



**A SHORT HISTORY OF
TRANSPORT IN JAPAN
FROM ANCIENT TIMES TO THE
PRESENT**

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6. Railways

Just like horse-drawn carriages and sailing ships were taken over by trains and steamships in the beginning of the 19th century the latter half of the 20th century is the age of automobiles and airplanes, and now the railway is on the road to extinction

Nishida, 1977, quoted by Strobel and Straszak, 1981: 56

Introduction

In the 19th century, railways were a significant marker in the industrialisation of Japan with the Meiji government introducing Western ideas and technologies. Great Britain had been keen to exploit new markets for its mature domestic railway industry, and in 1869, the British Minister to Japan, Harry Parkes, advocated to the Japanese Government that railways should be constructed as a matter of urgency (Aoki, 1994: 28). The first line opened between Shimbashi (Tōkyō) and Noge Kaigan, Yokohama, on 14 October 1872 under the control of the Ministry of Public Works. Other routes were completed in the 1870s until a cash strapped government allowed for the private sector to build and operate lines.

At the turn of the 20th century, and during the First Sino-Japanese War and the Russo-Japanese War, the Japanese Government realised the strategic functions of military transport, and, in 1906, enacted the *Railway Nationalization Act* and purchased 17 leading private railway companies. Japan Government Railways became a virtual monopoly of railway business until the Allied Occupation Forces instructed the Japanese Government to reorganise Japanese Government Railways as a public corporation (Japanese National Railways). Upon declaration of bankruptcy in 1987, Japanese National Railways was privatised and

broken up into geographical divisions over a network of 23,474 km (Imashiro, 1995).

Whilst the institutional trajectories of railway administration in Japan has mirrored international trends this chapter also places emphasis on high-speed rail developments (Hayashi *et al.*, 2020). A new age of inter-city passenger transport was heralded by the Japanese with the opening in 1964 of the Tōkaidō Shinkansen to the extent that its success encouraged several nations to change their minds about the role of railways—“a so called ‘railway renaissance’ began in a number of nations” (Straszak, 1981: 49)—an international story that has been updated by Loo and Comtois (2015).

The chapter summarises the external events leading to the roll out of early government narrow gauge railways and the role of the Japanese private sector in the expansion of this network. From the time that the main trunk railways were nationalised in 1906, the market was dominated by the government until 1987, when Japan National Railways was privatised, and the major changes in administration and their reasons are described. The story of private-railway development on even narrower gauges (782 mm) from the 1910 *Light Railway Act* is also pursued, including innovative business practices. The administration of municipal horse-drawn and electric tramways systems, from the late 19th century, and urban subway systems from 1920, where both private and public sectors were involved, are also explained. The greatest technological achievements—coming almost 100 years after the Russians demonstrated the steam engine in Japan—has been the development and deployment of high-speed rail and magnetic levitation rail, and the final sections of this chapter describe their driving forces.

Early Modern Period

Early Railways

British players dominated the early history of Japanese railways and its institutional arrangements, despite a number of other international players’ attempts at gaining influence by gifting steam engines to some regional *daimyō* late in Edō era (Free, 2008). The first railway equipment seen in Japan arrived with a Russian naval squadron lead by Admiral E.

V. Putiatin in 1853 (Kodansha, 1993: 1244). Foreigners had suggested to the Tokugawa *Shōgunate* the construction of concession railways between Tōkyō and Yokohama, Ōsaka and Kōbe and between concession ports and large cities (Aoki, 1994), but no action was taken with the regime in chaos.

With the establishment of the Meiji government, the British Minister to Japan stepped in and convened a meeting on 7 December 1869 with government leaders represented by Iwakura Tomomi (Vice Premier), Sawa Nobuyoshi (Minister of Foreign Affairs), Ōkuma Shigenobu (Vice Minister of Finance) and Itō Hirobumi (Assistant Vice Minister of Finance). Minister Parkes argued that railways were a symbol of centralised power and that railways could carry rice quickly from other areas to Tōhoku (then suffering from another poor year for the rice harvest) thereby minimising the effects of famine (Aoki, 1994: 28).

A decision was reached to build a priority line between Tōkyō and Kōbe and a branch line to Tsuruga, skirting Lake Biwa. The British Minister Parkes introduced to the government Horatio Nelson Lay, who sold railway bonds in London and who also began hiring British engineers to design and build railways in Japan. Lay signed a contract with the Meiji government at an interest rate of 12 per cent per annum over 10 years but the contract was abruptly terminated when the Japanese government discovered that Lay would make a 3 per cent margin on each bond sold (Aoki, 1994: 28). Instead, the Japanese Government decided to construct the first railway with a terminus in Tōkyō (Shimbashi) and the other at Noge Kaigan in Yokohama—a distance of 29 km.

In April 1870, the Japanese Government hired Edmund Morel (1841–1871) as its first Engineer-in-Chief. On his advice, in August 1871, the Ministry of Public Works was established, whose major role was introducing Western technology to Japan. He advised the government on engineering education and administration and, in April 1871, an engineering college (later, the Tōkyō Imperial Technical University) opened. The Ministry of Public Works administered the railway expansion program with Masaru Inoue, who had studied railway and mining at University College London, as its first Director of Railways in Japan.

The technical advice from British engineers was that the locomotives should run on the 3' 6" (1,067 mm) narrow-gauge tracks built in

British colonies, such as South Africa and Australia, where the density of traffic was relatively low. Morel's role was to guide and supervise construction, to screen engineers working on the project and to provide guidance on the screening of foreign equipment imports. The hiring of foreigners for railways began in 1870 and it is of little surprise that the majority were British working in civil engineering, machinery for manufacturing, rolling stock repair and train scheduling and operations. The peak number of 119 in June 1874 fell afterwards, especially when the curtailment policy was put into effect in 1881 by the Japanese Government (Aoki, 1994: 30). The first shipment of ten tank locomotives and 58 two-axle passenger carriages manufactured in Britain arrived in Yokohama in September 1871. On 12 June 1872, two daily train services started between Shimbashi and Yokohama, with six daily services beginning two days later. On 14 October 1872 the Meiji Emperor attended the opening ceremony at Shimbashi and Yokohama stations.

On 25 August 1870, surveying work began between Ōsaka and Kōbe. Construction included the first wrought-iron bridge and tunnel in Japan (running under a raised-bed river). Regular service started on 11 May 1874. Two years later, the line had been extended to Kyōto and reached Ōtsu on Lake Biwa in 1880. This section included the 670 metre-long Osakayama Tunnel that was designed and built by a British engineer, T. R. Shervinton (Rhymer-Jones, 1881: 316). By 1890, it was possible to travel by rail from Kōbe, Ōsaka, Kyōto and Nagoya to Shimbashi then transfer in Tōkyō crossing by road to Ueno Station then on to Sendai in the north east. There were also short sections of railway on the islands of Hokkaidō, Kyūshū and Shikōku (Figure 4).

Early Private Railways

Private companies were major players in the early stages of railway development in Japan because the government faced a financial crisis from the rapid introduction of Western technologies (Shindo, 1954), such as the construction of government-run plants and factories and compensation for *daimyō* deprived of feudal privileges. Japanese private railways were governed by the *Railway Construction Act of 1892* that recognised the distinction between inter-city private railways and government-owned railways. This legal framework for private

railways promulgated in their articles of association that their business be confined to moving people. After the mid-1880s, the apparent profitability of railways was sufficient to attract a flood of entrepreneurs with 60 per cent of revenue derived from passenger traffic.¹ Between 1887 and 1906, private companies laid down 5,253 km of track compared to the 1,880 km by the government (Moulton with Ko, 1931: 69)—a ratio of 2.8 to one.

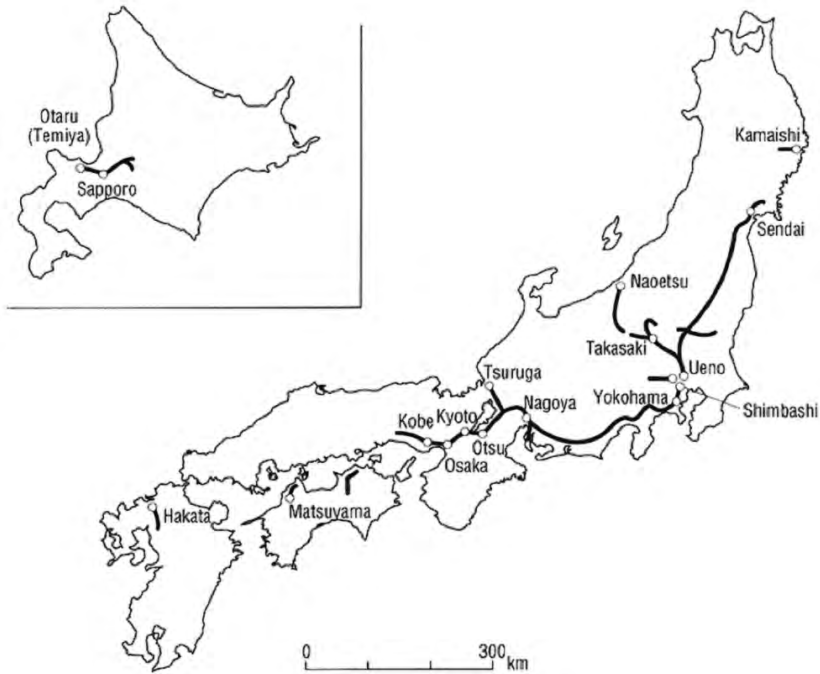


Figure 4. Extent of Japanese Railway Network by 1 January 1890.

Source: Aoki, 1994: 30, reproduced with permission.

Private operators were not constrained in introducing innovative methods to encourage patronage (Saito, 1997). For example, the Iyo Railway on Shikōkū island opened in October 1888 between Matsuyama

¹ From the fiscal year 1917–1918 to 1928–1929, railway earnings as a percentage of total capital ranged from 7.8 per cent to 11.6 per cent annual on government railways and from 6.1 per cent to 9.8 per cent on private railways (Moulton with Ko, 1931: 73–74).

Bay and Matsuyama (Kishi, n.d.)—a distance of about 12 km—operating on a 762 mm gauge. It was the first private railway company in Japan to involve itself in the development of bathing resorts. From the 1890s, the company offered generous fare reductions during the summer season because it considered summer bathers to be its most valuable customers. The company formed the Baishinji Bathing Association in June 1899, developed a new bathing resort by the Setō Inland Sea, opened a summer station and started operating special trains for bathers. Soon, it provided related facilities, including hot baths and inns (Ogawa, 1998: 29).

Another example of early railway entrepreneurship also occurred on Shikōkū. When Otsuka Koreaki (1864–1928) became the manager of the Sanuki Railway and the Nankai Railway, he took guidance from then current U.S.A. management practices and installed a tearoom in the first-class carriage, employed young women as waitresses, introduced a train supervisor system and transferred much of the authority to the train supervisor. Financed with the help of local capital, Otsuka built the Takamatsu Hotel at the Takamatsu Railway terminus, and aquariums and other recreational facilities at both the Takamatsu and Kotohira terminus (Ogawa, 1998: 30). Around the same time, railway companies in the Kansai area grew their business by transporting tourists during the spring and autumn sightseeing seasons. So powerful was this railway branding that the region has been named the “Empire of Private Railways” (Miki, 2003).

Private railway companies operated excursion trains and built temporary facilities on leased, publicly-owned land, such as beaches and riversides. For example, in August 1901, the Kyōto Railway Company (the present JR Sagano Line) operated a special evening train, with on-board performances of court music, to Arashiyama, one of Japan’s most famous scenic spots about 5 km from Kyōto, to catch cool breezes, to view a full harvest moon and to enjoy firework displays (Ogawa, 1998: 29). Excursion trains became a fashion in the Kansai area after the success of the Kyōto Railway Company.

The technological influence of American railways played a role during the establishment of both the Hankyū and the Hanshin Railways in the Kansai region. Key individuals within these corporations had visited cities in the U.S.A., such as New York, and decided that electric railways would be a good example of the power traction to adopt in Japan. In June 1899, the Settsu Electric Railway Company was founded

under the guidance of Sotoyama Shuzō. The company applied to the Japanese Government for permission to open a railway line between Kōbe and Amagasaki (about 22 km), and, on approval one month later, changed its trading name to the Hanshin Electric Railway Company. The transfer of American-style, wide-gauge high-speed technology to build this inter-city electric railway (construction began in 1900), was directed by Misaki Shozō—an engineering graduate of Purdue University in the U.S.A.—who devised a diversified model of private railway business, influenced by early private railways that were active in land speculation in Western countries (Semple, 2009: 213–214).

After the 17 major trunk-line railway companies disappeared after nationalisation, the private, short-distance electric railway companies in the Kansai area, such as Hanshin and Hankyū, changed their articles of association to start the management of amusement parks to attract more patronage. In October 1907, the board of directors at Hanshin Electric Railway Company permitted leasing of land and buildings and the management of recreational facilities. Other companies soon followed.

Management practices quickly evolved with railway companies first risking their own capital in the facilities that they leased to professional operators then making direct investments and managing their own permanent facilities. A good example of this is the Hanshin Amusement Park. This trend towards more business diversification occurred in metropolitan areas, where the number of individual shareholders on railway boards declined gradually and institutional investors, such as banks and insurance companies, emerged as the major shareholders, and put more pressure on increasing revenues and earnings, as detailed by Ogawa (1998, Table 1, p. 31). Private railway companies developed and operated 37 major amusement complexes between 1899 and 1924.

One of the key innovators in the diversification of railway businesses was Kobayashi Inchizō (1873–1957). He is widely regarded in Japan and his story is documented in an autobiography (see Semple, 2009: 219–226 and 410). He joined Mitsui Bank Ltd. in 1893 and helped establish the Minō Arima Railway Company (now Hankyū Corporation) in 1907, becoming its President in 1927 and chairman in 1934 (Kodansha, 1993: 801). After the nationalisation of the Hankaku Railway (now JR Takarazuka Line), the board of directors took advantage of the permit for Hankaku to run on to Umeda in Ōsaka. The planned destinations were Minō and the famous Arima Hot Spring. On the route to the hot

spring terminus, Takarazuka was then a modest place with only a few small inns and a cold spring. Kobayashi purchased reclaimed land at Mukogawa and opened a fashionable indoor swimming pool: it was a financial failure. Kobayashi covered the closed pool with planks and rebuilt it into a general amusement hall with 10 attractions and organised a performing girls chorus that has evolved into the present-day Takarazuka Operetta Troupe.

Regarded as the origin of large-scale suburban housing development by corporations in Japan, Kobayashi initiated the development of Ikeda New Town (Shuntaro and Lintonbon, 2016), about 16 km from central Ōsaka. In addition, the Hankyū markets, located near the railway terminus in Umeda (Ōsaka), were opened in 1925. It eventually became a modern, major department store with a food basement that would be familiar today to any traveller to a major Japanese town.

Kobayashi's innovative management techniques had a significant effect on railway companies throughout Japan: his ideas spread to the Mekama Railway and Tōkyū Railway and to many other railway companies. In 1918, Den-en Toshi Company built a "garden city" (Den'en chōfu) west of Tōkyō (Watanabe, 1980) and it was laid out by Busawa Eiichi along the format of an English Garden City, such as Letchworth that was founded in 1903. It was quickly realised that providing transport to its residents, who wanted to commute to central Tōkyō, was a necessity. The Tōkyū Group began as the Meguro-Kamata Electric Railway Company in 1922.

Government Railways

During the First Sino-Japanese War (1894–1895) and the Russo-Japanese War (1904–1905) the government recognised the strategic functions of transport and the undesirability of the private-sector control of national assets. Support grew for the government to control a unified railway network. The Chambers of Commerce in Tōkyō and in Kyōto were strong advocates for railway nationalisation. In 1906, the *Railway Nationalization Act* was introduced to nationalise railway trunk lines, where the government purchased, at generous prices for the private sector (479,320,000 yen), 17 leading railway enterprises. From the time of railway nationalisation onwards, government railways became the

major player on the railway network that had suddenly expanded its route kilometres from 2,500 km to 7,150 km (mainly narrow 1,067 mm gauge), and a market share of less than half growing to 90 per cent. Japan Government Railways was a government-owned monopoly business. However, this investment, in the period just before the First World War, resulted in the government not having the funds to further expand the railway network into the countryside.

Only 20 private steam railway companies continued operating (Terada, 2001). Generally, these companies operated short lines, and only four had a network of more than 50 km. In passing the *Light Railway Act 1910* (amended 1921) the government encouraged smaller, private operators into the market. The government subsidised these railways with 5 per cent each year of their construction costs for the first 10 years of their operations (Moulton with Ko, 1931: 70). The government retained the right to purchase these railways at any time.

In 1920, as the railway network expanded, the Ministry of Railways was established (absorbed in 1943 under the Ministry of Transport and Telecommunications). Route kilometres grew at an even annual rate reaching about 20,000 km by 1935 (Strobel and Straszak, 1981: Figure 4.3, p. 57). In the late 1920s, railways in Tōkyō were being electrified and the technology spread rapidly to the main lines. Development planning for an urban railway network in the Tōkyō metropolitan area began in 1925. The first government approved urban railway network plan (five lines, 82.4 km) was published in 1925 in conjunction with plans for reconstruction after the great Kantō earthquake disaster of 1923. After that, including the latest plan of 2000, there have been nine rounds of planning for this urban railway network (Morichi *et al.*, 2001).

The Japanese Government also made a shrewd allocation of research and development resources in an institution that returned spectacular results fifty years after its establishment. In 1907, when it was called the Imperial Railway Agency, the government formed the Railway Technical Research Institute. In the mid-1930s it developed a blueprint for a standard gauge line (1435 mm) between Tōkyō and Kyūshū and undertook research and development for a high-speed steam locomotive project (Genser and Straszak, 1981: 147–148).

Resources for civil purposes diminished as pressures for military leaders curtailed railway investment, although a unified railway system

was recognised as an essential aspect of Japan's growing militarisation (Aoki *et al.*, 2000). Nevertheless, passenger and freight traffic almost tripled between 1935 and 1945 (Genser and Straszak, 1981: 148). The Pacific War imposed obvious constraints on civilian passenger movements. From 1943, the national railway reduced its civilian passenger services, giving priority to military transport. In 1944, it abolished all the limited express trains, first-class carriages and dining and sleeping carriages. Under the *Ordinance for Collection of Metals* some railway operators were forced to remove one track from double-track lines, and others were forced to discontinue their business entirely, in order to satisfy the military demand for steel.

Railways became obvious strategic targets for Allied bombing raids over Japan. The damaged tracks were quickly repaired and made operational. For example, some lines on the national railway network resumed services one-day after Tōkyō was bombed, and the San'yō Main Line, in extraordinary circumstances, resumed services two days after the atomic bomb was dropped on Hiroshima. However, the aftermath of war left material shortages throughout the economy, including a lack of bunker coal for steam engines, and, inevitably, rail services were disrupted.

Urban Tramways

In addition to this national railway network, there were other railways operating electric, horse-drawn and man-powered trains, running mainly on tramways (Aoki, 1995; Yuzawa, 1985). The first horse-drawn tramway was constructed in Tōkyō in 1880 and within a few years most cities had a tramway. In 1890, an electric tramway experiment was conducted in Tōkyō, although the municipal government of Kyōto was the first to operate an electric streetcar on 1 February 1895 using electricity generated by the Lake Biwa Canal. Electric trams gradually replaced horse drawn and steam and gas propelled tramways in all cities. Table 16 summarises the tramway systems in the study area defined for this book that exist today, their date of opening and their network lengths.

Under the *Tramway Law of 1921*, the national and local governments had the option to purchase tramways from the private sector. By 1932, 83 tramways, with a total route length of 1,480 km, were operating in 67

Japanese cities (Utsunomiya, 2004: 10)—with the horse-drawn systems earning twice as much from their freight business as from receipts from passengers (Moulton with Ko, 1931: 79).

Table 16. Urban Tramways in the Study Area in the Modern Period.

Source: based on Utsunomiya, 2004, Table 1, p. 1.

Tram System	Opened	Length (km)	Operator
Tōkyō, Den'en chōfu	1907	5.0	Tōkyū Corporation
Kyōto, Arashiyama	1910	7.2	Arashiyama Electric Tram Railway
Tōkyō, Arakawa	1911	12.2	TMG Transportation Bureau
Ōsaka	1911	18.7	Hankai Tramway
Gifu	1911	23.9	Meitetsu
Matsuyama	1911	9.6	Iyō Railway
Ōtsu	1912	21.6	Keihan Electric Railway
Tōyama	1913	6.4	Tōyama Chiho Railway
Kyōto, Kitano	1925	3.8	Kyōto Dento
Toyohashi	1925	5.4	Toyohashi Railway
Fukui	1933	21.4	Fukui Railway

Urban Subways

In August 1920, a private venture—the Tōkyō Underground Railway Company—was established. Construction between Ueno and Asakusa—a distance of 2.2 km—commenced. This first subway line in Japan opened on 30 December 1927. In 1939, a through service from Asakusa to Shibuya commenced, with arrangements made with the Tōkyō Rapid Railway Company. Two years later, the Teito Rapid Transit Authority (*Teito Kōsokudo Kōtsū Eidan*) was created (Tokyo Metro, 2020). Ōsaka City was the first municipal government in Japan to manage an underground railway—the Midosuji Line between Umeda and Shinsaibashi.

Modern Democratic Period

Governance Model—Government Railways

The Ministry of Transport and Telecommunications was reorganised in 1945 when the Ministry of Transport was re-established. Japan's government railways were operated by the Ministry of Transport's Railway Department up until June 1949 when an entirely new institution for railway governance was imposed on the Japanese. Post-war Japan was run by the Allied Occupation Forces. A letter from General MacArthur dated 22 July 1948 instructed the Japanese Government to reorganise Japanese Government Railways as a public corporation called Japanese National Railways (JNR) which commenced business on 1 June 1949 (Imashiro, 1995).

The public corporation model was little understood by railway managers and it did not suit Japanese business culture. According to Okada (2010: 1), "rampant capital expenditure and irresponsible management" caused Japan National Railways to sink further into debt, with the inevitability of railway privatisation. Upon declaration of bankruptcy in 1987 (Saito, 1989), JNR was privatised and broken up into the West Japan Railway Company, the Central Japan Railway Company, the East Japan Railway Company, the Kyūshū Railway Company, the Shikōkū Railway Company and Hokkaidō Railway Company. All these companies operated narrow gauge and international standard gauge railways (Shinkansen, high-speed rail except on Shikōkū) over a network of 23,474 km.

While the division of operations began in April of 1987, privatisation was not immediate: initially, the government retained ownership of the companies. Privatisation of some of the companies began in the early 1990s (Mizutani, 2000). By 2006, all of the shares of JR East, JR Central and JR West had been offered to the market, and, today, they are publicly traded. On the other hand, all of the shares of JR Hokkaidō, JR Shikōkū, JR Kyūshū and JR Freight are still owned by the Japan Railway Construction, Transport and Technology Agency, which is an independent administrative state institution. Another nearly 3,400 km of routes are operated by the major private railways. These are known in Japan as "third sector railways"—new companies, financed with private

and local government funds that absorbed some of Japanese National Railways' rural lines.

The structure of a typical railway governance model, in the form of a hierarchical flow diagram, can be ascertained from company reports (Central Japan Railway Company, 2019: 40). JR-Central's Board of Directors is composed of 18 members (including three outside directors) and chaired by the company chairman. JR Central also employs an auditor system, and its Audit and Supervisory Board consists of five members (four of whom are outside auditors). JR-Central has appropriate accounting audits made by an audit corporation and by Deloitte Touche Tohmatsu LLC. A Management Meeting is held ahead of the monthly Board of Directors meeting for in-depth discussion of important management issues. Chaired by the president, the Management Meeting is attended by all full-time directors, Audit and Supervisory Board members and some corporate officers.

Whereas the separation of the ownership of infrastructure and operations has become common in Europe, in Japan, railway companies develop rolling stock, structures, track, electrical and signalling, manage operations and maintenance. The companies promote many affiliated businesses through its subsidiaries to maximise operating and flexibility, such as coach transportation, merchandise and food, real estate and other services such as hotels and travel tours.

Taking the JR-Central railway network (Figure 5) as an example as it covers most of this book's study area, its market area represents 23.7 per cent of the country's land area but contains, in 2019, about 60.6 per cent of national population and almost two-thirds (65.5 per cent) of prefectural GDP. The railway network is comprised of the 552.6 km Tōkaidō Shinkansen and twelve narrow-gauge lines of 1,418.2 km. For the year ended 31 March 2012, 85.4 per cent of revenue comes from the high-speed line, 8.2 per cent from other railways, 5.7 per cent from other railway revenues (track usage fees, land leasing fees at stations, usage fees from store operators at stations and advertising) with less than one per cent coming from other businesses (Central Japan Railway Company, 2012: 4). As would be expected during the Covid-19 global pandemic, its *Annual Report* ending June 2020 showed "comprehensive income" as 87 per cent of the previous year—and with a stability in the revenue streams similar to 2012 as reported above ([https://global.jr-central.co.jp/en/company/ir/brief announcement/2020/_pdf/2020_08.pdf](https://global.jr-central.co.jp/en/company/ir/brief%20announcement/2020/_pdf/2020_08.pdf)).

► Operating Area

JR Central operates the Tokaido Shinkansen, the main transportation artery linking Tokyo, Nagoya, and Osaka, and a network of 12 conventional lines centered on the Nagoya and Shizuoka City areas.



Figure 5. Central Japan Railway Network of Shinkansen and Other Lines, June 2019.

Source: Central Japan Railway Company, 2019: 48. All rights reserved.

Freight

International competitiveness for freight and logistics is a pressing issue for Japan. In 2011, the Ministry of Land, Infrastructure, Transport and Tourism formulated its policy on international container port strategy that promotes international competition through the creation of tactical ports (for example, the “Keihin” ports of Kawasaki, Tōkyō and Yokohama and the “Hanshin” ports of Ōsaka and Kōbe). Much of

the freight volume passes through ports on the Sea of Japan side that entails expensive domestic landside transport costs (together with road traffic incidents and the declining numbers of long-distance truck drives where the average age has exceeded 50 years).

To make ports in Eastern Japan more competitive, a more efficient nation-wide feeder transport system (road and rail) is required (Yamaguchi, 2011). For example, between 1998 and 2010, JR Freight (Yoshizawa, 2012) operated a dedicated rail service for sea containers between Yokohama Honmoku Station (on the Kanagawa Coastal Rail Line Company) and Sendai Port station (on the Sendai Coastal Rail Line Company). Foreign trade and inter-modal freight to selected regions of Japan involves JR 12-foot containers and international 20-foot and 40-foot containers. With rail freight operations running to schedule, it is possible to adhere to the loading program for export vessels in ports. With rail and sea modes integrated there is an environmental benefit with reduced carbon dioxide emission compared to air cargo. Furthermore, government reforms of domestic container distribution have allowed JR Freight to develop a business model for the feasibility of transporting bonded containers on round trips (Yoshizawa, 2012).

Governance Model—Private Railways

The Ministry of Land, Infrastructure, Transport and Tourism classifies private railways into different groups. Fifteen of the most important companies are classified as major private railways. One serves Nagoya, one serves Fukuoka and the rest are all in Tōkyō and Ōsaka. Some other railways operating in or near large metropolitan centres are classified as quasi-major private railways but there are no clear distinctions between these railways and major private railways (Terada, 2001).

It is instructive to compare the governance structures of private railways during the period that JNR ran at a loss and were privatised in the 1980s. The managements of Hanshin and Hankyū railways have been studied in detail by Semple (2009) and it is somewhat fortuitous that when identifying a suitable case study railway company, the management of Hankyū Holdings, Inc. and Hanshin Electric Railway Co., Ltd. were integrated to establish Hankyū Hanshin Holdings, Inc in October 2006 (Hankyū Hanshin Holdings, 2019). It is important to point out that another major private railway company—the Tōkyū Group, operating in the Tōkyō region—demonstrates leadership

in sustainability, corporate responsibility and local community development (Tokyu Corporation, 2019).

Hankyū Hanshin Holdings is structured with a Board of full-time (five) and part-time (four) Directors who have a two-way conversation with the President and the Chairman of the Group Management Committee (Hankyu Hanshin REIT, Inc., 2020: 21). The Group Management Committee itself is represented with the Heads of the various business divisions of the company and independent advisors. The group companies are also represented on the Group Management Committee. The company is guided by a Medium-Term Management Plan—a concrete action plan, extending over the period from the fiscal 2019 to 2022. Actions include enhancing the value of the Umeda area; activating the railway line-side land uses; improving the transport networks with new lines; facilitating inbound tourism; and expanding the scale of the condominium businesses (Hankyu Hanshin Holdings, 2019: 17 details 25–23).

Hankyū Hanshin Holdings operates the following divisions: railway, bus and taxi operations in the Kansai region through its Hanshin Electric Railway; Hankyū Travel provides Japanese travel arrangements for foreign visitors; Hankyū-Hanshin-Daiichi Hotel Group operates about 45 hotels, mostly in Tōkyō and Ōsaka; the Takarazuka Revue Company stages theatrical revues; and Hankyū Express imports and exports cargo, provides logistics and handles international shipping. A breakdown of its revenue streams in 2019 is provided in Table 17. It illustrates the diversity of the company business, and that railway income is similar to earnings on real estate development (about 30 per cent).

Table 17. Hankyū Hanshin Holdings Breakdown of Revenue Streams, 2019.

Source: calculated by author from Hankyū Hanshin Holdings, 2019: 5–6.

Business Activity	Annual Revenue (billion yen)	Percentage
Urban Transport	238.6	30.0
Real Estate	237.3	29.9
International transport	90.0	11.3
Entertainment	74.5	9.4
Hotels	64.9	8.2
Information & Communication Technology	53.5	6.7
Travel Services	35.5	4.5

The services offered by Japanese public- and private-sector railways (and airports) represent excellent examples of transport modal integration. All major economic activity areas in the Kantō, Kansai and Nagoya regions have international air services with the urban core areas connected by express rail services, with convenient interchange to the high-speed rail network. Passengers can transfer easily between the Shinkansen and conventional lines by simultaneously touching the ticket gates with an “EX-IC” card and a conventional line card such as TOICA (Tokai IC card) or PASMO. For example, JR Central has a special discount membership service—“Express Reservation” and “EX-IC”—which enables passengers to make reservations on the Tōkaidō and San’yō Shinkansen from mobile phones or personal computers, and to board the train directly from the entry gates without waiting in line at the ticket office window.

Urban Subways

There were only two subway systems in Japan—one in Tōkyō; the other in Ōsaka—before the modern democratic period. To keep pace with the commuter travel demands in the post-Second World War period, subways were constructed in a number of cities throughout Japan and Table 18 shows those subways in the study area. The table identifies the lines, network length and the year opened. The ownership structures are privately managed or a partnership between government and the private sector.

Table 18. Subway Lines and Network Length in the Study Area, 2020.
Source: Japan Subway Association, 2020; Japan Visitor, <https://www.japanvisitor.com/japan-travel/japan-transport/japan-subway#kysu>.

City	Lines	Network Length (km)	Year Opened
Nagoya	6 Main Lines	93.3	1957
Tōkyō	Asakusa Line, Mita Line, Shinjuku Line, Ōedo Line	109.0	1960
Yokohama	Blue Line, Green Line	53.4	1971
Kōbe	Seishin-Yamate Line, Kaigan Line	38.1	2002
Kyōto	Karasuma Line, Tōzai Line	31.2	1981

The Shinkansen Program

In the modern democratic period, the government of Japan was not burdened with a defence budget, had a long tradition of investing in education, had a strong engineering culture and, significantly for railway development, had a surplus of experienced military and aeronautical engineers at its disposal for peace-time research and development in the Japan Railway Research Institute. They were fully aware of developments in France and in West Germany on technical matters related to high-speed rail and magnetic levitation technologies. Furthermore, there was a strong tradition that private industry (construction, machine-building, electrical and electronics industries) be contracted by governments to execute railway designs (Genser and Straszak, 1981: 160).

These factors proved vital in the modernisation of the Japanese railway network, and for planning of high-speed rail systems. On May 10 1956, Japan National Railways Head Office set up the "Investigation Committee for Enhancement of Traffic Capacity on the Tokaidō Line". Fifteen months later the Ministry of Transport established the "Trunk Line Investigation Committee" that recommended, in July 1958, the need to construct an entirely new route for the Tōkaidō railway line. The JNR President Sogō Shinji (1864–1981) appropriated money in the company's 1959 budget.

Construction of the line with 10 approved stations, including platforms at Tōkyō and a new station in Ōsaka (Shin-Ōsaka), started in April 1959 (a loan of U.S. \$80 million was secured from the World Bank in 1961). In 1960, high-speed test operations with continuous mesh catenary were conducted on the JNR Tōhoku line, and, in November 1962, a prototype train topped 200 km/h. By mid-1964, tests were running on the completed section of the Tōkaidō track near Maibara (Shiga Prefecture) before full commercial services between Tōkyō and Shin-Ōsaka started on 1 October 1964 (Straszak, 1981, Table 1, pp. 29–32). This timing was to catch the world's attention as the 1964 Summer Olympic Games opened ten days later in Tōkyō, signalling that Japan had "been welcomed back" into the international (Western) community (Hood, 2006).

This highly successful completion of the "Tōkaidō Shinkansen" (Straszak and Tuch, 1977) was "due to the President of the JNR, Mr.

Sogo..." (Straszak, 1981: 7), and it opened the way for the Shinkansen program that was an exemplary international example of a national government development program as part of a national socio-economic system (Shima, 1994). In 1969, the New Comprehensive National Development Plan stated "...with the advanced information and rapid transport system...we can expect that all of Japan...will be integrated into a single unit" (Straszak, 1981: 5). To illustrate this, JNR prepared a series of iso-chrones maps from 1971 to 1985 to demonstrate the shrinking of journey times by rail from Tōkyō to the rest of the Japanese archipelago (Straszak, 1981, Figure 2.9, p. 21).

Development of the Shinkansen network was a key part of the 1969 Second Comprehensive National Development Plan and led to the Diet promulgating on 18 May 1970 *Law Number 71 "Law for Construction of Nation-Wide High-Speed Railways"* with the Minister of Transport as the authority to implement the Shinkansen Program. Originally, the Shinkansen lines were seen as a way to solve the problem of insufficient capacity on JNR's conventional lines, but the passage of the Development Law meant that Shinkansen lines had become part of the national strategy to achieve balanced development nationwide and to revitalise the more peripheral regions of Japan (Takatsu, 2007: 9).

In response, JNR set up its Network Planning Department that was reorganised in 1977 as the Planning Division in the Shinkansen Construction Department (Straszak, 1981: 7). A map of the early high-speed railway network to integrate the "whole of Japan into a single unit" is printed in Straszak (1981, Figure 2.5, p. 13). Details on the procedural process as to how the Minister of Transport approves the basic plan and construction approval can be found in Straszak (1981, Figure 2.6, p. 15) who also provides a description of the roles played by actors in civic and civil society in the planning for high-speed rail (Gensher and Straszak, 1981: 154–162).

High-speed railways continued to be constructed across Japan, but the expansion forced JNR further into debt. With high labour costs (the administration of the Shinkansen Program employed 13,369 people in March 1976) and expenses outstripping revenues, JNR accumulated annual deficit mushroomed from about 800,000 million yen in 1971 to 3,160 thousands of millions of yen in 1975 (Gensher and Straszak, 1981, Table 5.1, p. 151)—approximately a four-fold increase in four

years. To compound its financial problems, JNR also lost its share in ton-kilometres of domestic freight carried by the national rail network from about 30 per cent in 1965 to 13 per cent ten years later (Gensher and Straszak, 1981, Figure 5.18, p. 196).

The 1987 railway reforms transferred responsibility for operations of the Tōhoku and Jōetsu Shinkansen lines to JR East, the Tōkaidō Shinkansen to JR Central and the San'yō Shinkansen to JR West. The September 1987 *Law on the Transfer of Construction Projects for Shinkansen Lines Overseen by Passenger Railway Companies to the Japan Railway Construction Company* (JRCC) transferred responsibility for constructing Shinkansen lines to the JRCC (Takatsu, 2007: 9).

The Shinkansen Railway Holding Organization, established as part of the JNR privatisation process, owned the four existing Shinkansen lines (Tōkaidō, San'yō, Tōhoku and Jōetsu) and leased the infrastructure facilities to the operating companies. However, this arrangement was abandoned in 1991 when the operators complained that they could not easily draw-up long-term business plans because they could not depreciate Shinkansen assets. The role of the Shinkansen Railway Holding Organization was taken over by the Railway Development Fund (RDF) with responsibility for transferring all Shinkansen assets and liabilities to the railway operators in the JR group.

The Shinkansen Program has had extraordinary impacts (Hayashi *et al.*, 2017). The Tōkaidō Shinkansen has carried about 6.4 billion passengers since its inaugural commercial service in 1964 (Central Japan Railway Company, 2019:18). Journey times between Tōkyō and Shin-Ōsaka have dropped from 3 hours 10 minutes on the *hikari* service to 2 hours 33 minutes on the *nozomi* service. This has been facilitated by the construction of additional platforms and the installation of additional draw-out tracks at Shin-Ōsaka Station. Timetable changes in the Spring of 2020, introduced a "12 Nozomi Timetable," allowing all Nozomi 700A type services to run at the same highest speed of 285 km/h and reduce the journey time to 2 hours 30 minutes (Central Japan Railway Company, 2019: 8).

Magnetic Levitation Railways

Japan National Railways initiated research on a linear propulsion railway system in 1962. In July 1972, the JNR Technical Research

Institute ran a prototype called ML-100 using a superconducting magnet linear synchronised motor at 60 km/h. This represented a world's first. Germany followed with its maglev test track in Emsland. In 1977, testing of vehicles of speeds up to 500 km/h moved to a new track of length 7 km in Hyūga, a port-city on Kyūshū Island.

When JNR was privatised in 1987 the development of the maglev system was taken over by the Central Japan Railway Company. It decided to build a better testing facility in Yamanashi Prefecture to the west of Tōkyō with a longer track length of 18.4 km, including tunnels, steeper gradients and curves. From 1997, MLX01 trains were tested there, followed by long-distance running tests by alternately operating two trainsets with rolling stock and facilities for commercial use.² Cumulative running distance was 2.76 million km, as of February 28, 2019 (Central Japan Railway Company, 2019:12). Running tests were started with the Series L0 rolling stock, based on commercial specifications, and covered 4,064 km in one day reaching a top speed in 2015 of 603 km/h (Central Japan Railway Company, 2019: 25). In total, investment in the Yamanashi line was 170.6 billion yen; for its extension to 42.8 km there was an additional 339.1 billion yen. The investment in proprietary superconducting maglev technological developments was 197.1 billion yen (Central Japan Railway Company, 2019: 24).

When JR Central announced the decision of building the Maglev Chuō Shinkansen, and opening it in 2045, its stock price plunged. In May 2011, the Ministry of Land, Infrastructure, Transport and Tourism reported that it was appropriate to utilise the maglev technology on the inland Southern-Alps route and designated JR Central as the construction authority between Tōkyō and Ōsaka (and to finance the construction) and also to be the railway operator (Central Japan Railway Company, 2012: 24). The development concept for a service with a maximum speed of 505 km/h cost of 9,030 billion yen. The inland route avoids the coastal areas along the Tōkaidō route that are vulnerable to the risk of

2 In 2015, Professor Yoshitsugu Hayashi (Nagoya University) kindly arranged a site briefing and a test ride with JR Central Railway at the Yamanashi Test track. To illustrate the seamlessness of travel in Japan, that morning I took the JR Hokkaidō rapid transit from Sapporo to the New Chitose Airport, an ANA flight to Tōkyō Haneda Airport, followed by rail to the newly opened Shinagawa to Tōkyō Station—a short journey that few people would ever make by Shinkansen. At Tōkyō Station, I met up with Professor Hayashi and we took the JR Chuō line to Ōtsuki Station arriving mid-morning.

earthquakes and tsunami inundation. The environmental assessment, and the two-stage Construction Implementation Plan were approved in 2014 and 2018, respectively.

The first phase of the project is the extension of the Yamanashi line for a distance of 286 km that would link the stations at Shinagawa and Nagoya (Figure 6). The estimated cost for construction and rolling stock is 5,523.5 billion yen. As of 2020, construction contracts for the most time-consuming and most difficult construction work, such as the construction of the Southern Alps tunnel and the Shinagawa and Nagoya Terminal Stations, have been let. Work is proceeding towards a 2027 completion date (Central Japan Railway Company, 2019: 22). The *Act on the Japan Railway Construction, Transport and Technology Agency, Independent Administrative Agency*, was revised in November 2016. The Agency provides JR Central with the loans for part of the funds required for the construction of the Chuō Shinkansen. Japan Central Railway borrowed a total of 3 trillion yen before July 2017 (Japan Central Railway Company (2020: 73).

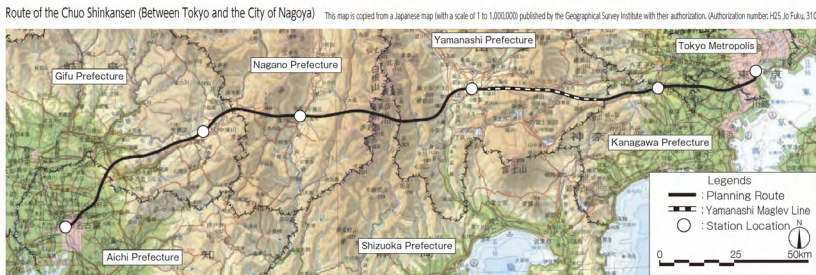


Figure 6. Proposed Route for the Chuō Shinkansen between Shinagawa, Tōkyō, and Nagoya (Approximate Locations of the New Stations are Indicated) and the Current Yamanashi Test Track.

Source: Central Japan Railway Company, 2020: 102. All rights reserved.

Conclusions

The import of railway technology in Japan had a strong British connection (Table 19). The British Minister convened a meeting in late 1869 with the Vice Premier, the Minister and Vice Minister of Foreign Affairs and the Assistant Vice Minister of Finance. Railways were perceived as a symbol of centralised political power that would reinforce the legitimacy of

the new Meiji government. The Japanese Cabinet began hiring British engineers to design and build railways in Japan and appointed Edmund Morel as its first Engineer-in-Chief. On his advice, the Ministry of Public Works was established in 1871 to administer the railway expansion program with Masaru Inoue (who had studied railway and mining at University College London) as its first Director of Railways. British engineers determined that the locomotives should run on the 3' 6" (1,067 mm) narrow gauge tracks. The first railway, with a terminus in Tōkyō (Shimbashi) and the other at Noge Kaigan (Yokohama), opened in 1872.

The private sector entered into railway construction also at an early date, until the government privatised all major trunk lines in 1906. The government promoted railway construction in regional areas on an even narrower gauge (782 mm) through the 1910 *Light Railway Act* (revised 1921). The dominance in ownership of railways by the government lasted until 1987 when Japan National Railways was privatised and divided into the regional operations that exist today. Municipal governments were largely responsible for the introduction of horse-drawn and electric trams from the late 19th century, and urban subway construction was initiated in Tōkyō by the private sector, although subsequent developments in other cities involved both sectors.

Table 19. Summary of Major Events in Japanese Railway Development—
Institutions and Organisations.

Source: Author.

Major Event	Date	Key Players
Introduction of steam engine	1853	Russian government
Lobbying to introduce railways	1869	British Minister to Japan
British railway expert, Edmund Morel hired as Engineer-in-Chief.	1870	Japanese Cabinet
Establishment of Ministry of Public Works Masaru Inoue appointed as first Director of Railways in Japan	1871	Japanese Cabinet
Shimbashi to Yokohama railway opens	1872	Ministry of Public Works
Ōsaka to Kōbe railway opens	1874	Ministry of Public Works
First horse-drawn tramway, Tōkyō	1880	Municipal Government
Railway Construction Act	1892	Private companies

Major Event	Date	Key Players
Railway Nationalization purchase of 17 private railway companies.	1906	Japanese Government <i>Diet</i>
Railway Technical Research Institute formed	1907	Imperial Railway Agency
Light Railway Act 1910 encouraged narrower gauge 762 mm railways	1910	Japanese Government <i>Diet</i>
Ministry of Railways established	1920	Japanese Government <i>Diet</i>
Urban railway network plan approved	1925	Japanese Government <i>Diet</i>
First Subway opens, Tōkyō	1927	Private company
Japanese National Railways (JNR) formed	1948	Allied Occupation Forces
High-speed rail opens Tōkyō and Shin-Ōsaka	1964	Japanese National Railways
Privatisation of JNR	1987	Japanese Government <i>Diet</i>
Company assumes responsibility for maglev	1987	Central Japan Railway Company
Construction of Chuō maglev approved	2018	Ministry of Land, Infrastructure, Transport and Tourism

By international standards, the post-Second World War technological developments in high-speed rail and in magnetic levitation systems have been impressive. The Railway Technical Research Institute (established in 1907) and the Japan Railway Research Institute (established 1948), together with research and development (R&D) expertise from industry and the military, provided the platform for this railway expertise.

Although derided at the time, the vision of a national network of high-speed rail provided by the JNR President, Mr. Sogo, has been spectacularly realised. The New Comprehensive National Development Plan of 1968 foresaw that the technology would integrate the economy and society into a single unit—a policy aspiration that has been highly successful. The opening of the Maglev Chuō Shinkansen later this decade will further speed up the flow of people, information and new ideas in the study area.

Possibly the greatest challenge is how best to maintain the vast railway system against a context of an ageing population, reduced government income from taxation and a lack of central and local government capacity to provide the required subsidies. One way is to separate the owner of

the infrastructure from the rail operator (the franchise model), as in the European Union, but policy reform and transitions from existing arrangements to new ones have proved to be difficult in the Japanese cultural context. Most profitable lines are owned by private entities and the new model would force operators into an internal subsidy of the less lucrative services with the beneficiary being the government with reduced subsidies. Whatever the institutional arrangements in the future, there is the problem of maintaining ageing infrastructure such as tunnels and bridges where the average age of these infrastructure maintained by governments is 32 years (Okajima Gen³ pers. comm.). The collapse, in early December 2012, of the Sasago motorway tunnel highlights the risks of under-investing in the maintenance of infrastructure.

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³ At the time, Gen Okajima was the Manager of the Sydney Office of the Central Japan Railway Company.

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