities began to explore the layered development path with local characteristics. Shenzhen in 2008 in Qianhai Bay Vehicle Depot for the allocation of less than 0m land, 0-15m on the ground for the transfer agreement, more than 15m listed for the transfer of three-dimensional development of other cities to provide experience. Chengdu is similar to Shenzhen in that the integrated development land of the layered rail transit yard station will be sold as a whole. Hangzhou is different in terms of timing. The measures for the implementation of land supply for the comprehensive development of above-and below-ground space in Hangzhou Urban Rail Transit, published in 2018, clarify the unity of objects for remising above-and below-ground space at the yard station, however, the land for construction on the surface was first allocated, and then through the declaration of the agreement to obtain the comprehensive development of the above-ground and underground space use rights.

Table 4 summarizes the methods of urban land transfer

TAB. 4 Summary of regulations on the transfer of land development rights

城市	出让范围	出让方式
上海	车辆基地上盖	协议出让
	轨道交通场站	协议出让,若引入社会资本,则需“招拍挂”
南京	轨道交通场站核心区内不具备单独规划建设条件的用地	协议出让
杭州	车辆段综合开发项目	带条件“招拍挂” ^①
	不具备单独规划建设条件的经营性地下土地	协议出让
合肥	轨道工程预留用地	协议出让
	后期综合开发工程用地	带条件“招拍挂” ^②
成都	不具备单独规划建设条件的轨道交通场站综合开发用地	带条件“招拍挂” ^③
	车辆基地上盖	拍卖、挂牌
西安	不具备单独规划建设条件的经营性地下空间	协议出让
	不具备单独规划建设条件的经营性地上空间	带条件“招拍挂” ^④
南京	具备条件的规划区内土地	“招拍挂”
南通、佛山、青岛、郑州、宁波	属经营性项目用地(包括采用分层供应方式进行供地的地下空间、地面空间等)	“招拍挂”

Promoting the mixed and refined land use types in a planned way can save land use, increase the diversity of urban development and adapt to the trend of urbanization ^[43]. Mixed-use land is also becoming a trend in TOD development. For example, the 2020 regulations on the management of land and space mixed use in the Tod area of Dongguan urban rail transit continuously promote the mixing of land-use functions and enhance the combined use of land and space in the Tod area, it is the supplement and extension of land compatibility, mixed land use and plot ratio on the basis of “Dongguan urban planning and Management Technical Regulations”. Through the supply-oriented and environmental policy tools, strengthen the management of laws and regulations and infrastructure construction, the practice of TOD localization in our country has formed some innovations in land reserve, supply and utilization.

4.3 design and target control

4.3.1 the site classification is stratified

Most cities in our country are characterized by single-center intensive development and mixed land-use functions. How to integrate Tod with surrounding land use and improve the overall vitality is one of the difficulties ^[41]. In practice, it is beneficial to release the potential of Tod by giving specific design and relaxing the index control. Tod site classification layer based on function can be developed differently, but the classification standards are different. Hangzhou is classified into special class, Class I and Class II in terms of transfer conditions, passenger flow and the total number of residents and employees in the area covered. The super-class has the conditions of multi-rail transfer, the passenger flow of the station is more than 100,000

person-times/day, the land use function is highly mixed, the radius of the core area can reach more than 1,000 meters, and the total number of people living and working is not less than 200,000, it has rich urban functions and three-dimensional traffic scenarios. Chengdu and Chongqing mainly consider the supporting role of the sites to the surrounding industries and urban functions. According to the development conditions, Guangzhou can be divided into four categories: comprehensive development (Class A) , good development conditions (Class B) , partial development conditions (Class C) and non-development conditions (Class D) . The division of circle layer is a further differential design based on the site classification. The division standard is divided into two categories: the first category is divided according to the site type, such as Hangzhou, Chengdu, Hefei, Nantong are in this category. The scope of Hangzhou Super Core area and radiation affected area is 1000-1500m, the scope of Class I circle is 800-1000m, the scope of Class II circle is 500-1000m. The second type is not directly related to the site grade, and can be divided into 500-800m by taking into account the walking distance and topographic features. For example, the general sites in Suzhou, Hefei, Nantong and Zhengzhou can be developed in 500m, the development scope of transfer stations is 800m. Chongqing is mainly mountainous, so the development area is set at 600m.

4.3.2 adjustments to detailed planning indicators

Integrated Development of urban rail transit (Tod) relies on multi-level policy support and planning synergy. Policies at all levels provide guidelines and guidelines for the development of Tod, and specific planning, regulatory detailed planning and development guidelines embody and implement the policy. Therefore, on the basis of combing policy points, combined with specific cases can better reveal the characteristics of Tod localization practice. (1) volume rate adjustment. Increasing the site area ratio is conducive to giving full play to the Tod's territorial and spatial leadership. The first approach is to adjust the volume rate upper bound within the Tod region (Fig. 4) and the given correction coefficient (table 5) . This method is more flexible than the traditional floor area ratio ceiling, can stimulate the enthusiasm of developers and urban vitality ^[44] . For example, Hangzhou is divided into three intensity development zones according to site type and distance, and the maximum volume ratio is defined respectively. The correction coefficients of high-grade stations are higher than those of general stations, such as Chengdu; the range correction coefficients of core areas are higher than those of radiation areas, such as Dongguan; and the correction coefficients of multi-line stations are higher than those of single-line stations, such as Shenzhen. The second is floor-to-floor transfer (figure 5) , in which development rights that can not be achieved under planning are transferred for a fee to other parcels of land that can be built, it has the function of balancing land development and space efficient use game in stock development ^[45-46] . Tod range of plot rate transfer is mainly to optimize public green space and open space, such as Chengdu and Shanghai. However, there is a lack of institutional safeguards and procedures in practice, and progress is slow ^[47] . (2) control of other indicators. In addition to volume ratio, parking assignment criteria were also key factors affecting Tod Effectiveness. For example, Zhengzhou and Dongguan have lowered parking standards by 20 percent in the metro superstructure project and Tod area, respectively, to guide the shift from car travel to public transportation. A reasonable and efficient station access system can improve pedestrian comfort and public transport utilisation ^[48] , such as the

construction of a “Ground + ground” slow access system in Chengdu, where road network density and public transport access requirements are specified by station grade ^[49] .

4.3 investment and financing model mechanism

As a quasi-public product, urban rail transit (URT) is characterized by a large amount of investment and a long period of return. It is difficult to balance construction and operation by relying on passenger transport income, while relying on financial subsidies has certain financial pressure and debt risk ^[50] . For example, 70% of the funds for the first phase of Shenzhen subway construction came from the direct investment of the municipal government, and the other 30% came from bank loans. With the expansion of rail transit and the crowding-out effect of other infrastructure, subway construction is in urgent need of new sources of funding ^[51] . Government-led, market operation, to attract social investment, expand diversified financing channels become a consensus. As a result, in addition to government subsidies and bank lending, local governments are actively exploring new forms of financing such as corporate bonds and trust funds, build-operate-transfer and rail + property models to address funding pressures. In the investment and financing model, public-private partnership and other demand-based policy tools are constantly improving, in order to release market vitality and attract social capital. “Track + property” as a set of track investment, construction, operation and land development in an integrated model, in Hong Kong, Tokyo and other areas have achieved good results. On this basis, Guangzhou, Shenzhen and other through the “Auction hanging” land transfer funds to compensate for the early funding gap, began to explore the appropriate “Track + property” model, such as the subway and social capital to form a joint development. In addition, land-pricing financing has become a trial route aimed at securing metro groups’ deep involvement in land development, reducing financing and market risks, improving the efficiency of land tenure transfer and the profitability of metro companies ^[52] . In short, our country’s subway construction and operation from the government single investment to multi-investment and financing, localization “Track + property” Tod model, to achieve self-regulation function.

Table 5 part of the city site high-density development statistics

Tab. 5 Regulations on high-density development surrounding rail transit stations

城市	站点分类	圈层划分	容积率政策
杭州	特级	核心区 1000 m, 辐射区 1500 m	根据站点特征分为高、中、低强度。高强度区内允许容积率大于4.0以上, 中强度区控制在2.5—4.0, 低强度区允许小于2.5
	I级	核心区 800 m, 辐射区 1000 m	
	II级	核心区 500—1000 m, 辐射区 800—1000 m	
成都	城市级和片区级	核心区 500 m, 辐射区 800 m	城市级站点容积率根据城市设计方案确定 区域级站点 100 m 内容积率上浮不超过 20% 组团级站点 100 m 内容积率上浮不超过 20% 核心区形态分区不大于 8.0, 一般形态区不大于 4.5, 特别形态分区不大于 2.5
	组团级	核心区 300 m, 辐射区 800 m	
	一般级	核心区 300 m, 辐射区 500 m	
东莞	枢纽型、市域级、镇区级、社区型、特殊型	由近及远划分为核心区、控制区和协调区; 控制区为 500 m; 协调区、核心区根据实际划定	修正系数: 枢纽站核心区为 0.7, 控制区为 0.5 一般站核心区为 0.5, 控制区为 0.3
深圳	综合枢纽站、交通接驳站、片区中心站和一般站	—	修正系数: 多线车站 0—200 m 范围为 0.7, 200—500 m 范围为 0.5 单线车站 0—200 m 范围为 0.5, 200—500 m 范围为 0.3
武汉	枢纽站、一般站	—	修正系数: 站点外轮廓线 200 m, 商业、商业服务设施、其他公共服务设施用地枢纽站为 1.5, 一般站为 1.3 站点外轮廓线 400 m 居住用地为 1.2
石家庄	枢纽站、一般站	核心控制区: 200 m 核心范围区: 500 m	修正系数: 枢纽站 0—200 m 范围为 0.2, 200—400 m 范围为 0.15 一般站 0—200 m 范围为 0.15, 200—400 m 范围内为 0.10
重庆	城市级、片区级站点、规划单元级、街区级站点	综合开发辐射范围: 600 m 综合开发研究范围: 800 m	修正系数: 单线站点 0—300 m 范围为 0.3, 300—600 m 范围为 0.1 多线站点 0—300 m 范围为 0.5, 300—600 m 范围为 0.2

Fig. 5 plot rate transfer diagram

Fig. 5 Transfer of floor area ratio

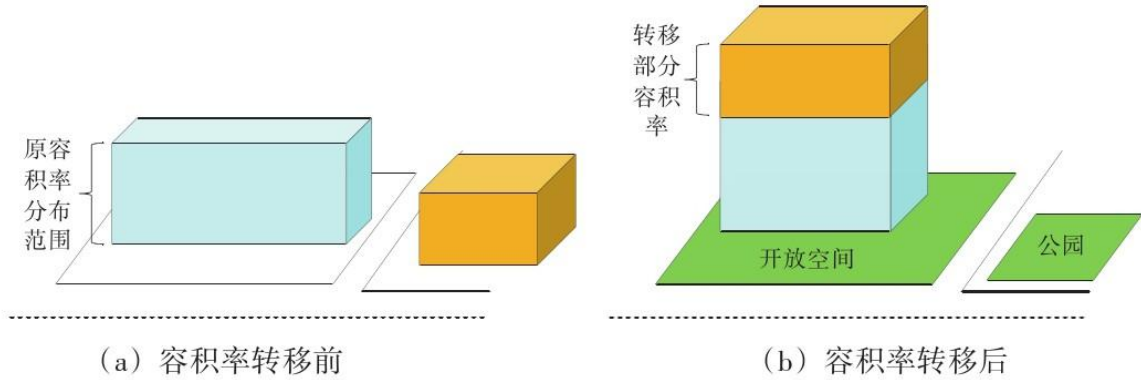
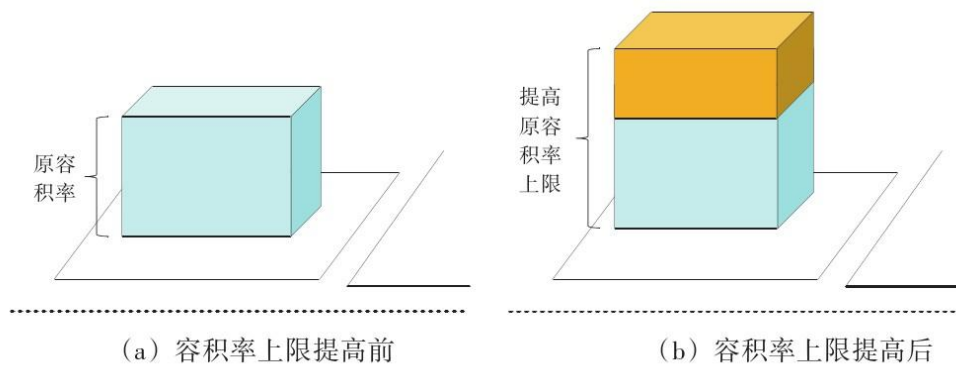


Fig. 4 schematic diagram of volume rate adjustment

Fig. 4 Adjustment of floor area ratio



5 conclusion and discussion

With the high-quality integration of urban rail transit construction needs, how to give full play to the rail transit along the land use and urban sustainable development, to achieve social, economic and environmental benefits has become the focus of local governments. Based on the classification of policy tools, this paper combs the policy tools and practice models of local governments to promote the comprehensive development of Tod, the practice of TOD localization in our country can be divided into three periods: incubation period, rapid development period and steady development period, supply is the second, and demand is the least. Among them, the tools of target planning and regulation management are frequently used, which indicates that Tod development in our country is at the exploration stage. The gradual increase in information support and talent development in supply-side tools demonstrates the recognition of the importance of technology and professionals to sustainable TOD development.

(2) a more mature model has been explored in the overall planning and coordination mechanism. Firstly, the concept of Tod has been incorporated into the planning system at different levels, and secondly, a leading group mainly composed of government departments and track builders has been set up, responsible for overall planning of the development process, coordination of stakeholders, and finally give priority in the approval process to save time.

(3) to explore and innovate ways of land development and utilization that are more suitable for our country, it includes the mode of land directional reserve and urban co-construction, the way of directional "Bidding and hanging", the way of capital transfer, the direction of three-dimensional development and mixed use.

(4) in the aspect of development design and index control, the aim is to improve the development intensity around the site by classifying the site into different layers and increasing the volume ratio of the layers.

(5) the idea of government leading and market-oriented operation and the development mode of "Track + property" have become the ways for the government to ease the capital shortage. It can be seen that strengthening the government-led, giving full play to the advantages of the main bodies, and giving policy innovation in the aspects of land pricing, allocation, mixed use, volume ratio adjustment, and so on, has become a way to attract the participation of social capital, explore an important way to deepen the localization of Tod.

In view of the transformation and reconstruction of urbanization and land development, the future Tod Policy and practice need to strengthen the adaptation to the new situation and new

requirements. On the one hand, under the strategy of land and space planning, we should strengthen the coordination and adaptation between rail transit financing, planning, construction and operation and land use development, the integration of rail transit and land use will become more and more important. This is conducive to the construction of a standardized and healthy urban rail transit construction and Tod Integrated Development, as well as a rational and effective land premium capture mechanism from the perspective of fiscal health, 53 and to the strengthening of local debt management, 54-55, to construct the pattern, process and mechanism of Tod comprehensive development in accordance with urbanization and high-quality development of social economy in our country. On the other hand, we should deepen the innovation of the policy and practice of Tod. Based on the present situation and advantages of different regions, the land supply, planning and design strategy of Tod should be strengthened, including land reserve, first-and second-level development, layered transfer, mixed use, high-density development, etc. , we should strengthen policy exploration and innovation, form policy demonstration and policy diffusion mechanism, and better realize the promotion of Tod's comprehensive effect.

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Notes

- (1) it can be sold by public bidding, auction and listing with the requirements of technical ability, architectural design scheme and yard-station construction scheme.
- (2) land bidders should have the strength, experience and Operation Management ability to match the development function and scale determined in the planning and design plan.

(3) the bidder shall have the capacity to operate rail transit lines.

(4) attached technical ability, architectural design, construction requirements and other conditions of land transfer.