Integrating Station-Area Development with Rail Transit Networks: Lessons from Japan Railway in Tokyo

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Abstract Rail transit is a primary transport mode in Tokyo and has become the backbone of its urban development. Tokyo rail transit networks consist of the subway in the central area, private railways in the suburban area, and Japan Railway (JR) in both central and suburban areas. Prior research revealed that JR has better coordination of transit node functions and station-area development than subway and private railway stations, but how Tokyo’s JR station-area development integrates with its network growth is less explored. This work investigates how JR station-area development grows in tandem with network expansion, by revisiting different historical phases. The results show that, in the beginning of the twentieth century, JR connected major urban nodes in both central and suburban Tokyo, and therefore became the skeleton of Tokyo’s transit systems. During the post-earthquake and post-war period, central subway and suburban private railways gradually met JR on the Yamanote line, enabling the major interchange stations to develop into urban centers. In the 1960s, JR increased its services to alleviate passenger congestion and undertook grade separation projects to reduce conflicts with road networks. The 1987 JR privatization marked a turning point of massive station-area redevelopment. JR station areas have been transformed from underutilized industrial land into high-density commercial use, and major JR stations were comprehensively replanned for identity and place-making. After a centennial development, JR stations have become important interchange and express-service nodes on Tokyo transit networks with intensive land use and different urban functions. The Tokyo JR case can provide insights for metropolitan cities on how to integrate rail transit infrastructure with station-area development, including matching critical nodes in transit networks with urban functions and high-density land use and connecting these urban functions through express line services.

Keywords Transit-oriented development · Transit network · Land use · Japan Railway · Tokyo

1 Introduction

Rail transit systems are the backbone of urban public transport, with high capacity and low environmental impacts [1]. Transit-oriented development (TOD) has become an important planning strategy for sustainable urban development that underlines the coordination between land use and transit infrastructure [2, 3]. In Tokyo, rail transit constitutes a daily commuting tool and undertakes a mode share of 51% in 2018. Tokyo rail transit networks consist of three interconnected layers: subway in the central area, private railways in the suburban area, and Japan Railway (JR) in both central and suburban areas. While subway and private railways serve dedicated areas, JR functions as the major channel that not only connects important locations inside Tokyo, but also links Tokyo to greater areas. Prior research revealed that JR has better coordination between transit node functions and station-area development, thus having a higher average ridership.
than subway and private railway stations [4]. However, how Tokyo JR station-area development integrates with its network growth is less explored. The existing literature about JR examines either JR national-scale network [5, 6] or JR institutional reforms [7–9]. Studies on Tokyo transit-oriented development are mostly focused on all transit operators as a whole [10–12], private railway stations in suburban areas [13], and examples of big stations [14]. There are still very few studies on transit-oriented development of JR stations in Tokyo.

JR in Tokyo has a history of more than 100 years. Its predecessor was the national railway in the late nineteenth century. In 1949, the national railway became the Japan National Railway (JNR), a state-owned public corporation. In 1978, JNR was privatized and divided into six regional passenger companies. This work aims to understand how the Tokyo JR station-area development grow in tandem with transit network expansion, by revisiting different historical phases.

2 Before the 1923 Great Kanto Earthquake: JR Connected Major Districts of Tokyo as Commuting Corridors

Japan ushered in the Meiji Restoration in 1868 and shifted the capital from Kyoto to Tokyo. Since the late nineteenth century, Tokyo has been a test bed for westernization and industrialization. Rail transit was recognized as a symbol of modernization and a new infrastructure for efficient transportation. When the Tokyo Rearrangement Ordinance was passed, rail transit received much attention to lead modern urban planning. This gave a chance for the national railway to flourish, which was the initial form of the JR.

Tokyo opened its first national railway line in 1872, which ran from Shimbashi station in Tokyo to the city of Yokohama [6]. The services and operations were under the direct management of the Japanese government, but the tracks and locomotives were built with British support. In the 1880s, privately owned railway operations were allowed, among which the Nippon Railway company started to build lines from the Tokyo Ueno station to the Tohoku region (the northeast of Japan) [5]. However, as the 1892 Railway Construction Act and 1906 Railway Nationalization Bill were passed to restrict private operation and make way for national power, private railways in the mainline networks were nationalized. The combined national railways further entered Tokyo and grew into a loop to connect major districts [15]. As shown in Fig. 1, the Yamanote line is the circle line that connects the Shimbashi, Ueno, Shibuya, Shinjuku, Ikebukuro, and Tokyo railway stations; the Chuo line runs east–west and cuts through the circle Yamanote line. Passengers used national railway lines for both inner-city commuting and regional connections, which became the skeleton of future Tokyo transit systems.

3 Post-earthquake and Post-war Development: Interchange Stations Between JR, Private Railway, and Subway Grew into Urban Centers

Tokyo was destroyed in the 1923 Great Kanto Earthquake and then experienced a great boom in the Second World War. After the earthquake and the Second World War, Tokyo started two rounds of reconstructions and experienced fast population growth. Under the pressure of increasing population, Tokyo began building subway lines in its central area to relieve road congestion and building private railway lines in suburban area to lead urban expansion. The development of subway and private railway lines gradually met JR networks, where the interchange stations grew into different urban centers.

The subway networks were constructed in central Tokyo as a replacement for road trams. In the 1920s, the tram length reached 140 km, and was still unable to meet the soaring demand. Tokui Hayakawa was a pioneer in proposing underground subways and successfully applied for approval from the Tokyo government. He founded the Tokyo Underground Railway Company and built the first subway line in 1927 to connect the Ueno station to the Asakusa station. Then, in 1934, a new subway line from Asakusa station to Shimbashi station was added [16]. At the same time, another subway company was set up in 1934, called the Tokyo Rapid Transit Company. In 1941, the Tokyo Underground Railway Company and the Tokyo Rapid Company were merged into the Teito Rapid Transit Authority (TRTA) under the government’s control. The subway stations were built around many department stores, the owners of which jointly constructed stations and provided capital support. Later in the 1960s, as the above-ground trams produced severe road congestion, they were completely replaced by underground subway lines.

The private railway networks saw rapid expansion in Tokyo’s suburban area. After the 1923 Great Kanto Earthquake, the middle class began to escape from high-density central Tokyo to the suburbs for a more tranquil life. Smelling the opportunity, the private railway companies started to procure land and build lines in Tokyo’s suburban area [13]. The private railway operators not only ran train services, but also constructed houses, department stores, recreation centers, and tourism sites along railways to stimulate passenger demand. There were multiple private railway operators and each served a dedicated suburban area. As private railways had restricted the right to
enter central Tokyo, they had to terminate at stations of the national railway Yamanote line.

The national railway in Tokyo completed most of its networks before the 1920s and went through institutional reform in the late 1940s. In the post-war era, the national railway faced fiscal severity and strikes. In order to impose fiscal austerity, the national railway in 1949 was changed into Japan National Railway (JNR), a state-owned public corporation with an independent budget. JNR electrified trains and increased line capacity in the 1950s. As subway and private railways gradually integrated with JNR at the circle Yamanote line, the major interchange stations, especially Shibuya, Ikebukuro, Shinjuku, and Tokyo stations, were grown into urban centers.

4 After the 1964 Tokyo Olympic Games: JR Increased Line Service and Reduced Conflicts with Road Networks

The 1964 Tokyo Olympic Games marked a turning point for Japan by significantly stimulating its economy. After the Olympic Games, Tokyo experienced a new wave of urban population growth. Meanwhile, Japan’s automotive industry rapidly increased and led to urban motorization and road expansion. Tokyo JNR suffered from passenger congestion during rush hours, and had space conflicts with road networks. To solve these problems, JNR increased the line services and carried out grade separation projects.

To relieve passenger congestion, JNR initiated a project to enhance the services of five major lines that radiate from the center of Tokyo, namely the Tokaido line, Chuo line, Tohoku main line, Joban line, and Sobu main line [17]. This includes improving the speed and capacity, upgrading...
single tracks to double tracks, and providing express line services that only stop at major stations.

In the late 1960s, when road networks were expanded to satisfy the increasing demand for automobiles, there had been numerous rail crossings that interfered with road traffic. Rail crossings are barriers to transport efficiency, dangers to street safety, and dividers of urban activities. The Tokyo Metropolitan Government moved with road and railway grade separation projects at these rail crossings, in order to alleviate traffic congestion and promote urban functionality integration. Some segments of JNR tracks at the ground level were elevated and some were moved underground [10]. The projects greatly benefit the development of the surrounding areas by reconnecting the communities and facilitating the use of space under the elevated railway tracks.

5 Since 1987 JR Privatization: Redevelopment of JR Station Areas

In 1987, JNR was privatized due to severe debt, inefficient management in bureaucratic organizations, rivalry of private railways, and competition from auto and air transportation. In the process of privatization, JNR adopted a decentralized organization. It was divided into six regional passenger companies (JR East\(^1\), JR West, JR Central, JR Hokkaido, JR Shikoku, JR Kyushu), one freight company (JR Freight), and two non-operator organizations (JNR Settlement Corporation, Shinkansen Holding Corporation). Passenger and freight services were separated, while operation and infrastructure were integrated. After the privatization, the frequency, train speed, stations, and facilities were much improved, resulting in the growth of the ridership [8]. More importantly, with the passage of the 1987 JR law, JR was allowed to operate business and non-rail services, such as department stores above stations. JR also repaid its debts by selling its industrial land for commercial use. This became a stimulator of JR station-area redevelopment.

5.1 Adding Commercial Use in JR Station Areas

In the late 1980s, JR was permitted to construct shops, markets, offices, restaurants, and hotels, and manage bus terminals and parking lots inside a station complex [18]. In the Greater Tokyo Area, Atré, the subsidiary of JR East, has constructed more than 40 department stores at JR stations. Taking advantage of the large passenger volumes, Atré develops multi-purpose facilities within or adjacent to JR stations, including kiosks and food markets on the base level, retails, shops, to-go services, restaurants on the middle level, and offices on the top level. People are more than just using rail transit services. The station areas have become a place for lifestyle, an attractor for travel demand, and a unique center for surrounding communities.

Also, during the process of privatization, the JNR Settlement Corporation was established to handle liabilities. It undertook 70% of the total debts and liquidated the debts by selling JNR-owned land [7]. In 23 wards of Tokyo, nearly 50% of the JNR-owned land was transferred to JNR Settlement Corporation to pay off debt and increase asset values. This land was the formerly underutilized transit fields, and was handled for redevelopment into high-density commercial use.

For example, 10 hectares of the JNR Shinagawa station yard was comprehensively redeveloped into a business district of six skyscrapers, under the joint efforts of the JNR Settlement Corporation, Bureau of Urban Development, local government, and private developers. The commercial development also made room for public space. To promote amenities and pedestrian networks within the sites of private properties, incentive zoning was applied by giving a 1.9 floor area ratio (FAR) bonus to new property owners [19]. This generated shared public space and walking connections between different skyscrapers.

Another example is the JR Shiodome station-area redevelopment. Shiodome is the interface between Tokyo city center and the harbor front. The ownership of the 22-hectare freight yard was transferred to the JNR Settlement Corporation in 1988. The Tokyo Metropolitan Government approved rezoning it from a standard industrial zone into a commercial zone, with FAR increasing from 4 to 8. Collaborating with the Tokyo Metropolitan Government and local government, JNR Settlement Corporation redeveloped it into a multi-functional district with international business offices, residential space, transit stations, and pedestrian walkways.

5.2 Place-Making of JR Station Areas

Since JR was the first transit operator to enter Tokyo, many JR stations were in good locations. In the early twenty-first century, these JR station areas were designated as Redevelopment Promotion Districts by the Tokyo Bureau of Urban Development for better place-making. Inside the Redevelopment Promotion Districts, the land was replanned for efficient use, in order to better utilize rail transit infrastructure and promote integrated development of the surrounding areas.

Table 1 lists the Tokyo JR station areas that have been selected as Redevelopment Promotion Districts. They include JR Shinagawa station, Osaka Station, Tamachi station, Idabashi station, Yotsuya station, and others. It can

\(^1\) JR East provides services for the Greater Tokyo Area.
be seen that each JR station area has a unique identity for place-making. Some station areas are to be strengthened as city sub-centers, district centers, and local centers. Others are to be redeveloped into hubs for business offices, shops, culture, and international communications. Nevertheless, their place-making shares some common features, such as mixed land use, high-density development, better pedestrian connections, resilience to disasters, reutilization of station front space, and creation of a pleasurable urban environment.

### Table 1 Tokyo JR station areas that were selected as redevelopment promotion districts. Source: summarized from Tokyo Bureau of Urban Development

| JR station areas | Planning objectives |
|-----------------|---------------------|
| East gate area of JR Shinagawa station | Enhance the place-making as a district center | Create a multifunctional place of mixed land use | Create a pleasurable urban environment with various facilities |
| Surrounding area of JR Shinagawa station | Develop the surrounding area of JR Shinagawa station and JR new Shinagawa station into a district for international business and communications | Fill the station front plaza with more urban functions | Promote mixed land use |
| West gate area of JR Shinagawa station | Develop functions of international communications | Construct public squares and parks, and connect them to surrounding communities with pedestrian networks |
| 2nd east gate area of JR Osaki station | Enhance the place-making as a city sub-center of business, residence, and culture |
| 3rd east gate area of JR Osaki station | Balance commercial land use with residential land use | Improve urban vibrance and resilience to disasters |
| West gate area of JR Osaki station | Promote dense and mixed land use | Enhance the station’s node functions | Improve the resilience to disasters | Create a vibrant urban space and a pleasurable urban environment |
| East gate area of JR Tamachi station | Develop the station back space with mixed land use | Fill the station front space with new urban functions |
| Northeast gate area of JR Tamachi station | Develop a place for business offices, shops, culture, and communications | Promote mixed land use | Create a local transportation hub | Improve the urban environment and enhance resilience to disasters |
| West gate area of JR Idabashi station | Enhance the place-making as an attractive local center for business offices, shops, residence, and services | Enhance the station’s node functions | Redevelop the station front space | Increase the land use density | Improve the safety and connectivity of pedestrian networks |
| Surrounded area of JR Yotsuya station | Promote functions of business, culture, and communications | Increase the land-use efficiency of the station’s front space | Improve the urban vibrancy of the station’s front space | Enhance the resilience to disasters | Integrate station-area development with surrounding historic and natural context |

### 6 Insights from the Tokyo JR Case

The history of Tokyo JR network growth and station-area development shows a reciprocal interaction between rail transits and land use. In the beginning of the twentieth century, JR connected major districts in both central and suburban Tokyo, and therefore became the skeleton of Tokyo transit systems. During the post-earthquake and post-war period, the subway in central Tokyo and private railways in suburban Tokyo gradually met JR on the Yamanote line, enabling the major interchange stations to
develop into urban centers. In the 1960s, JR increased its services to alleviate passenger congestion and undertook grade separation projects to reduce conflicts with road networks. The 1987 JR privatization marked a turning point for massive station-area redevelopment. JR station areas have been changed from underutilized industrial land into high-density commercial use, and major JR stations were comprehensively replanned for identity and place-making.

Nowadays, in the 23 wards of Tokyo, 16 JR lines and 77 JR stations have been established, and more than half of the JR stations are interchange stations with subway and private railways. JR stations have become the critical nodes on Tokyo rail transit networks and have more important node functions than subway and private railway stations. This can be seen in the comparison between JR, subway, and private railway stations. Figure 2 compares the number of connections for 77 JR stations, 206 subway stations, and 266 private railway stations in Tokyo’s 23 wards. Source: the author makes statistics based on the 2018 Tokyo rail transit map.

![Fig. 2 Number of connections for 77 JR stations, 206 subway stations, and 266 private railway stations in Tokyo’s 23 wards. Source: the author makes statistics based on the 2018 Tokyo rail transit map.](image)

| Number of express line services | JR | Subway | Private railway |
|-------------------------------|----|--------|----------------|
| Counts | Percentage | Counts | Percentage | Counts | Percentage |
| 0     | 31 40.3% | 149 72.3% | 193 72.6% |
| 1     | 25 32.5% | 37 18.0% | 48 18.0% |
| 2     | 13 16.9% | 14 6.8% | 17 6.4% |
| 3     | 5 6.5% | 3 1.5% | 5 1.9% |
| 4     | 0 0.0% | 0 0.0% | 0 0.0% |
| 5     | 2 2.6% | 2 1.0% | 2 0.8% |
| 6     | 1 1.3% | 1 0.5% | 1 0.4% |

Table 3 Average density of commercial facilities, public facilities, parking lots, fed bus stops inside the 500 m-radius catchment area for 77 JR, 206 subway, and 266 private railway stations in Tokyo’s 23 wards. Source: the author calculates the density base on Point of Interest data from the 2018 Japan National Land Numerical Information Download Service Website and Open Street Map.

| Commercial facilities (unit/km²) | Public facilities (unit/km²) | Parking lots (unit/km²) | Fed bus stops (unit/km²) |
|---------------------------------|-----------------------------|------------------------|-------------------------|
| JR                              | 275                         | 114                    | 5                       | 16                      |
| Subway                          | 251                         | 114                    | 5                       | 15                      |
| Private railway                 | 116                         | 72                     | 2                       | 10                      |

2 The number of connections is measured by the number of rail transit links from one station to other stations. For example, if a station is in the middle of a single rail transit line, the number of connections is 2; if a station is at the end of a single rail transit line, the number of connections is 1; if a station is the interchange station between 2 rail transit lines, the number of connections is 4.
Tokyo’s 23 wards, finding that the JR station has an average of 1.04 express line services, while subway and private railway stations have 0.44 and 0.42 express line services on average, and the percentage of stations with more than one express line is much higher for JR than for subway and private railway.

Additionally, JR station-area redevelopment after 1987 privatization brought about intensive land use and multiple urban functions in station areas. JR stations have higher land-use density than subway and private railway stations, as evidenced in the comparison between them. Table 3 compares the average density of commercial facilities (amenities, leisure, tourism, shops, and offices), public facilities (civic facilities, cultural facilities, schools, hospitals), parking lots, and fed bus stops inside the 500 m-radius catchment area for JR, subway, and private railway stations in Tokyo’s 23 wards. The results show that JR stations rank the highest in all facility densities, indicating a much higher development intensity for JR station areas than for subway and private railways. Table 4 lists the urban functions around major JR interchange stations, showing that each station area has a dominant function for place-making.

The Tokyo JR case presents an integration mode between station-area development and rail transit networks. From JR’s history and today’s form, we can learn three strategies on how it promotes reciprocal interactions between land use and transit. (1) JR was the first transit operator to enter Tokyo and had a first-mover advantage. Therefore, JR lines evolved into the skeleton of Tokyo transit systems where the subway and private railways are connected. Also, JR stations have strong interchange functions and are critical nodes in Tokyo transit networks. (2) To better utilize transit infrastructure, station areas around these critical JR nodes have been developed into different urban functions with high-density land use. (3) In turn, the high-density station areas have become attractors for more travel demand, and this travel demand is further served through express line services. The Tokyo JR case provides suggestions for metropolitan cities on how to integrate rail transit infrastructure with station-area development, including matching critical nodes in transit networks with urban functions and high-density land use, and connecting these urban functions through express line services.

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