«Beyond Growth» in China: Coordinated Optimisation Strategies for Rail Transit Networks and Regional Spatial Structure in the Post-Urbaniastion Context

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Abstract:
This study investigates the role of multi-level rail transit systems in optimising spatial structures during China's post-urbanisation phase under the "high-quality development" framework. By comparing international urbanisation trajectories, it identifies China's unique tension: a need to support continued urban development amid population decline and fiscal constraints. The study proposes a multi-scalar optimisation strategy—regional corridors, metropolitan integration, and urban-scale structural reinforcement—highlighting selective, structure-oriented approaches over extensive construction. Using Shanghai's metropolitan region as a case, the paper demonstrates the feasibility and strategic value of this approach in supporting spatial balance, efficient mobility, and sustainable urban transformation.

Keywords: Cities beyond growth; High-quality development; Rail transit network; Regional integration; Spatial structure

1. Introduction

In recent years, terms such as "stock-oriented development" (, development based on existing assets) and "high-quality development" (, development emphasising sustainability, equity, and efficiency) have become increasingly prevalent in government documents and academic publications on urban planning in China (Xi, 2022). After four decades of rapid and large-scale urbanisation, major cities and developed regions in China have begun to exhibit characteristics of a post-urbanisation stage in terms of population growth, economic structure, and spatial expansion. These regions now face associated challenges (Wu and Phelps, 2011). Globally, many cities have experienced slowing or even negative population growth, stabilising or contracting spatial expansion, and a growing need to discuss "de-growth". Against this backdrop, "beyond growth" has emerged in Western contexts, emphasising the optimisation of spatial structures, equitable allocation of public resources, and environmental sustainability rather than continued expansion. However, in China, although some cities display typical features of post-urbanisation, unbalanced regional development, ongoing urban migration, and continuous industrial restructuring mean that China cannot simply replicate the development trajectory of Western countries. Instead, it must adopt a distinct approach through "high-quality development" to respond to the "beyond growth" concept.

Under this framework, rail transit has become more than a mere mode of transport; it now plays a strategic role in optimising spatial structure, fostering regional coordination, and enhancing urban quality (Wu et al., 2020; Cao, 2023). Nevertheless, the development and operation of rail transit in major Chinese cities currently face a series of pressing challenges, including limited corridor capacity, insufficient reusable infrastructure, rising construction costs, and fragmented operational governance. These constraints highlight the urgent need to shift from a traditional expansionist approach to a more layered, structural, and coordinated rail transit system.

This study, therefore, adopts a regional integration perspective contextualised within China's unique urbanisation process to investigate the critical role of rail transit in optimising spatial structure. Focusing on the Yangtze River Delta and the Shanghai Metropolitan Area1 As cases, the study draws on literature review, policy analysis, and case studies to construct a multi-level, collaborative rail optimisation framework tailored to the Chinese context. The main contribution lies in clarifying cross-jurisdictional and multi-scalar spatial coordination strategies under

1 In the Chinese planning context, the term "Metropolitan Area" (Da Dushi Quan, , literally "Metropolitan Circle") often refers to a broad spatial unit centred on a megacity, encompassing multiple adjacent cities with strong functional and economic linkages. For example, the "Shanghai Metropolitan Area ()" covers over 56,000 square kilometres and includes more than ten major urban centres (Shanghai Municipality People's Government et al., 2022). This scale and structure go well beyond the conventional international definition of a "Metropolitan Area," which typically refers to a single large city and its contiguous suburban or satellite areas. To avoid confusion, this paper refers to the Chinese concept of "Da Dushi Quan" as an "Extended Metropolitan Region (EMR)," emphasising its cross-jurisdictional, polycentric, and functionally integrated nature.

China's specific developmental background, thereby enriching theoretical and practical links between high-quality development and rail transit planning.

The paper is structured as follows: first, it outlines the research background and theoretical foundations; second, it examines China's urbanisation stage and its comparison with international processes; third, it analyses the current challenges in rail transit development and proposes multi-scalar optimisation strategies for the regional, metropolitan, and suburban levels; and finally, it evaluates the applicability and feasibility of these strategies through a case study of Shanghai and its surrounding areas.

2. Theoretical Framework and Literature Review

2.1 Definition and Characteristics of Post-urbanisation

Around the 1970s, population stagnation and even decline in some large Western cities attracted attention in the fields of planning and geography. This prompted research on whether urban dispersal signified a new stage of development (Korcelli, 1980). Berry (1980) introduced the concept of "counter-urbanisation" to describe the shift of population from metropolitan areas to smaller towns and rural areas. Subsequent studies have explored various features of "post-urban society", including ageing populations, urban shrinkage, and the governance of urban regeneration (Mitchell, 2004; Tateishi et al., 2025).

Existing literature often evaluates whether a region has entered a "post-urbanisation" stage based on population dynamics, spatial patterns, and industrial transformation (Martinez-Fernandez et al., 2012). The most typical indicator is demographic: a marked slowdown in urban population growth, stabilisation of urbanisation rates at a high plateau, and signs of zero or negative growth in urban population. Under continued population decline, urban shrinkage becomes tangible (Tateishi et al., 2025). Spatially, cities experience slower expansion, decoupling economic growth from land development and trends such as polycentricity, suburbanisation, and counter-urbanisation. Central areas may see declining density and functional reconfiguration (Bontje, 2004; Wan et al., 2023). Industrially, a shift from industrial to service-oriented economies—i.e., post-industrialisation—is observed. Urban development transitions from incremental expansion to productivity enhancement and innovation-driven growth, relying less on population and land increases (Cai et al., 2020).

2.2 Post-urbanisation in the Chinese Context: New Urbanisation and High-Quality Development

"Post-urbanisation" is rarely used in Chinese official and academic discourse. Instead, phrases such as the "later stage of urbanisation" or "second half of urbanisation" are more common and often discussed in relation to concepts like "counter-urbanisation" and "urban shrinkage". Data indicate that China's population began to decline in 2021. However, due to regional disparities, the urbanisation rate of the resident population continues to rise—reaching approximately 67% by the end of 2024—marking an entry into the late stage of urbanisation.

Scholars remain divided on whether China is entering an era of urban shrinkage. Some argue that due to large rural populations and uneven development, China still has untapped potential for rural-to-urban migration, and the demographic dividend of urbanisation has not yet been exhausted (Xie and Lin, 2023). Others note that China's working-age population has already peaked, with one-third of cities exhibiting signs of shrinkage (Li et al., 2025) and that the momentum of urbanisation is weakening. Some scholars contend that, given China's vast territory and internal heterogeneity, post-urbanisation phenomena first appear in megacities and developed regions, while less developed areas remain in earlier stages. There is also no consensus on the urbanisation rate at which China will stabilise: some estimates suggest it will not exceed 80% (Qiao et al., 2018), while others anticipate it will surpass that threshold (Chen and Luo, 2006). Nonetheless, there is broad agreement that China's developed regions and megacities already exhibit post-urbanisation traits. Most researchers advocate for proactive planning responses to the profound impacts of demographic and spatial changes (Wu et al., 2020).

From a policy perspective, the Chinese government has shifted its urban development focus from rapid expansion to stabilisation, calling for a transition from incremental to stock-based optimisation. As such, Chinese discourse centres more on "new urbanisation" or "high-quality development", emphasising rural-urban integration, regional coordination, and qualitative urban enhancement, rather than adopting the "post-urbanisation" label.

In this sense, China's interpretation of "post-urbanisation" implies a phase of quality improvement and structural optimisation, rather than an outright decline following complete urbanisation.

2.3 Optimising Spatial Structures and the Role of Rail Transit under High-Quality Development

The effective interplay between spatial structure optimisation and transport systems is essential for achieving regional high-quality development. In China, megacities showing post-urbanisation features must simultaneously restructure their economies and support regional growth, necessitating refined spatial strategies. Theoretical foundations for spatial structure optimisation—such as central place theory, growth pole theory, polycentricity, and corridor–node theory—have evolved and combined in planning practice to provide robust conceptual tools. It is now widely acknowledged that transport systems—particularly rail transit—play a pivotal role in shaping and improving urban–regional spatial configurations (Urena et al., 2009; Gu and Kou, 2017; Hu et al., 2023). Transport influences spatial form, evolution, and restructuring by enhancing accessibility, guiding land use, and shaping corridors and nodes. International experiences in metropolitan regions reveal the profound effects of rail systems on spatial transformation, underscoring the need for coordinated transport–land use planning as a foundation for structural optimisation (Cao, 2023; Sun, 2024; Chen et al., 2010).

3. "Beyond Growth" in China: Indicators and Contradictions in the Post-urbanisation Stage

3.1 Assessing China's Urbanisation Stage: Domestic and International Comparisons

(1) China's Urbanisation Stage

In recent years, China has entered a transitional period characterised by population decline and a continued rise in the urbanisation rate. This is particularly evident in megacities such as Beijing and Shanghai, where post-urbanisation features have emerged. Although the national urbanisation rate has not yet stabilised, government policy has clearly shifted towards "stock optimisation" and "decremental development", emphasising spatial quality and efficiency more.

From a macro perspective, China raised its urbanisation rate from 20% to 67% within four decades, adding 670 million urban residents. This rapid increase has begun to slow. Meanwhile, by 2024, the national population had fallen to 1.408 billion, with a natural growth rate of –0.99‰—the third consecutive year of negative growth. The proportion of the population aged 65 and above rose to 15.6% and continues to climb (NBS, 2023; NBS, 2024; NBS, 2025). In 2024, the natural growth rates of Beijing and Shanghai were 0.01‰ and –1.53‰, respectively (Beijing Municipal Bureau of Statistics and NBS Survey Office in Beijing, 2025; Shanghai Municipal Bureau of Statistics and NBS Survey Office in Shanghai, 2025). Both cities have adopted "zero growth" targets for built-up areas, and the tertiary sector accounts for over 75% of their GDP, illustrating clear signs of post-urbanisation. However, beyond these megacities, many large cities remain in an expansion phase.

(2) Origins of the "Beyond Growth" Framework: An International Comparison of Urbanisation

Regional disparities in China have resulted in population migration toward cities continuing even as the total population declines. This means that urbanisation is still unfolding even as the negative growth sets in. Despite resource constraints and social tensions, megacities must continue growing to support surrounding underdeveloped areas. During the high-speed urbanisation era, motorisation accompanied urban expansion, leading to spatial growth driven mainly by land development and road construction, while rail transit development lagged. As a result, applying the "beyond growth" framework in China requires addressing both the limitations of growth-dependent planning and the historical challenges of rapid urbanisation.

International comparisons reveal that China's urbanisation exhibits distinct temporal and structural differences. First, China's urbanisation process has been speedy and involves a massive population. While its speed is comparable to that of Japan and South Korea, the scale is much larger. When Japan and South Korea surpassed 60% urbanisation, they had urban populations of approximately 103 million and 41 million, respectively. In contrast, China's population reached 1.4 billion in 2019 when the urbanisation rate hit 60.6%, placing greater pressure on infrastructure and public services. Second, the sequencing of urbanisation and population decline differs significantly. In most developed countries, population decline followed stabilisation at urbanisation rates of over 70%. In China, however, population decline began when the urbanisation rate was around 65%, and rural-to-urban migration had not yet concluded. Urbanisation is still advancing. Consequently, China must simultaneously address ageing, absorb migrating populations, and continue urban development—creating unprecedented fiscal and planning pressures. Third, rail transit development lagged behind motorisation, exacerbating structural urban challenges. Road-based expansion dominated during China's rapid growth phase, but rising congestion now hinders efficiency. Moreover, China entered the post-demographic-dividend phase before fully transitioning to a service economy. As a result, cities face dual pressures: job provision and revenue generation.

In summary, China cannot directly adopt the "stop expanding" model of developed countries. Even in a post-urbanisation context, structural optimisation and functional transformation are necessary to promote spatial efficiency and regional balance—goals for which rail transit is a key driver.

3.2 The Demand and Dilemmas of Rail Transit under High-Quality Development

China's unique urbanisation background explains the necessity of rail transit development and the conditions it must address. As a guiding principle, high-quality development imposes new structural demands on spatial planning and infrastructure systems. Functionally, rail transit is no longer simply a commuter tool but a critical mechanism for urban structural adjustment and transformation of the urban settlement system (Chen et al., 2017; Chen et al., 2022).

However, in practice, Chinese metropolitan rail transit systems still face multiple challenges. First, corridor capacity is limited and construction space in central areas is nearly saturated. Second, reuse rates of existing railways remain low, especially for mid-level suburban rail networks, which are severely underdeveloped (Li, 2022). Third, marginal returns are diminishing, with high construction costs, low returns, and rising fiscal pressure. Fourth, operational fragmentation persists, with inadequate cross-jurisdictional collaboration and a lack of integrated systems.

In response to these issues, China's rail transit must move beyond linear, expansion-based logic and adopt a more efficient, structural, and coordinated development model. On one hand, the system should support regional rebalancing and the reorganisation of urban–rural structures, ensuring strong connections to new towns and key regional nodes. On the other hand, it must also evolve internally—from quantity-driven supply to quality-oriented structure—achieving a clear division of labour and coupling within a multi-level rail system.

Based on these goals, this paper proposes a rail transit optimisation framework across three spatial scales: the regional level, the metropolitan level, and the suburban level. This framework aligns with the values of high-quality development—equity, efficiency, and sustainability—and aims to provide systematic support for spatial restructuring and industrial transformation in China's megacities during this critical "window period".

4. A Framework for Coordinated Optimisation Between Rail Transit Networks and Regional Spatial Structures: Strategy and Case Study

4.1 Key Elements and Framework for Coordination Between Rail Transit Networks and Spatial Development

(1) The Nature of Coordinated Development

The coordinated development between rail transit networks and urban spatial structures is fundamentally a dynamic, bidirectional interaction. Each influences and reinforces the other, forming a feedback mechanism. Urban spatial development goals support and guide the optimisation of rail networks, while rail networks themselves serve as a critical system for directing resource allocation and the evolution of spatial structure.

Optimising rail network layout requires a sound understanding of current spatial conditions and development objectives. A clear strategic vision for spatial development forms the foundation for identifying rail priorities and improving network efficiency. Rail systems, built upon corridors and nodes, directly affect population mobility, land use, and industrial distribution. By improving accessibility and strengthening regional linkages, rail transit shapes spatial structure and influences resource allocation efficiency.

(2) Core Elements and Multi-level Framework

When urban and regional development demands are reflected in rail networks, they manifest as spatial connections and expectations regarding travel time and service intensity. A multi-level framework can represent these dynamics from a spatiotemporal perspective.

This framework should include at least three spatial levels, each with distinct functions and elements. The three core components for coordinated optimisation are rail lines (enabling the flow of resources across different scales), nodes or hubs (connecting systems and spaces), and policy mechanisms (ensuring implementation and governance) (Figure 1). Specifically:

At the regional level, intercity and high-speed rail connect major urban nodes, support the formation of strategic corridors, and serve business travel needs. The target is to reach metropolitan hubs within one hour.
At the metropolitan level, rail systems—comprising suburban rail, intercity lines, and metro—link central cities, new towns, and peripheral urban areas, supporting medium- to long-distance commuting.

At the central level, metro systems form dense intra-city networks primarily used for short-distance daily travel. Service coverage should also reach within an hour.

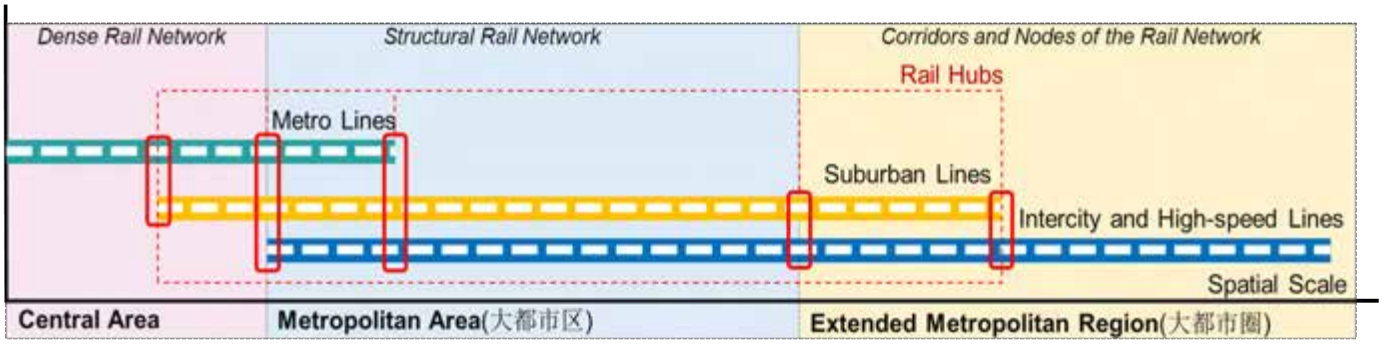

Figure 1. Multi-level Rail Transit Network Framework

4.2 Specific Strategies and Case Studies for Coordinated Optimisation of Rail Transit and Spatial Structure

4.2.1 Objectives and Strategies of Rail Transit Optimisation

The objectives of rail transit network optimisation should be determined by regional challenges and strategic development goals. In the current Chinese context, rail transit optimisation aims to establish a multi-level rail transit system operating across three spatial levels: the regional level, the metropolitan level, and the central level. This system facilitates development goals through strategic node connections and varying operational frequencies.

Specific strategies include: Firstly, at the regional level, enhancing functional corridors centred around major cities to guide the urban settlement system. Secondly, at the Extended Metropolitan Region (EMR) level, promoting efficient resource mobility through multi-layered, multifunctional rail hubs and mitigating spatial fragmentation caused by administrative boundaries. Thirdly, at the metropolitan level, establishing suburban rail as the structural backbone network to overcome the limitations of existing dense metro networks and efficiently connect central urban areas with peripheral new towns (Figure 2).

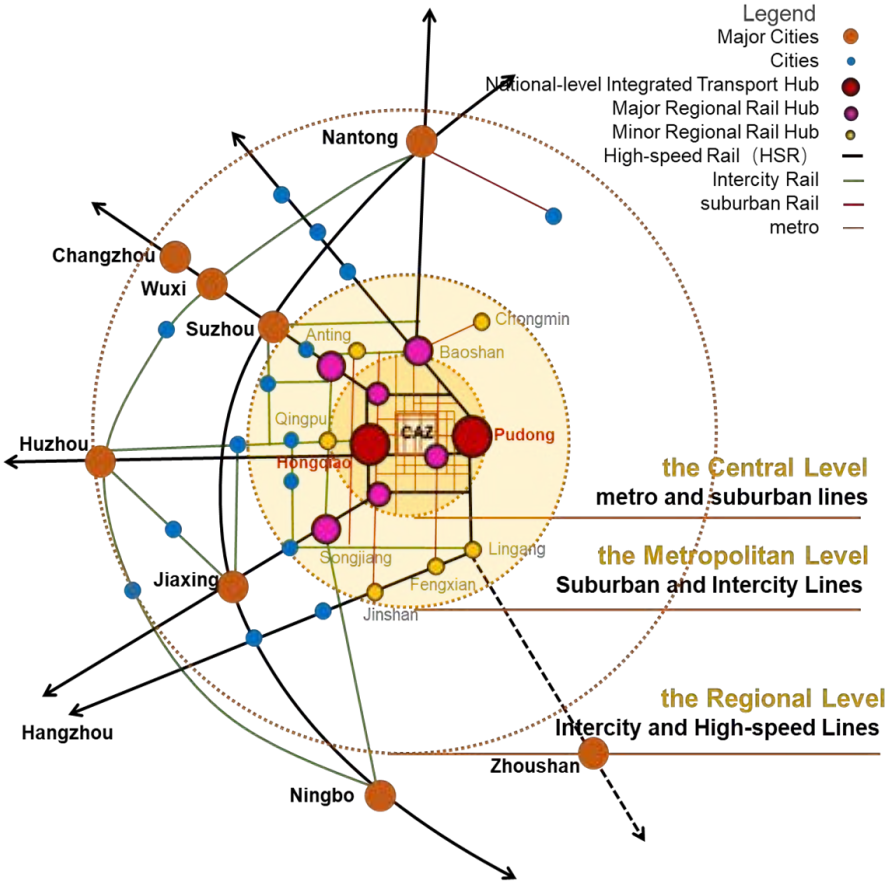

Figure 2. Multi-level Spatial Structure of Rail Transit

The following sections use the Yangtze River Delta and Shanghai Metropolitan Area to further illustrate these strategies.

4.2.2 Urban Agglomerations and Extended Metropolitan Regions: Corridors and Nodes

(1) Regional Corridors and Urban Strategies

At the regional level, rail transit serves not only connectivity functions but also as a strategic instrument for urban development, guiding the implementation of regional goals related to population mobility, economic development, ecological protection, and cultural exchange.

Taking the Shanghai Metropolitan Area as a case, optimisation strategies are developed around these regional strategic goals. Six strategic corridors have been identified: Shanghai–Nanjing, Shanghai–Hangzhou, Yangtze River Corridor, Coastal Corridor, Hangzhou Bay Corridor, and Shanghai–Huzhou Corridor. The Shanghai–Nanjing and Shanghai–Hangzhou corridors should enhance service frequency to maximise existing capacity. The Yangtze River and Coastal Corridors are reserved corridors prioritised based on industrial development demands, while the Shanghai–Huzhou Corridor is prioritised for immediate development, serving tourism and cultural needs (Figure 3). The analysis evaluates corridor performance through both industrial and cultural lenses, ensuring that key natural and cultural nodes—such as World Heritage Sites—are connected to external hubs via rail transit. (Figure 4).

Figure 3. Strategic Rail Corridors in the Shanghai Metropolitan Area

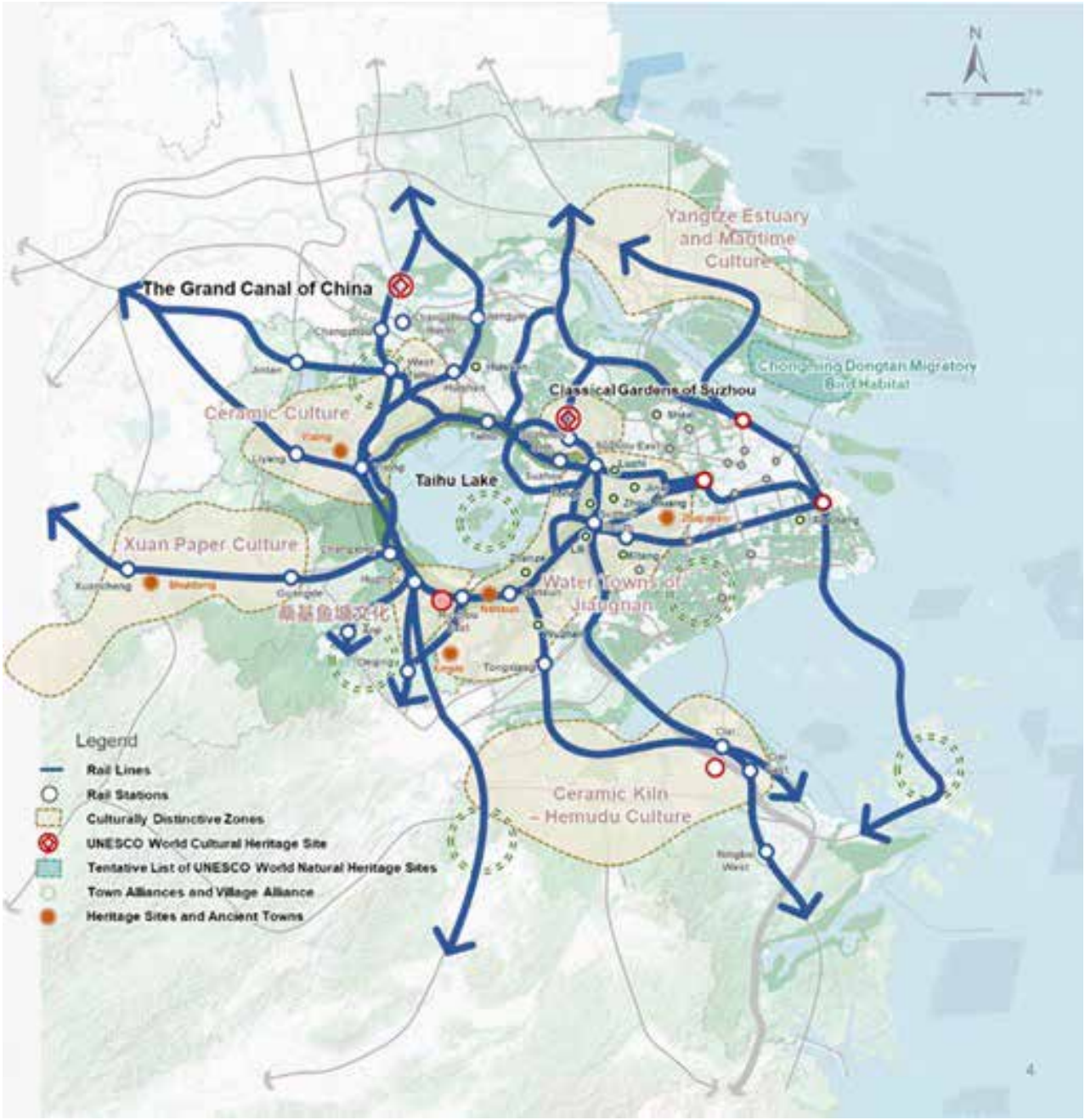

Figure 4. Rail Transit System Supporting Natural and Cultural Heritage in the Shanghai Metropolitan Area

(2) Multi-level Networks and Urban-town Systems
Establishing multi-level rail transit systems supports the optimisation of regional spatial structures and urban settlement systems in the framework of high-quality urbanisation. Rail transit networks should address three connection types: intercity connections at the regional level, daily commuting within Extended Metropolitan Regions, and internal city connections.

Using the Shanghai Metropolitan Area as an example, the study analyses urban development roles and inter-city connectivity, proposing layered and composite optimisation strategies. It emphasises compound utilisation of corridor resources, detailed layered scheduling, and differentiated stop schemes to enhance overall network efficiency and spatial structural optimisation (Figure 5).

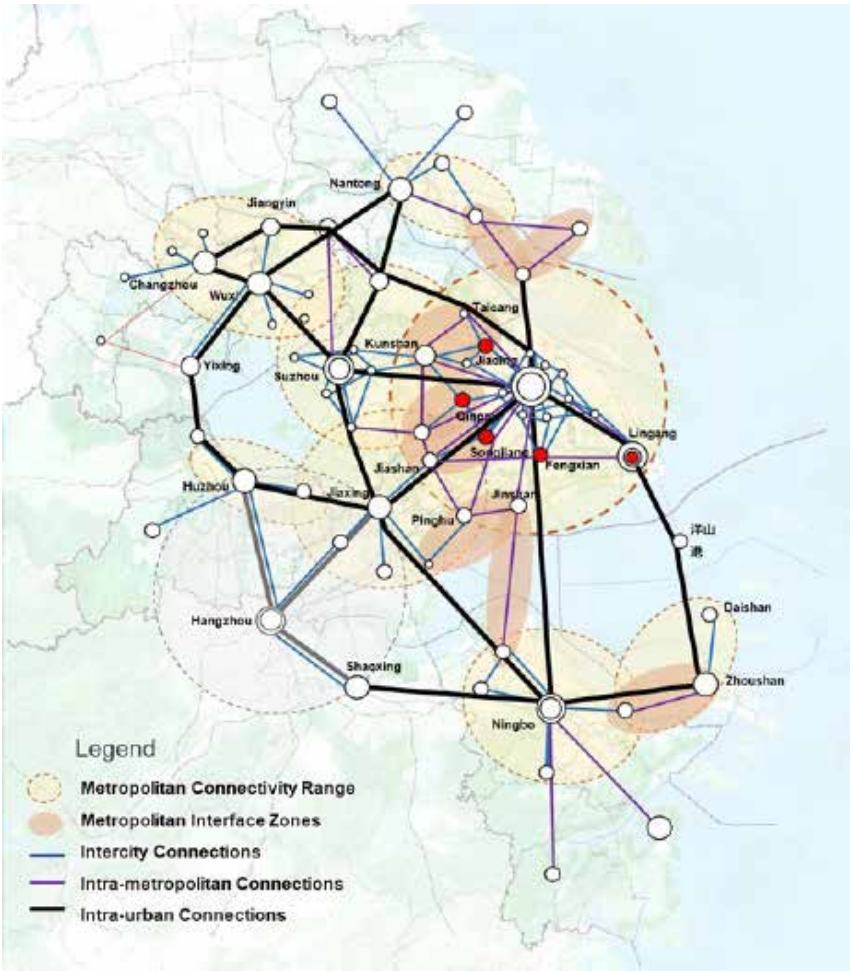

Figure 5. Inter-city Connectivity in the Shanghai Metropolitan Area

4.2.3 Metropolitan Area: Structural Network

(1) Hub Systems and Resource Allocation

Rail stations serve as critical interfaces linking transit systems with urban spaces. Rather than relying on a single mega-hub, tiered and functionally differentiated hub systems can more effectively facilitate the allocation of urban resources. This study proposes a classification of five hub types, divided into two categories. Type I includes national and regional hubs: national-level integrated transport hubs (such as the Hongqiao Integrated Transport Hub), major regional rail hubs, and minor regional rail hubs (Figure 6).. Type II includes suburban network hubs, which consist of new town hubs (designed to link newly developed urban areas with the broader regional network) and central hubs (which integrate suburban rail with metro systems to enable seamless transfers) (Figure 7).

In the case of Shanghai, the city's excessive dependence on the Hongqiao Integrated Transport Hub—currently handling 60% of all rail passengers and operating at nearly 90% of its designed capacity—necessitates a more balanced hub network. To address this, the study recommends strengthening the role of the Eastern Hub, centred around Pudong International Airport, to ease pressure on the western corridor. It also advocates for the enhancement of Baoshan and Longyang Road stations to complement the functions of Shanghai, South, and West stations as part of the regional hub system. Additionally, the study proposes establishing general-purpose suburban hubs along the urban periphery, designating new town hubs in each of the five new towns, and developing new central hubs at the edge of the central area to improve integration between suburban rail and metro services.

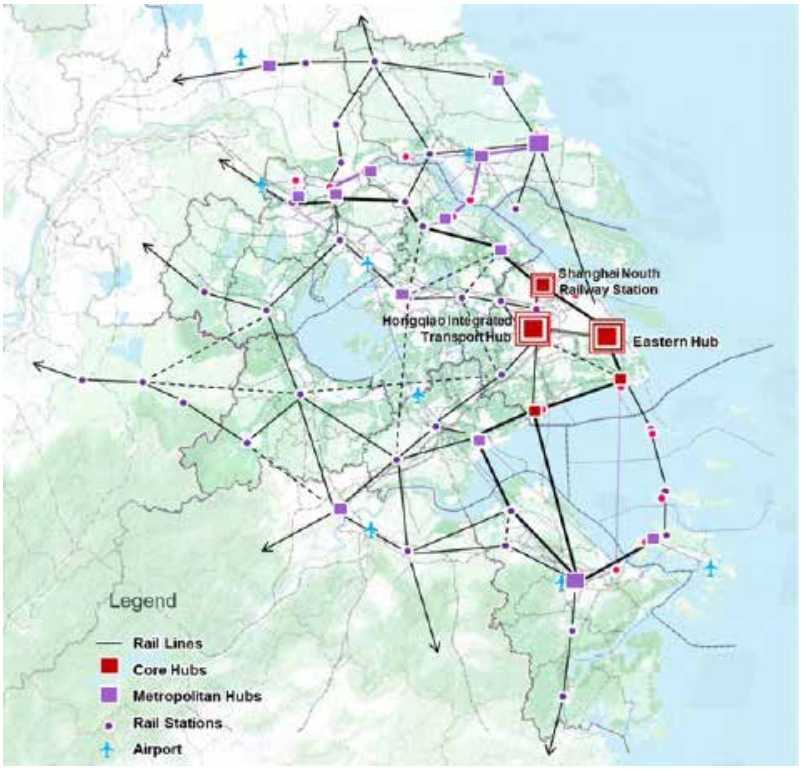

Figure 6. Rail Hub System of the Shanghai Metropolitan Area

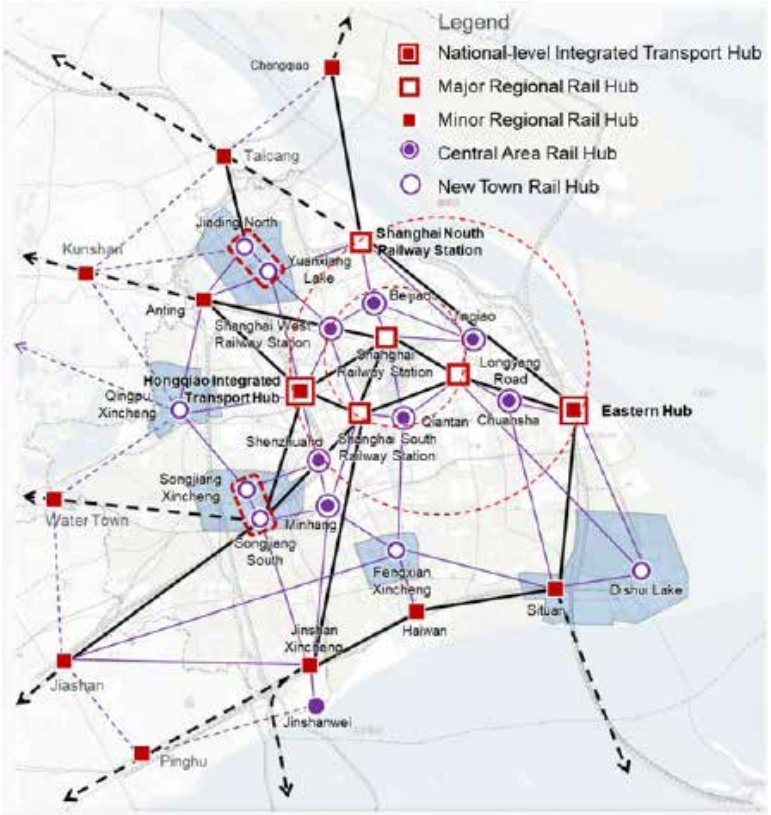

Figure 7. Rail Hub System of Shanghai and Its Adjacent Areas

(2) Suburban Rail and Inter-jurisdictional Cooperation
With increasing cross-boundary commuting within metropolitan areas, administrative boundaries currently limit the effectiveness of rail systems, hindering new town development. The study suggests integrating suburban and intercity rail at boundary regions to enhance connectivity.

In the Shanghai Metropolitan Area, insufficient suburban and intercity rail infrastructure currently restricts cross-city commuting, risking increased traffic congestion. Drawing lessons from Paris and Tokyo, this study advocates detailed reclassification of rail lines within boundary areas, aiming to strengthen regional cooperation and transform peripheral new towns into multifunctional urban nodes, thus preventing their evolution into mere residential towns (Figure 8).

Figure 8. Cross-boundary Rail Coordination

4.2.4 Metropolitan Areas: Structural Dense Networks
Central urban rail networks are increasingly complete in most major cities, but peripheral areas remain inadequately supported. As a structural backbone, suburban rail efficiently links central and peripheral areas. The study recommends a phased, demand-driven approach rather than extensive new construction.

In Shanghai, peripheral central areas experience high commuting pressures, significant industrial and population renewal, and severe congestion. Structural reinforcement through constructing a central loop line and radial suburban lines is proposed to strengthen connectivity between central areas and new towns, optimising regional spatial structures (Figure 10).

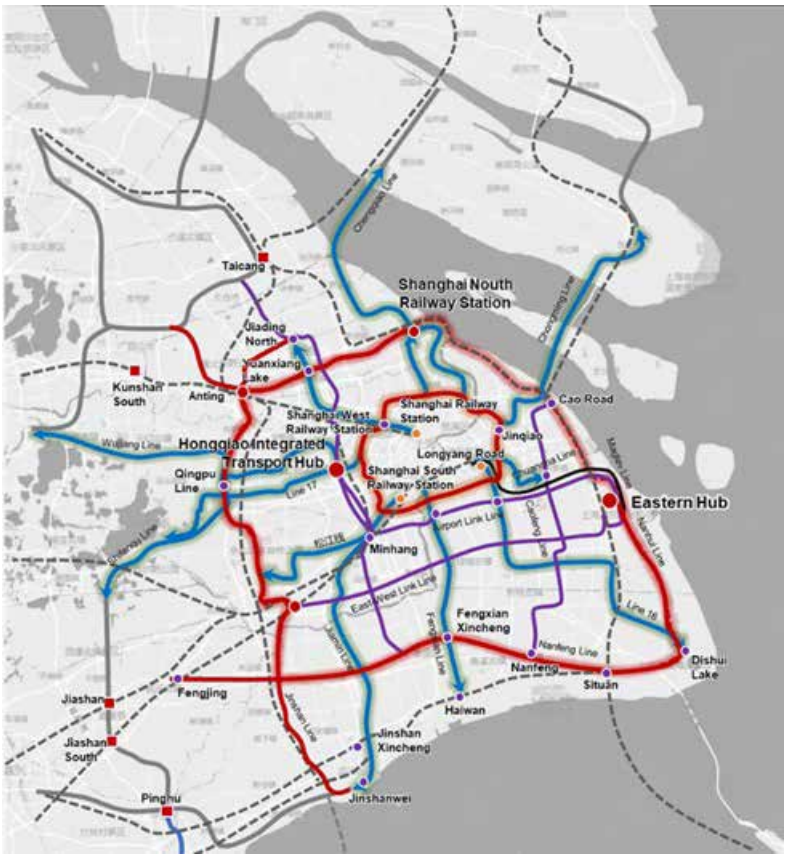

Figure 10. Suburban Rail Structure in Shanghai

4.2.5 Development, Construction and Operation Modes

Clear delineation of rail transit development, construction, and operation responsibilities is critical for sustainability. The study highlights the importance of clarifying roles between central and local governments and establishing inter-jurisdictional coordination mechanisms.

It recommends that Shanghai leads coordination efforts, establishing a comprehensive planning, construction, and operation platform involving neighbouring cities. The coordination should define technical schemes, operational responsibilities, and service standards for network integration. Diversified financing models and Transit-Oriented Development (TOD) approaches should be adopted to ensure sustainable rail transit development.

5. Conclusion

This study, situated in the context of China's transition to the mid-to-late stage of urbanisation, explores the key role and practical challenges of rail transit in promoting spatial optimisation and facilitating the flow of urban elements under the high-quality development paradigm.

Comparative analysis reveals that China's urbanisation path differs significantly from Western models: population decline has begun before urbanisation is complete; inefficient spatial expansion resulted from delayed rail development; and industrial restructuring is under pressure due to an underdeveloped service sector. These contradictions make it clear that China cannot follow a "de-growth" model but must pursue a focused, structure-oriented, high-quality development strategy within the "beyond growth" framework.

To this end, the study proposes a multi-level rail transit optimisation framework across regional, metropolitan, and suburban scales. Unlike traditional large-scale expansion, the proposed approach emphasises structural reinforcement, integrated corridor use, and hub function reconfiguration:

At the regional level, high-speed and intercity rail should support corridors and key nodes.

At the metropolitan level, cross-jurisdictional coordination and balanced functionality are key.

At the suburban level, suburban rail should form the backbone, supported by the metro system, to enhance commuting efficiency and reduce central city pressure.

The case study of the Shanghai Metropolitan Area confirms the framework's applicability and feasibility. Practices such as structural optimisation, corridor integration, and operational coordination align with today's resource constraints and governance complexities more than blind expansion.

This research expands the theoretical discourse on rail transit and offers a context-specific strategy for China's development model. It may also be a reference for other countries facing similar post-urbanisation challenges. Nonetheless, limitations remain—for instance, further research is needed to assess economic impacts and operational mechanisms in greater detail. Future studies should explore the design of inter-jurisdictional governance systems and assess the long-term spatial and socio-economic effects of rail transit strategies.

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