

– внедрение нейросетевой системы прогнозирования отказов тягового оборудования в проектах РЖД на участках Московского транспортного узла.

К ключевым проблемам внедрения предиктивных моделей относятся:

- высокая стоимость сенсорной и вычислительной инфраструктуры;
- недостаточная унификация данных разных подсистем;
- сложности интерпретации решений нейронных сетей;
- кадровый дефицит специалистов по ИИ в транспортной отрасли.

По сравнению с традиционными методами диагностики (периодический контроль и ручной анализ), системы ИИ обладают более высокой чувствительностью и скоростью реагирования. В отличие от статистических моделей, они обеспечивают адаптивность к изменяющимся условиям эксплуатации и возможность самообучения на новых данных.

Для повышения эффективности внедрения систем ИИ в пассажирских перевозках рекомендуется:

- разработать национальные стандарты цифровых данных железнодорожной инфраструктуры;
- внедрить единую платформу предиктивной аналитики на уровне транспортных холдингов;
- стимулировать совместные проекты ИИ-разработчиков и железнодорожных предприятий;
- развивать подготовку инженерных кадров с компетенциями в области анализа данных и машинного обучения.

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## RESEARCH ON OPTIMIZATION STRATEGY OF RAILWAY PASSENGER TRANSPORT HUB LAYOUT OF GUANGZHOU BASED ON STATION-CITY INTEGRATION

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As a connection point between urban internal transportation and external transportation, the layout of railway passenger transport hubs affects the comprehensive efficiency of urban operation. With the finalization and implementation of plans for railway passenger stations in central cities such as Tongzhou Station in Beijing's sub-center, Guangzhou Baiyun Station, and Chongqing Shapingba Station, the development of station-city integration in China has entered a new stage. Comprehensive transportation hubs featuring station-city integration are characterized by invisible transportation, spatial integration, seamless connection, centralized management, and intelligent services [1, 2].

By sorting out the layout of railway passenger transport hubs in typical cities at home and abroad, summarizing the requirements for urban territorial space optimization and the development trends and experiences of the railway system in high-speed railways, conventional railways, and freight transportation, combined with the actual situation of Guangzhou as a national central city, this paper puts forward targeted optimization strategies for the station-city integrated layout planning of Guangzhou's railway passenger transport hubs [3].

In accordance with the hub layout optimization strategy and the idea of "multi-station layout, large concentration with small dispersion, and direction-specific management", Guangzhou plans 15 railway

passenger stations around the Guangfo area, presenting an overall pattern of "five inner stations and five outer stations", while strengthening hub interconnection [4]. The overall layout of Guangzhou's railway hubs is shown in Figure 1.

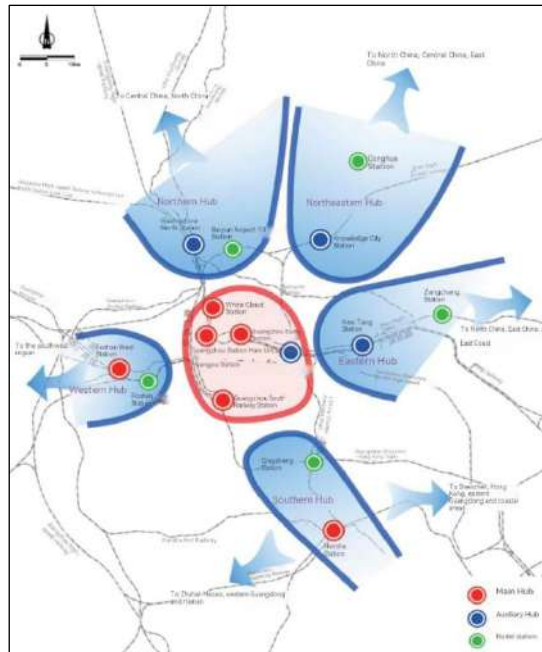


Figure 1 – General Layout of Guangzhou Railway Transport Hubs

Guangzhou Station is located in the core of Guangzhou's traditional old urban area, and Guangzhou East Station is located in the modern CBD area, boasting advantageous locations and superior passenger distribution conditions. Therefore, they will be constructed in accordance with the standards of central railway stations. Through hub optimization and double-deck station reconstruction, the capacity of station facilities will be improved to achieve "zero transfer, integration, and connectivity between buildings", boosting urban renewal and upgrading, and enhancing the overall environment of the stations and the city. At the same time, the operation of Baiyun Station will be accelerated, and Huangpu Station will be added in the eastern part of the main urban area. It will undertake the passing and originating/terminating trains of the newly added north-south trunk railways, including the Guangzhou – Zhongshan – Zhuhai – Macao High-Speed Railway (Guangzhou North – Macao), the Second Guangzhou – Shenzhen High-Speed Railway (Guangzhou East – Xili), and the Guangzhou – Yongzhou High-Speed Railway (Guangzhou North – Yongzhou), sharing the arrival and departure pressure of Guangzhou East Station and serving the second central business district of Guangzhou nearby [5, 6]. In general, the 5 hubs in Guangzhou's main urban area, namely Guangzhou Station, Guangzhou East Station, Guangzhou South Station, Baiyun Station, and Huangpu Station, handle the originating and terminating operations of most trains in all directions, with frequent train services, short departure intervals, high service levels, and a wider service scope. In terms of station-city integration, taking Baiyun Station as an example, in addition to transportation facilities, a 460000-square-meter over-cover comprehensive development is planned, including mixed functions such as commercial retail, hotels, office buildings, and apartments [7].

Guangzhou's conventional passenger flow mainly comes from the Pearl River Delta region. With the completion and operation of the Pearl River Delta intercity railway network, the regional collection and distribution system of peripheral railway passenger stations has been gradually improved, and the time is ripe for the relocation of conventional railways. With the improvement of the high-speed railway network and the transformation of railway travel modes, the volume of conventional railway departures has decreased significantly. Guangzhou's conventional trains will be concentrated at Baiyun Station for arrival and departure. From Guangzhou North Station, they will travel westward via the Guangzhou Railway (Jiangcun – Gaolan Port) to the west bank of the Pearl River and western Guangdong, and eastward via the Northeast Freight Bypass Line to the east bank of the Pearl River and eastern Guangdong. With the completion of the Northeast Freight Bypass Line, Datian Container Yard, Zengcheng Freight Yard, etc., all freight functions of railway lines in Guangzhou's central area will be transferred to the periphery, effectively improving the internal transportation efficiency of Guangzhou's railway hub.

Guangzhou's peripheral urban areas are far from the main urban area, resulting in inconvenient travel. There are no railway passenger stations in Conghua, Nansha, and other places. To improve the level of railway services and facilitate passengers in peripheral urban areas to take high-speed railways, 5 high-speed railway stations will be set up in peripheral urban areas in combination with the trunk railways introduced into Guangzhou's main urban area, forming the "five outer stations" hub layout and solving the problem of unbalanced and inadequate hub services. These stations will serve the travel of nearby groups on the railway corridors in their respective directions, mainly handling passing trains with relatively few services, long departure intervals, and a relatively small service scope. The interconnection of railway hubs is shown in Figure 2.

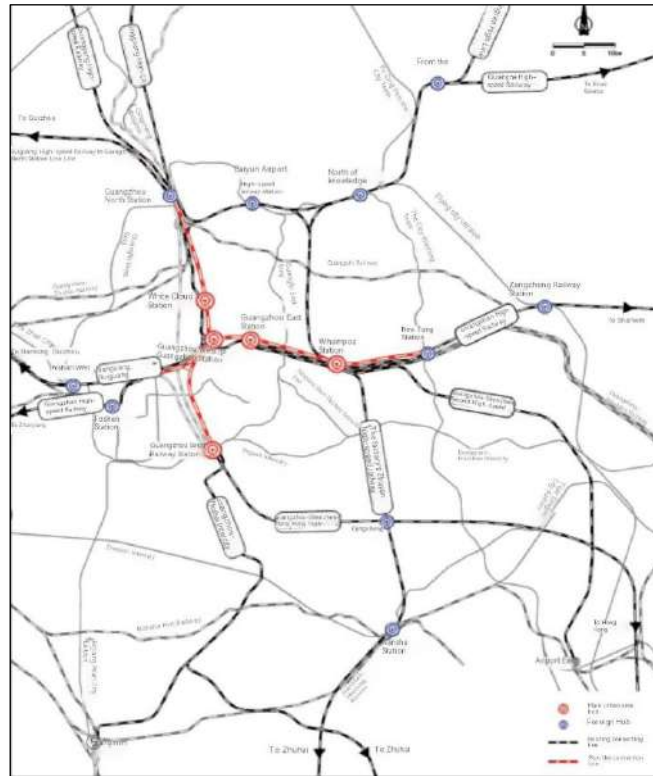


Figure 2 – Interconnection between Guangzhou Railway Transport Hubs

In the north direction, Guangzhou North Station will serve as a composite group hub, serving Huadu District and the Airport Economic Zone. In the northeast direction, the Baiyun Airport High-Speed Railway Station, Knowledge City Station, and Conghua Station are planned. Among them, the Baiyun Airport High-Speed Railway Station is positioned as an air-rail intermodal hub, serving the Airport Economic Zone and air-rail intermodal passenger flow, while Knowledge City Station and Conghua Station are single-group hubs serving their respective areas. In the east direction, Xintang Station and Zengcheng Station will serve the eastern composite group and the Licheng single group respectively.

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