Chapter 2
Railway Engineers of the Japanese Empire and the Significance of Collaborative R&D Activities

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Abstract Lushun Institute of Technology (LIT) and South Manchuria Technical College (SMTC) played a great role in supplying engineers for colonial government railways in Taiwan and Korea, South Manchuria Railway (SMR) , and rolling stock and locomotive companies in Dalian and Seoul. Dependent on educational organizations, such as LIT and SMTC with regard to the supply of engineers, railways within the Japanese empire were organized into an ellipse with JNR and SMR at its apex. The collaborative research activities demonstrated in the case of Conference on Rolling Stock between users and designated manufacturers able to produce high-quality products was one aspect of the "efficient" R&D adopted by a latecomer to industrialization—i.e., Imperial Japan. However, in this method of selecting qualified manufacturers, the state—the largest buyer—determined which manufacturers were candidates for optional contracts. For non-member firms excluded from collaborative research, this was the closed system of R&D activities.

Keywords JNR · SMR · Conference on rolling stock · Technical committee on rolling stock

2.1 Introduction

During the Meiji period (1868–1912), Japan imported steam locomotives and railway technologies from the UK, USA, and Germany. During Japan's road to nationalization in 1906 and 1907, the country's railway engineers had to unify those disparate imported technologies, create their own technologies, or import substitutes. To do so, Japanese National Railways (JNR) adopted a "designated factory system" in 1912 to secure privately built rolling stock and locomotives from three factories: Kisha Seizō, Nippon Sharyō Seizō, and Kawasaki Shipyard (Amano

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M. Sawai (ed.), *The Development of Railway Technology in East Asia in Comparative Perspective*, Studies in Economic History,
DOI 10.1007/978-981-10-4904-0_2

Factory was added later). The system prohibited purchase of imported locomotives and ended the manufacture of new rolling stock at JNR's factories.

The designated factory system established a demarcation between Japan's private and public sectors and shaped the trajectory of Japan's rolling stock industry afterwards: JNR's factories would concentrate on repair, and private companies would manufacture rolling stock and locomotives. The designated factory system for rolling stock and locomotives was one of the several similar systems established by public sector entities, including the military and Ministry of Telecommunication. This system nurtured a select few private manufacturers who were instrumental in the industrialization of modern Japan. It was a key feature in Japan's experience and the industrial development of developing economies in the 20th century.

JNR influenced the development of railway technology in Japan and elsewhere. Colonial governments in Taiwan, Korea, and south Sakhalin built railways generally operated by bureau of transportation of Taiwan Sōtokufu (operated under the Governor General of Taiwan), railway bureau of Chōsen Sōtokufu (operated under the Governor General of Korea) and Sakhalin Agency. Colonial government railway factories were established in Taiwan and Korea for both repair and manufacturing of new rolling stock and locomotives. In 1906, the South Manchuria Railway (SMR) was established, and the Shahekou railway factory was built in Dalian. Colonial government railways and the SMR had remained close to their designated factories over a long period, as had JNR, which mentored colonial governments and the SMR in maintaining relationships with designated factories. Designated factories were not limited to private rolling stock enterprises in Japan. *Ryūzan Kōsaku* in Korea and *Dairen Kikai Seisakusho* in Dalian were important private designated factories in their regions.

After the Japanese Empire collapsed in 1945, Japanese employees of colonial government railways and the SMR began to return to Japan. Most could return relatively quickly, except for a small number of engineers. Railway workers and engineers on site operated and maintained former colonial government railways and the SMR. For example, not only the "legacy" of colonial times but also Nationalist Party-related engineers who came from the continent and US foreign aid influenced the development of railway technology in postwar Taiwan. Postwar railways in Taiwan groped their way toward "Taiwanese" railway technology under these circumstances.

To consider the development of railway technologies in East Asia in the 20th century, this chapter examines the historical significance of technological alternatives under imperialism; how workers, engineers, and managers were supplied; how collaborative R&D activities organized by the JNR worked in the development of railway technology.

This chapter first examines the allocation of railway engineers, especially those involved in manufacturing rolling stock and locomotives, who advanced railway development in the Japanese Empire. Latter portions of this chapter detail the significance of collaborative R&D supported by engineers within the Japanese Empire, particularly the Conference on Rolling Stock and Technical Committee on Rolling Stock.

2.2 Engineers of the Ministry of Railways, South Manchuria Railway, and Colonial Government Railways

2.2.1 Bureau of Manufacturing Within the Ministry of Railways

The manufacturing bureau within the Ministry of Railways technologically controlled Japan's rolling stock technology.[1] Its first chief—Yasujirō Shima (from June 1915 to April 1918 in office)—was followed by seven successors: Seiji Takasu, Shōhachi Akiyama, Okiie Yamashita, Kiichi Asakura, Hisaji Kii, Shinsaku Tokunaga, and Kingo Mukasa. The bureau was reorganized under the Ministry of Transportation and Telecommunication in 1943 (Sawai 2015, 45). All eight chiefs were graduates of the Department of Engineering at Tokyo Imperial University. Initially, the manufacturing bureau comprised three divisions: factory, rolling stock, and electricity. The electricity division acquired bureau status in 1920, and the division of machinery was added in 1927. Within the manufacturing bureau, the division of rolling stock planned, designed, and executed "manufacturing and remodeling of rolling stock."(Tetsudō Daijinkanbō Jinjika 1934, 4).

After retiring from the Ministry of Railways in 1919, Shima was named the director of the SMR. In 1934, Shima became the president of Kisha Seizō, the most famous designated factory. Takasu was appointed the president of Hatsudōki Seizō and an advisor to Nippon Air Brake (Nihon Kōtsū Kyōkai 1972, 216). Akiyama, who retired in 1929, was appointed managing director and vice president at Nippon Sharyō Seizō, becoming the president of Manshū Sharyō in Manchuria. Yamashita retired in 1933 and was named the director of Nissan Motor and Hitachi Seisakusho. After retiring in 1936, Asakura was appointed the managing director of Kisha Seizō and Kii was appointed the managing director of Shibaura Kyōdō Kōgyō. Tokunaga was appointed the managing director of Nippon Sharyō Seizō. Mukasa was appointed the president of Kawasaki Heavy Industries (Kawasaki Shipyard changed its name in 1939) (Sawai 2015, 46–50).

The custom of instating chiefs of JNR's manufacturing bureau as directors at designated factories or related companies is called *amakudari* (descent from heaven). The custom deepened relationships between JNR and designated factories. *Amakudari* was also the custom among other ministries of Japan's army and navy. Former chiefs of JNR's manufacturing bureau were often appointed as board members of academic associations, such as the Japan Society of Mechanical Engineers. They were key in promoting cooperation among industry, government, and universities.

[1]Names of government offices responsible for national railways changed frequently until the mid Meiji period. In 1908, just after nationalization, the Tesudō-in (Agency of Railways) was established, followed by Tetsudō-shō (Ministry of Railways) in 1920. This chapter consistently uses the term "JNR" to indicate the continuity of these government offices.

Table 2.1 presents the members of the rolling stock division of JNR's manufacturing bureau. We could confirm 11 engineers and 15 assistant engineers. Ten of the engineers were engineering graduates of Tokyo Imperial University, and one was a graduate from the Department of Engineering at Kyushu Imperial University. The rolling stock division of JNR's manufacturing bureau and the naval ship headquarters absorbed large numbers of elite engineering graduates from imperial universities, particularly Tokyo Imperial University.[2]

Hideo Shima, first-born son of Yasujirō Shima and a 1925 engineering graduate from Tokyo Imperial University, was appointed assistant engineer of the rolling stock division of the manufacturing bureau in 1927 after a training course at JNR's Ômiya factory(Takahashi 2000, 18.). He was promoted to engineer status in 1928, became chief designer of C10 steam locomotives (SL) in 1930 at age 29, and remained in that position to design types C54 to D51, one of the most excellent engines in the history of Japan's SLs (Takahashi 2000, 19–20). Hideo Shima went abroad as a researcher from February 1936 to December 1937, then was appointed manager of locomotives at the Takatori factory within the Osaka railway bureau in January 1938. He became the superintendent of Hamamatsu factory in August 1941 and director and chief of JNR's manufacturing bureau in June 1949 (Tetsudōshi Gakkai 2013, 227–228).[3]

Senichirō Hosokawa (Table 2.1) was appointed assistant engineer of the rolling stock division of the manufacturing bureau in 1932. He was promoted to chief engineer for C56, C57, and C58 type SLs during the war, and type D52, a large locomotive that pulled freight cars. According to Hosokawa, teams needed more than 20 engineers, assistant engineers, and staff to design boilers, cylinders, wheels, and drives. Designing a new SL took about one year (Takahashi 2000, 20). An engineer concerned should be a project manager of design of new steam locomotives.

Alongside engineers and assistant engineers, the manufacturing bureau employed many technical assistants (*Gijutsu Yatoi* or *Koin*) (Table 2.2). Most were promoted to assistant engineers in charge of developing SLs. For example, Kenjirō Katayama (Table 2.1) was chief engineer for machine parts in construction of SL types EF10, EF11, EF12, and EF14, early stage locomotives that pulled freight cars. Mitsuyuki Fukasawa served that role for bogies and brakes, as did Toyokazu Maki for electrical parts (Table 2.2) (Uninscribed 1965, 16).

Before being transferred to the manufacturing bureau in Tokyo, Toyokazu Maki had worked at a local operation site (Uninscribed 1957, 66). Engineering graduates from universities and technical colleges who also had been trained in workshops advanced R&D and manufacturing processes.

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[2]The Japanese navy brought in "entrusted students" from imperial universities every year and gave them scholarships. After graduating, they were required to undergo a year of military training and were appointed as lieutenants, called "Bukan" or "Gijutsu shikan" (naval technical officers). Graduates of universities and technical colleges who did not receive military training continued their careers as *Bunkan* or naval engineers.

[3]He returned to JNR as a chief engineer in 1955 and in March 1957 announced plans for the bullet train (*Shinkansen*) to link Tokyo and Osaka in three hours (Tetsudōshi Gakkai 2013, 228).

Table 2.1 Engineers of rolling stock division of manufacturing bureau and research institute of JNR (15th August, 1934)

Division	Name	Affiliated colleges and universities department	Major	Year of graduation
Chief of rolling stock division of manufacturing bureau	Shinsaku Tokunaga	Tokyo Imperial University, Engineering	Machinery	1915
Engineer	Shinsuke Hashimoto	Tokyo Imperial University, Engineering	Machinery	1921
〃	Zentarō Yamamoto	Kyushu Imperial University, Engineering	Electricity	1919
〃	Takeshi Gotō	Tokyo Imprerial University, Engineering	Machinery	1922
〃	Yasuto Kōzu	〃	〃	1921
〃	Sukeshige Taga	〃	〃	1923
〃	Hideo Shima	〃	〃	1925
〃	Hideo Yoshizawa	〃	Metallurgy	1925
〃	Tatsuji Satake	〃	Machinery	1926
〃	Taro Tanaka	〃	〃	1928
〃	Tomoshige Sekiguchi	〃	〃	1928
〃	Akimasa Kitabatake	〃	〃	1929
Assistant Engineer	Hironosuke Sekine	Kyoto Imperial University	〃	1918
〃	Atsutoshi Yokota	Waseda University, Science and Engineering	〃	1923
〃	Tōru Yokoyama	〃	〃	1923
〃	Tarô Yasaka	〃	Electricity	1924
〃	Keizō Hiyama	Meiji Technical College	Machinery	1923
〃	Kichiji Yoshida	Nagoya Technical College	〃	1922
〃	Kenjirō Katayama	Tokyo Imperial University, Engineering	〃	1929
〃	Mamoru Shibata	Nihon Daigaku Technical College	〃	1923
〃	Sakae Fujiwara	Yokohama Technical College	〃	1924
〃	Yasunosuke Sugano			
〃	Takeshi Ōno			
〃	Kyūzo Oka	Kobe Technical College	Electricity	1925
〃	Shōichi Yokobori	Tokyo Imperial University, Engineering	Machinery	1930

(continued)

Table 2.1 (continued)

Division	Name	Affiliated colleges and universities department	Major	Year of graduation
〃	Hideo Mori	Tokyo Technical College	〃	1926
〃	Senichirō Hosokawa	Tokyo Imperial University, Engineering	〃	1931
Director of research institute	Ryūji Yamada	Tokyo Imperial University, Engineering	Civil engineering	1911
Chief of first section	Tadakazu Chō	Tokyo Imperial University, Engineering	Applied chemistry	1908
Engineer of first section	Kinpei Yoshida	〃	〃	1914
〃	Tōichirô Amano	Tokyo Imperial University, Agriculture	Forestry	1916
〃	Kanehiro Sugayama			
〃	Fusatoshi Nozawa	Tohoku Imperial University, Science	Chemistry	1917
〃	Seiichi Hirose	Tokyo Imperial University, Engineering	Applied chemistry	1919
〃	Hidetoshi Matsunami	Kyoto Imperial University, Engineering	Metallurgy	1921
〃	Tadao Nakamura	Tokyo Imperial University, Agriculture	Forestry	1924
〃	Takashi Tamura	Tohoku Imperial University, Engineering	Chemical engineering	1914
Chief of second section	Ryūji Yamada			
Engineer of second section	Keiji Fujita	Tokyo Imperial University, Engineering	Machinery	1911
〃	Masuhiro Suzuki	Tohoku Imperial University, Science	Physics	1921
〃	Shōji Ikeda	Tohoku Imperial University, Engineering	Machinery	1923
〃	Kuraji Musashi	〃	〃	1923
〃	Haruhiko Shibata	Tokyo Imperial University, Engineering	Weapon manufacture	1924
Assistant engineer of second section	Yoshitarō Kimura	Waseda University, Science and Engineering	Machinery	1917
〃	Matsusaburō Wakasugi			
〃	Motomu Ishida	Tokyo Imperial University, Engineering	Metallurgy	1928
〃	Masaki Kubo	Waseda University, Science and Engineering	Machinery	1924
〃	Kō Chiba			

(continued)

Table 2.1 (continued)

Division	Name	Affiliated colleges and universities department	Major	Year of graduation
〃	Tōzō Ōiwa	Kanazawa Techcal College	Machinery	1928
〃	Masao Koibuchi	Tokyo Technical College	Electrical chemistry	1928
〃	Hikogorō Kobayashi			
〃	Yoshijirō Kunieda	Nihondaigaku Technical College	Machinery	1932
Chief of third section	Hisao Nakayama	Tokyo Imperial University, Engineering	Electricity	1913
Engineer of third section	Sadakazu Hattori	Tohoku Imperial University, Science	Physics	1923
〃	Shizuo Nakamura	Kyushu Imrerial University, Engineering	Electricity	1927
Chief of fourth section	Masanori Numata	Tokyo Imperial University, Engineering	Civil engineering	1919
Engineer of fourth section	Juichirō Nakahara	Kyushu Imrerial University, Engineering	〃	1921
〃	Kan Watanabe	Tokyo Imperial University, Science	Geology	1923
〃	Gonbe Inaba	Tokyo Imperial University, Engineering	Civil engineering	1923
〃	Minoru Uchiyama	〃	〃	1927
Chief of fifth section	Fumisaburō Sawa	Tokyo Imperial University, Science	Physics	1907

Source Tetsudō Daijinkanbō Jinjika (1934), Gakushikai (each year), and Nikkan Kōgyō Shinbunsha (1934)

Notes (1) Engineers from Shinsaku Tokunaga to Senichirô Hosokawa were in the rolling stock division of manufacturing bureau, and engineers from Ryûji Yamada to Fumisaburô Sawa were in the research institute of JNR. Only the second section of the institute shows assistant engineers

(2) Assistant engineers of rolling stock division of manufacturing bureau are shown only those of the second and the third grades

(3) The blank is unknown

JNR trained workers at in-house schools (*Tetsudō Kyōshūjo*) that prepared them to become assistant engineers and engineers. After 1922, the curriculum included railway middle school (five years of night school), ordinary in-house training at each local railway bureau (three years),[4] and special courses at each local railway bureau (four to eight months). This training was provided to workers who had completed higher elementary school (two years for those who completed six years

[4]JNR had six local railway bureaus: Sapporo in Hokkaido, Sendai, Tokyo, Nagoya, Kobe in Honshu and Moji in Kyushu from 1920.

Table 2.2 Technical assistants of rolling stock division of manufacturing bureau (on August 15, 1934)

Name	Monthly salary (yen)	1941 (yen)
Eikichi Yoneoka	75	
Manji Satō	70	Assitant engineer (fourth grade)
Mitsuyuki Fukazawa	70	〃
Suehito Tanaka	70	〃
Masao Yamazaki	70	〃
Masami Morita	69	
Shunpei Imoo	65	
Kōzō Noguchi	65	
Kiyoshi Nemoto	62	Assitant engineer (fourth grade)
Shunichi Ōshima	61	Assitant engineer (fifth grade)
Toyokazu Maki	61	〃
Eiichi Saiga	61	
Hitoshi Honda	61	〃
Toshio Yamamoto	61	
Teijiro Wakabayashi	60	
Isamu Fujita	59	〃
Sakuo Motoyama	59	〃
Masao Hosokawa	58	
Daizō Hanada	58	〃
Shūichi Nakajima	58	
Sadao Chine	58	
Kōtarō Uchida	58	
Kotokichi Nagamori	57	
Kō Sone	57	
Turukichi Ishii	57	〃
Kumakichi Takaoka	56	
Etsuji Tanaka	55	Assistant engineer (sixth grade)(1)
Keizō Yajima	55	Assistant engineer (sixth grade)
Yasuo Higuchi	55	〃
Gorō Ōsawa	55	
Isamu Nagashima	55	〃
Yasuo Hayashi	54	〃
Asagorō Enomoto	54	〃
Yukio Watanabe	53	〃
Ichiro Inoue	52	〃
Zensaku Yoshizawa	51	74
Tosaburō Noda	51	Assistant engineer (sixth grade)
Shigetaka Sekiguchi	51	72
Kō Honda	51	

(continued)

Table 2.2 (continued)

Name	Monthly salary (yen)	1941 (yen)
Gorō Tōya	50	74
Kikue Matsumoto	50	
Yoshitaka Nagai	49	
Tetsumi Suzuki	49	
Sôsaku Okada	48	
Tei Senda	48	69
Katsutarō Morikawa	47	
Sadakichi Tanaka	47	
Masao Kudo	46	67
Yôji Takaoka	1.42(daily)	
Kiyoharu Iijima	1.35(daily)	68
Tōichi Mochizuki	1.27(daily)	
Iwao Okamatsu	1.23(daily)	

Source Tetsudō Daijinkanbō Jinjika (1934 and 1941)
Note (1) Factory division of manufacturing bureau

elementary schools). Those who completed in-house training at each local railway bureau could continue their education, selecting among two-year routine and advanced courses at the Ministry of Railways. Workers who entered in-house training at local railway bureaus and of the Ministry of Railways were upgraded to posts formerly held by graduates of middle school and technical colleges although they were obligated to work twice as long as their period of education (Mikami 2004, 225).

The ascent of workers to assistant engineers or engineers through in-house training diffused throughout large Japanese private companies and national enterprises around WWI. The Naval Training School for Assistant Engineers (*Kaigun Gite Yôseijo*) was equivalent to JNR's *Tetsudō Kyōshūjo*. It was established at Yokosuka Naval Shipyard in 1919; subsequently, it moved to Kure Naval Shipyard in 1928. Open to talented workers who passed stringent examinations, its three-year curriculum was equivalent to technical college. Initially, comprising two divisions—shipbuilding and marine engines—it added a division of weaponry after redeployment to Kure. To qualify for entrance examinations, workers had to be 21 years old with at least three years of experience in the workshop. In prewar Japan, the division between engineers and workers was sharp and based on academic careers. In-house training provided by JNR and the navy was a means whereby ambitious workers could advance as assistant engineers and engineers. It also opened channels through which JNR and the navy could recruit engineers with practical workshop experience and knowledge of shop culture. It was sure that the existence of this carrier pass encouraged workers to upgrade their posts and experiences.

As mentioned, the Imperial Japanese Navy employed two kinds of engineers in shipbuilding: naval technical officers and naval engineers. The former were university and technical college graduates who took a military training after

Table 2.3 The number of shipbuilding officers (naval officers and engineers) at the end of Pacific War (person)

By placement	Officers/engineers	Graduates of technical colleges and universities	Graduates of naval training school
Naval ships headquarter	33	33	
	24	6	13
Technical institute of the navy	11	11	
	11	4	4
Yokosuka naval shipyard	60	60	
	19	5	11
Kure naval shipyard	65	65	
	31	11	18
Sasebo naval shipyard	51	51	
	15	1	11
Maizuru naval shipyard	42	42	
	12	5	4
Naval ships headquarter Inspectors of shipbuilding	41	40	
	44	8	34
Manufacturing bureau of the navy Others	41	41	
	9	1	8
Naval air headquarter	3	3	
	3	2	
Ministry of munition	2	2	
Ministry of the navy	1		
Total	350	348	
	168	43	103

Source Kaigun Zōsenkai Kaiin Gyōseki Kenshō Shiryō Sakusei Iinkai (1988), pp. 10–27
Note The upper is naval officers, and the lower is naval engineers

employment; the latter were graduates of universities and technical colleges who continued to serve as engineers. Naval technical officers potentially could be promoted to vice admiral. Table 2.3 surveys the composition of the Japanese navy's shipbuilding officers (technical officers and engineers). At the end of the Pacific War, 348 of 350 naval technical officers were university and technical college graduates, 43 of 168 naval engineers were university and technical college graduates, and 103 were graduates of the naval training school for assistant engineers. In the case of the fourth division of the naval headquarter in charge of designing of naval ships, the number of graduates of the naval training school who became assistant engineers were much larger than university and technical college graduates who became naval engineers. This was also the case at Yokosuka, Kure, and Sasebo naval shipyards. Table 2.3 confirms the significance of engineers who

began as shop workers at the naval shipyards. Engineers who had graduated from universities and technical colleges could not manage workshops without help from assistant engineers promoted from among workers. Graduates of JNR's and the navy's training schools were bilingual in "shop culture" and "school culture".

Entering the naval training school for assistant engineers was a narrow path. Among the tens of thousands of shipyard workers, only 20 to 40 graduated from the program each year, although their numbers ballooned during the war. However, naval training school was an important path for workers to become assistant engineers or engineers, especially if they could not afford higher technical education. Such was also the case at JNR's *Tetsudō Kyōshūjo*.

2.2.2 JNR Research Institute of Railway Technology

The Ministry of Railways established a research institute in 1907 (its name was changed and its curriculum upgraded in 1910, 1913, 1920, and 1942). As Table 2.1 shows, it had five sections in 1934. There were 24 engineers, including section chiefs, for 23 of whom academic careers could be confirmed: 14 were graduates of Tokyo Imperial University, six were graduates of Tohoku Imperial University, two were graduates of Kyushu Imperial University, and one was a graduate of Kyoto Imperial University.

Expenses for the research institute, excluding salaries of engineers and assistant engineers, were around 400,000 yen from 1927 to 1938, rising to 740,000 yen in 1940 and 1,070,000 yen in 1942 (Sawai 2015, 51–52). The institute employed 294 staff in 1935, 496 in 1942, and 1,567 at the end of October 1947, when it received many ex-military and aeronautics engineers unemployed after the war (Tetsudō Gijutsu Kenkyūsho 1957, 41–42).

2.2.3 Manufacturing Division of South Manchuria Railway Company and Its Research Institute of Railway Technology

As Table 2.4 shows, the manufacturing division of South Manchuria Railway Company (SMR) had four sections; planning, locomotives, rolling stock, and machinery. The manufacturing division included a chief (Hidetsugu Nonaka, graduate of Tokyo Imperial University), four section chiefs, and 48 assistant engineers. Of the four section chiefs, three were graduates of Lushun Institute of Technology (LIT) established in 1910 and upgraded to university status in 1922. The chief of the machinery section graduated from Kumamoto Technical College. Among the 29 assistant engineers whose academic careers could be confirmed, 11 graduated from South Manchuria Technical College (SMTC) , nine from LIT, four from a technical college in Japan, two from Kyushu Imperial University, and three

Table 2.4 Engineers of manufacturing division of South Manchuria Railway (on the 1st September, 1934)

Post	Name	Affiliated colleges and universities department	Major	Year of graduation
Division chief/engineer	Hidetsugu Nonaka	Tokyo Imperial University, Engineering	Machinery	1913
Section chief of planning/engineer	Masatsugu Kubota	Lushun Institute of Technology	〃	1914
Section chief of locomotives/engineer	Shintarō Yoshino	〃	〃	1918
Section chief of rolling stock/engineer	Yoshizumi Ichihara	〃	〃	1916
Section chief of machinery/engineer	Shigeru Ishio	Kumamoto Technical College	〃	1911
Assistant engineer	Tatsuya Azuma	Yonezawa Technical College	〃	1932
〃	Hiroshi Kojima	Lushun Institute of Technology	〃	1921
〃	Yōtarō Ichijō	〃	〃	1922
〃	Michiji Fukui	〃	〃	1924
〃	Ryōichi Morimoto			
〃	Kōjirō Kawaguchi	〃	〃	1924
〃	Itaro Horiuchi	Kyushu Imperial University, Engineering	〃	1927
〃	Taneo Saeki	Lushun Institute of Technology	〃	1922
〃	Tatsuji Hidaka			
〃	Takeo Hirayama			
〃	Kiyoaki Yanagishita	Kyushu Imperial University, Engineering	〃	1929
〃	Yoshio Okamoto			
〃	Takeo Namiki	Lushun Institute of Technology	〃	1925
〃	Tatsuzō Kumioka			
〃	Azuma Yamaguchi	South Manchurian Technical College	〃	1928
〃	Tetsuya Morita	Waseda University, Science and Engineering	〃	1928
〃	Shigeo Fukushima			
〃	Washirō Nakamura	South Manchurian Technical College	〃	1917
〃	Chikao Sagawa	Lushun Institute of Technology	〃	1929

(continued)

Table 2.4 (continued)

Post	Name	Affiliated colleges and universities department	Major	Year of graduation
〃	Kazuo Tayama	〃	〃	1931
〃	Sadayoshi Hosoda	South Manchurian Technical College	〃	1927
〃	Tatsuo Maejima	〃	〃	1928
〃	Yoshihiko Higo			
〃	Shōji Sano			
〃	Genichi Etō	〃	〃	1928
〃	Kazutoki Yoshida			
〃	Masao Sone			
〃	Toshien Song	Nihon Daigaku Technical College	〃	1927
〃	Mitsuyoshi Ishihara			
〃	Shiro Hidejima	Lushun Institute of Technology	〃	1933
〃	Hachiro Inamoto	Fukui Technical College	〃	1929
〃	Masao Kawai	Yokohama Technical College	〃	1927
〃	Tsurukazu Mikami	South Manchurian Technical College	〃	1930
〃	Masuo Mizoo	〃	〃	1930
〃	Yasuzō Koga	〃	〃	1931
〃	Toshio Kazumaru			
〃	Tatsuichi Ōkubo			
〃	Toshio Tokawa			
〃	Kishirō Kumagai	〃	〃	1932
〃	Yoshio Minemura			
〃	Tamaji Nishiyama	〃	〃	1933
〃	Kazuo Katō	Nihon Daigaku, Special Courses	〃	1923
〃	Hiroshi Takahama	Fukui Technical College	〃	1933
〃	Yukiyoshi Murakami			
〃	Masatsugu Tanigawa			
〃	Susumu Katō	South Manchurian Technical College	〃	1929
〃	Toshio Samejima			
〃	Yasuna Takeuchi			

Source Minami Manshū Tetsudō Kabushiki Kaisha (1934), and Nikkan Kōgyō Shinbunsha (1934)

from other schools. These figures confirm the intimate ties among SMR, LIT, and SMTC in supplying engineers.

LIT had four departments—machinery, electricity, mining, and metallurgy—and added a department of applied chemistry and aeronautics during the war. Upon its elevation to a university in 1922, the Agency of the Kwantung Leased Territory indicated the following (Kantōchō (Agency of Kwantung Leased Territory) 1922).

> More than 10 years ago young Chinese students were eager to go to Japan for study. However Japanese people took a short view, did not keep good relationships with Chinese students, often lacerated them with the result of emergence of anti-Japanese sentiment among them. […] the place of south Manchuria is the paradise for them. The Chinese students of LIT and South Manchuria Medical School in Lushun enjoy campus life in a good relationships with Japanese students. […] if we could turn out people who would become leaders of China in the future, that would largely contribute to our national interest.

Although LIT was established in China, there were only 98 Chinese among its 1,333 graduates in 1937 (Sawai 2012, 25).

SMR established South Manchuria Technical School in Dalian in 1911. Its five sections—civil engineering, architecture, machinery, electricity, and mining—covered four years of schooling. SMTC succeeded it in May 1922.

Shintarō Yoshino, chief of the locomotive section of the manufacturing division, graduated from LIT's machinery department in 1918 and began his career as an engineer at SMR's Shahekou railway factory in Dalian. He studied at the American Locomotive Company, one of the world's largest locomotive builders, from 1923 to 1925. He designed the fastest locomotive in the Japanese empire and Manchuria, which pulled streamlined passenger cars called "Asia," in 1933 (Sawai 2015, 6–7). According to Yoshino, SMR imitated, then improved the imported locomotives, mostly made in the US, for about 20 years after establishment. In 1927, a Pashiko-type locomotive was for the first time designed based not on imported locomotives but on original ideas from SMR engineers (Yoshino 1939, 36).

The SMR also established the research institute of railway technology in 1922 on the advice of Yasujirō Shima, who retired from JNR in 1919 and became a director of SMR. Table 2.5 notes 44 primary researchers whose academic careers could be confirmed among 52 posted as chief researchers from 1923 to 1942. Seven were LIT graduates, and three were SMTC graduates. This proportion is relatively small compared with that in the manufacturing division, in which 20 were graduates of imperial universities and 15 graduated from technical colleges in Japan. However, engineers frequently transferred among SMR's railway factories, manufacturing division, and research institute.

Many SMR researchers had studied abroad (Table 2.5). In 1911, SMR established rules that prescribed two kinds of foreign study: two-year study abroad, especially in the US and Europe, for those with five or six years of experience and study abroad for officer candidates with 10 years of experience at SMR. SMR often sent engineers and researchers on six-month sojourns to study advanced

Table 2.5 Main researchers of South Manchuria Railway Company and the research institute of the SMR

Name	Name of post	Affiliated colleges and universities department	Major	Year of graduation	Remarks
Kiyoshi Takemura	Interlocking director (23)	Tokyo Imperial University, Engineering	Machinery	1902	
Aihito Inoue	Section chief of machinery & rolling stock (23), section chief of machinery (24), laboratory chief of machinery (32), assistant director of machinery department (38), assistant director of metal department (40)	Osaka Technical College	〃	1911	Official trip to Europe and USA (34)/ 8 months
Kaneyuki Ochiai	Section chief of electricity (23)	Lushun Institute of Technology	Electricity	1915	
Kingo Kaise	Interlocking director (24)	Kyoto Imperial University, Engineering	Machinery	1901	
Yoshio Nakahara	Section chief of rolling stock (25)				
Masatoshi Koreyasu	Section chief of rolling stock (26)	Lushun Institute of Technology	〃	1918	Study in USA (23)/ 2 years
Tadao Miyajima	Section chief of civil engineering (26), laboratory chief of civil engineering and construction (32), of water and sewerage (32)	Kyushu Imperial University, Engineering	Civil engineering	1917	Official trip to Europe and USA (36)/ 8 months
Inosuke Watanabe	Director (27), research section chief of machinery and electricity (31), of machinery (32), director (37)	Kyoto Imperial University, Engineering	Machinery	1913	
Kazuharu Kusaka	Section chief of analysis (27), research section chief of metals (34)	Lushun Institute of Technology	Mining and metallurgy	1921	Study in Europe and USA/2 years
Kojirō Takagi	Section chief of rail tracks (28), research section chief of civil engineering (31), assitant director of civil engineering depaertment (38)	Kumamoto Technical College	Civil engineering	1916	

(continued)

Table 2.5 (continued)

Name	Name of post	Affiliated colleges and universities department	Major	Year of graduation	Remarks
Teiji Nebashi	Director (31, 34), temporary director (39)				
Kanji Kurihara	Director (31)	Tokyo Imperial University, Engineering	Applied chemistry	1905	
Hiro Yamamoto	Research section chief of electricity (31)	Lushun Institute of Technology	Electricity	1922	
Matsunosuke Iwatake	Research section deputy chief of electricity (32), research section chief of light electricity (32), of heavy electricity (34) Research section chief of electricity (34), assitant director of investigation and electricity departments (38)		Machinery	1921	
Masuzō Isokane	Research section chief of rolling stock (32), of locomotives (35), assitant director of rolling stock department (38)	Lushun Institute of Technology	Machinery	1919	Official trip to Europe and USA (35)/ 5 months
Shōichi Fujii	Research section chief of heavy electricity (32)	〃	Electricity	1923	
Shikimatsu Tanaka	Laboratory chief of purchasing goods (32), of electrical goods (35)	South Manchurian Technical College	〃	1927	
Nobuhiro Ishibashi	Research section chief of rail tracks (32)	Kyoto Imperial University, Engineering	Civil engineering	1927	
Teiji Node	Research section chief of heat economy (33), assistant director of machinery department (40), Research section chief of machinery (40) Research section chief of heat (40), chief of design roon (40)	Tokyo Imperial University, Engineering	Machinery	1927	Official trip to Europe and USA (36)/ 6 months

(continued)

Table 2.5 (continued)

Name	Name of post	Affiliated colleges and universities department	Major	Year of graduation	Remarks
Chūji Fuse	Research section chief of civil engineering and construction (33), research section chief of structure and construction (40)	Kyoto Imperial University, Engineering	Architecture	1925	
Hanzō Omi	Research section chief of light electricity (34)	Tokyo Technical College	Electricity	1923	
Kazuo Endō	Section chief of metal analysis (35), of analysis (39), research section chief of chemistry (40)	〃	Ceramic engineering	1913	
Tokijirō Takeuchi	Deputy chief of manufacturing Sect. (35), section chief of manufacturing (39)				
Shigeru Ishio	Research section chief of rolling stock (35), assistant director of rolling stock department (38)	Kumamoto Technical College	Machinery	1911	
Itaru Kawada	Research section chief of general rolling stock (35)	Kyoto Imperial University, Engineering	〃	1927	
Ichirō Kanō	Research section chief of heavy electricity (35), of electric power (38)	Tohoku Imperial University, Engineering	Electricity	1930	
Shigeyoshi Kutsukake	Research section chief of rail tracks (35)	Nagoya Technical College	Civil engineering	1924	
Takuitsu Kamisaka	Research section chief of machinery (35)	Kyushu Imperial University, Engineering	Machinery	1928	Study in Europe and USA (33)/ 2 years
Tsuneya Marusawa	Director (36)	Kyoto Imperial University, Engineering	Applied chemistry	1907	
Kiyoaki Yanagishita	Research section chief of general rolling stock (36)	Kyushu Imperial University, Engineering	Machinery	1929	

(continued)

Table 2.5 (continued)

Name	Name of post	Affiliated colleges and universities department	Major	Year of graduation	Remarks
Tan Furuno	Research section chief of light electricity (36), of cable communication (38), of general communication (40)	Tohoku Imperial University, Engineering	Electricity	1930	
Toshitarō Matsunawa	Assistant director of standard investigation (38)	Lushun Institute of Technology	〃	1917	
Yoshihiko Hara	Research section chief of metals (38)	Tohoku Imperial University, Engineering	Metal	1929	
Hideo Itatani	Research section chief of wireless communication (38), of cable communication (40)	〃	Electricity	1934	Study in UK and Germany (36)/2 years
Kikuo Matsui	Research section chief of signals (38)	Kobe Technical College	〃	1926	
Shûsaku Kamiya	Research section chief of rail tracks (38)	Tokyo Imperial University, Engineering	Civil engineering	1932	
Sueyoshi Kojirō	Research section chief of bridges (38), of steel structure (40)	Kumamoto Technical College	〃		
Hiroshi Yamaoka	Chief of standard investigation (38), of standard investigation and architecture group (39)	South Manchurian Technical College	Architecture	1925	
Toyozō Dōke	Research section chief of locomotives (39)	Tokyo Technical College	Machinery	1929	
Hajime Hirose	Research section chief of wireless communication (39)	Yonezawa Technical College	Electricity	1931	
Fusatarō Aizawa	Section of standard investigation, civil engineering group (39)				
Isamu Satō	Research section chief of machinery (39)	Hokkaido Imperial University, Engineering		1932	

(continued)

Table 2.5 (continued)

Name	Name of post	Affiliated colleges and universities department	Major	Year of graduation	Remarks
Tsuyoshi Oka	Assistant director of internal combustion department (40)	Tohoku Imperial University, Engineering	Machinery	1927	
Eizaburō Yamauchi	Research section chief of automobiles (40), of mechanism of automobiles (41)				
Shōju Kawarai	Research section chief of wireless communication (40)	Sendai Technical College	Electricity	1933	
Toshiaki Takabayashi	Research section chief of concrete (40)				
Yu Onogawa	Research section chief of structural welding (40)	Kumamoto Technical College	Civil engineering	1932	
Morikazu Takahashi	Research section chief of civil engineering (40)	Nagoya Technical College	〃	1919	
Keigo Yoshizaki	Section chief of electrical goods experiments (40)	South Manchurian Technical College	Electricity	1933	
Manrei Yoneda	Research section chief of internal combustion (41)				
Rinzō Asahi	Section chief of metal analysis (41)	Osaka Technical College	Applied chemistry	1914	
Sōichi Nishikawa	Director (42)	Kyoto Imperial University, Engineering	Civil engineering	1916	

Source Nikkan Kōgyō Shinbunsha (1934), Gakushikai (each year), Mimami Manshū Tetsudō Kabushiki Kaisha Tetsudō Gijutsu Kenkyūsho (1943), pp. 103–116, Mantetsu Tekkenkai (1990), pp. 153–161
Notes (1) Figures in parentheses of name of post are the first year of placement
(2) Figures in parentheses of remarks are departure year of official trip and study abroad

locomotives and rolling stock and participate in international academic conferences (Amano 2012, 22–23).

For engineers in prewar Japan, study abroad and overseas business trips were important for building skills. For example, Mitsubishi Electric Co. Ltd., which had technological ties with US-based Westinghouse in 1923, sent more than 60 engineers abroad before 1939 (Sawai 2015, 36–37).

2.2.4 Colonial Government Railways: Taiwan and Korea

During the first half of the 1930s, Taiwan stopped importing steam locomotives from Japan, and the Taipei and Gaoxiong factories of the colonial government railways began to manufacture rolling stock for passengers and freight (Sawai 2015, 58).

As Table 2.6 shows, 27 engineers and assistant engineers worked in the manufacturing section of the railway division of the transportation bureau of Taiwan Sōtokufu (TS) in 1934. Among the 16 engineers and assistant engineers whose academic credentials could be confirmed, one was an LIT graduate and one an SMTC graduate.

In Korea, new rolling stock as well as steam locomotives were manufactured in Keijo (Seoul) and Pusan at factories of colonial government railways. Colonial government railway bought large quantities of rolling stock from designated private companies besides manufacturing it in-house.

As Table 2.7 shows, six engineers from the manufacturing division of the railway bureau of Chōsen Sōtokufu (CS) in 1934 were graduates of Tokyo Imperial University, Kyushu Imperial University, and Tokyo Technical College. Engineers at railway factories included graduates of LIT, and we could confirm that many graduates of LIT and SMTC were assistant engineers in railway factories.

Table 2.8 lists *Tetsudō-shu* (junior assistant engineers, a post established during a 1925 ministerial reorganization) (Chong 2008, 496) in 1934. They supported engineers and assistant engineers in workshops. Promotion to junior assistant engineer required that workers had at least five years of workshop experience and satisfactory performance (Chong 2008, 503). As an in-house training facility for employees of the railway bureau of the CS, SMR who managed government railways in Korea at that time, established the Seoul Railway School in 1919. Although the school was abolished in March 1925, another superseded it the following month. It included four courses: the regular, manufacturing, telegraph, and short. The regular course featured three sections: management, civil engineering, and driving. Admission qualifications for the regular course were completion of three years of higher elementary school (14 years old). Admission to the four-year manufacturing course (for factory workers) required completing elementary school (12 years old). The admission and schooling requirements were altered to completion of higher elementary school and two years of schooling in March 1928. After admission, trainees in the manufacturing course agreed to be apprenticed to workshops and received allowances (Railway Bureau of Governor-General of Korea 1934, 87–88). From 1925 to 1941, it graduated 269 students: 118 Koreans and 151 Japanese (Chong 2008, 508).

As an example of engineers who worked at the railway bureau of CS, we follow Kiichi Imai (1912–2005) in prewar and postwar periods. After graduating from Komagome Middle School in Tokyo, he completed the Concrete Vocational School (established in 1929 with a two-year curriculum) in 1934. He started his career as an engineer at the CS railway bureau in 1934, was promoted to assistant engineer in

Table 2.6 Engineers of section of manufacturing of railway division of transportation bureau of Governor-General of Taiwan (on August 1st, 1934)

	Name	Affiliated colleges and universities department	Major	Year of graduation
Engineers	Kazuhiko Hayami	Kyoto Imperial University, Engineering	Machinery	1913
	Shunichi Azuma	Kyushu Imperial University, Engineering	〃	1925
	An Ogawa	Sendai Technical College	〃	1917
Assistant engineers	Tadao Yamazaki	South Manchurian Technical College	Architecture	1929
	Kiichi Itō			
	Misoji Watanabe			
	Tatsuji Tsuyuki	Hokkaido Imperial University, Engineering		1928
	Itoku Ōmachi	Nagoya Technical College	Machinery	1927
	Shichitarō Okamoto	Osaka Technical College	〃	1920
	Katsushi Iwaki			
	Kiichi Nakajima	Sendai Technical College	〃	1922
	Kōichi Koizumi			
	Yasuyoshi Hirakawa	Lushun Institute of Technology	〃	1930
	Teiji Igawa			
	Ushichi Ōmura	Waseda University, Science and Engineering	〃	1925
	Wataru Satō	Kanazawa Technical College	〃	1925
	Takashi Shingō			
	Mitsuyoshi Miwa			
	Keiichi Honda	Nagoya Technical College	〃	1925
	Akira Yoshino	Kanazawa Technical College	〃	1926
	Kei Satō	Waseda University, Science and Engineering	〃	1929
	Kenji Yasuda			
	Yoshio Katō	Nagaoka Technical College	〃	1927
	Kiyoshi Shimizu			
	Seiji Motoyoshi			
	Toshio Matsuno	Kumamoto Technical College	〃	1928
	Hiroshi Sakata			

Source Taiwan Sōtokufu (1934), and Nikkan Kōgyō Shinbunsha (1934)

the construction division, worked at the CS research institute of government railways, and retired from there in 1946. After returning to Japan, he worked part-time and thereafter full-time at JNR's research institute in May 1947. He founded MARUTO Testing Machine Co., Ltd. in December 1951 after retiring from the

Table 2.7 Engineers of manufacturing division of railway bureau and railway factories of Governor-General of Korea (on July 1st, 1934)

	Name	Affiliated colleges and universities department	Major	Year of graduation
Engineers of the manufacturing division of railway bureau	Sadaharu Fukumi	Tokyo Imperial University, Engineering	Machinery	1915
	Hajime Kan	〃	〃	1919
	Sanichirō Sakiyama	〃	〃	1922
	Yoshimitsu Hara	Tokyo Technical College	〃	1915
	Shūji Imai	Kyushu Imperial University, Engineering	〃	1920
	Shigeharu Toda	Tokyo Technical College	〃	1919
Assistant engineers of the manufacturing division of railway bureau	Masanobu Sugimoto	Lushun Institute of Technology	〃	1920
	Rikio Tsunatani	Tokyo Technical College	〃	1921
	Ichiro Tsuchisaki	Yonezawa Technical College	〃	1921
	Hiroshi Maeda	Lushun Institute of Technology	〃	1921
	Masao Somatani	Nagoya Technical College	〃	1921
	Ryōzō Yonezawa	Tokyo Technical College	Electricity	1922
	Shigemichi Nishiyama	〃	Machinery	1923
	Tsuruzō Hongō	Kyoto Technical College	Design	1923
	Nikichi Fujii			
	Tetsuichi Yamada			
	Young-jik Kang	Waseda University, Science and Engineering	Electricity	1927
	Tōru Yoshimori			
	Kiichi Satō			
	Eung-gil Lee	Osaka Technical College	Machinery	1926
	Taku Ishii			
	Takashi Wada	Tokyo Institute of technology	Machinery	1932
	Naoya Maehara	Lushun Institute of Technology	〃	1925
	Nobukichi Satō	Sendai Technical College	〃	1926
	Kaizō Furuya	Waseda University, Science and Engineering	〃	1926
	Manpei Shimizu			
	Rizō Mitsutani	Keijo (Seoul) Technical College	Applied chemistry	1921
	No-su Kim	Waseda University, Science and Engineering	Machinery	1929

(continued)

Table 2.7 (continued)

	Name	Affiliated colleges and universities department	Major	Year of graduation
	Takeo Tanaka			
	Tatsuo Iwasaki	South Manchurian Technical College	Machinery	1923
	Li-hyeong Chon	Hamamatsu Technical College	Electricity	1927
	Kenichi Fukatsu	〃	Machinery	1928
	Myon-gyu Chang			
	Mong-sik Gwon	Yonezawa Technical College	Machinery	1929
	Ei Fukuya	Hiroshima technical College	〃	1929
	Mitsuo Saitō	Meiji Technical College	Applied chemistry	1927
	Torao Nakajima			
	Kiyoshi Ichinose	Lushun Institute of Technology	Electricity	1930
	Tatsusaburō Ikuta			
	Tōru Fujii	Kyoto Imperial University, Engineering	Machinery	1931
	Sumio Satō			
	Jirō Hosoya	South Manchurian Technical College	Machinery	1931
Pusan factory engineers	Sakae Hayashibe	Osaka Technical College	Machinery	1912
	Heiichi Noguchi	Tokyo Imperial University, Engineering	〃	1927
Pusan factory assistant engineers	Hidetsuna Sasaki	Waseda University, Science and Engineering	〃	1917
	Michio Higuchi	〃	〃	1927
	Takasaku Uzawa	Yamanashi Technical College	〃	1928
	Torao Matsui	Sendai Technical College	Electricity	1928
	Minoru Shiode			
	Ikuzō Fujinawa	Kyushu Imperial University, Engineering	Machinery	1930
Seoul factory engineers	Hidesuke Miyahara	Tokyo Imperial University, Engineering	〃	1917
	San Aoki	Osaka Technical College	〃	1913
	Nobukazu Satō	Lushun Institute of Technology	Electricity	1915
	Hōkichi Aihara	Tokyo Imperial University, Engineering	Machinery	1926
	Mankichi Kawamoto	Lushun Institute of Technology	〃	1919
	Sanshirō Kawashima	Tohoku Imperial University, Engineering	〃	1927

(continued)

Table 2.7 (continued)

	Name	Affiliated colleges and universities department	Major	Year of graduation
Seoul factory assistant engineers	Sanji Igarashi			
	Kaku Iwasaki	Lushun Institute of Technology	Machinery	1920
	Kenzō Takahashi	〃	〃	1921
	Yoshiyuki Ōno			
	Yasushi Tazawa	Tokyo Technical College	Machinery	1922
	Yasuji Nagayasu	Meiji Technical College	〃	1923
	Shirō Yoshida	Tokyo Technical College	〃	1924
	Jirō Miyazono	Kyushu Imperial University, Engineering	〃	1926
	Shigeo Inoue			
	Osamu Ezaki			
	Taneo Harada			
	Toshio Higuchi	Meiji Technical College	Machinery	1924
	Yoshimasa Tokitō	Hokkaido Imperial University, Engineering		1929
	Fusakichi Saitō			
	Yoshio Yamada	Lushun Institute of Technology	Machinery	1929
	Tamotsu Nyutani			
	Nakahiko Yasuki			
	Kamejirō Izawa	Lushun Institute of Technology	Machinery	1923
	Yoshio Ioribara			
	Takeo Tsuchikawa			
	Kiyonobu Aoki	Hamamatsu Technical College	Machinery	1927
	Haruzō Maeda	South Manchurian Technical College	Mining & Machinery	1927
	Hiroo Miyoshi			
	Setsuzō Kobayashi	Yonezawa Technical College	Machinery	1927
	Fumio Satō	Kumamoto Technical College	〃	1928
	Kusue Kawachi	Hiroshima Technical College	Machinery, special courses	
	Kazuo Nojima	Meiji Technical College	Machinery	1928
	Kazuo Sakurai	Hamamatsu Technical College	Electricity	1929

(continued)

Table 2.7 (continued)

	Name	Affiliated colleges and universities department	Major	Year of graduation
	Kiyonojō Nakano			
	Tsukuo Aoki			
	Toshio Shiba			
	Chōshichi Kawamura	Hiroshima Technical College	Machinery	1928
	Kazuo Tashiro	Yokohama Technical College	〃	1930
Pyongyang branch factory assistant engineers	Goshichi Miki			
	Shunichi Koga			
	Hakuai Ōsaki	Waseda University, Science and Engineering	Machinery	1924
	Masuo Kanzaki	South Manchurian Technical College	〃	1923
Chongjin factory engineers	Takesaburō Miyauchi	Tokyo Technical College	〃	1910
Chongjin factory assistant engineers	Hanji Tominaga			
	Kyūhei Tsuboi			
	Naokichi Inaba	Waseda University, Science and Engineering	Electricity	1928

Source Chōsen Sōtokufu (1934), Chōsen Kōgyō Kyōkai (1939), and Nikkan Kōgyō Shinbunsha (1934)
Notes (1) The blank is unknown
(2) The first line of engineers and assistant engineers of each railway factory is a factory superintendent

Table 2.8 Tetsudō-shu (junior assistant engineers) of Keijo (Seoul) factory of railway bureau of Governor-General of Korea (on July 1st, 1934)

Name	Monthly salary (yen)
Sun-dal Kim	98
Ichigorō Arai	95
Yutaka Hano	95
Kiyoharu Shimoura	93
Ushitaro Igarashi	90
Tomokichi Yamada	90
Makoto Tanaka	89
Takisaburō Sekiya	88
Jon-tae Kim	88
Hideharu Miyawaki	88
Hanjūrō Tsukamoto	86
Yon-il Choe	84
Matsutarō Ōnishi	84
Ryūnoshin Matsumiya	82
Sadao Yoshimune	81
Kisuke Yoshimoto	80
Shigetsugu Ishiguro	77
Mito Sasaki	77
Morifumi Arima	77
Tatsuzō Fukuda	76
Takaichi Ōno	76
Tomesaku Kinoshita	76
Kinsaku Kurakata	74
Otojirō Komatsu	73
Tomotsuchi Ōyama	66

Source Chōsen Sōtokufu (1934)

institute in 1949. In 1953, Imai developed Japan's first instrument to measure air in ready-mixed concrete.[5]

Dalian Machine Works (*Dairen Kikai Seisakusho*) employed15 engineers in 1934, 12 of them graduated from LIT and SMTC and three from technical colleges in Tokyo, Yokohama, and Nagoya. At Yongsan Manufacturing Co., Ltd. (*Ryūsan Kōsaku*) in Seoul, a representative maker of rolling stock in Korea, there were four LIT graduates among 11 engineers in 1934 (tallied from Nikkan Kōgyō Shinbunsha 1934).

As above-mentioned, LIT and SMTC played a great role in supplying engineers for colonial government railways in Taiwan and Korea, SMR, and rolling stock and locomotive companies in Dalian and Seoul. By 1942, the number of living LIT

[5]HP of MARUTO Testing Machine Company.

graduates approached 1,337, of which 660 were working in "Manchukuo" and the Kwantung Leased Territory, 130 in China, 76 in Korea, 24 in Taiwan, and 436 in Japan (Sawai 2012, 28).

2.3 Collaborative Research and Institutionalized Interactions Within Organizations

2.3.1 Conference on Rolling Stock

Among the technological activities led by JNR, the Conference on Rolling Stock (*Sharyō Kenkyūkai*) was significant. The conference was established in 1922 as an annual meeting, becoming biannual after 1925. Through 1942, 19 conferences addressed locomotives and 17 concerned freight cars and passenger cars. Other topics of common interest were raised, sponsored by JNR's manufacturing bureau (Kubota 1981, 107).

The group of JNR engineers from the rolling stock division of the manufacturing bureau formed core of *Sharyō Kenkyūkai*, augmented by engineers from SMR, government railways in Taiwan and Korea, private railway companies, materials and parts producers, and designated factories. In this sense, the network of collaborative research organized by the rolling stock division of JNR's manufacturing bureau spread throughout the Japanese Empire.

Activities of the conference, where 70 to 100 engineers gathered, exceeded the few days of sessions. Conference topics were announced a year in advance so that members could conduct related research in their own workshops and research institutes beforehand (Tetsudō-shō Kōsakukyoku 1925, 16). Results were discussed at the conference. JNR, SMR, and government railways in Taiwan and Korea promptly put some into practice (Nihon Kokuyū Tetsudō (JNR) 1972, 446–453). Thus, the conference, where collaborative research could be evaluated via exchanges between users and builders of rolling stock and locomotives, contributed to the technological upgrading of the Japanese empire's rolling stock industry.

Okiie Yamashita, former chief of JNR's manufacturing bureau, noted (Inoue 1952, 241).

> As many difficult research themes were delivered to the Conference on Rolling Stock, the conference often could not discover the best solution in a short time, carried discussion forward in a few years. The research institute of JNR played an important role in solving the problems, with the result of upgrading of the presence of the research institute in JNR.

Practical research topics covered by the Conference on Rolling Stock gave direction to the research institute, minimizing research for its own sake and promoting research for practical application.

2.3.2 Technical Committee on Rolling Stock

Kiichi Asakura, former chief of JNR's manufacturing bureau, went to Manchuria with an opinion concerning the unification of materials and parts for rolling stock of JNR, SMR, and government railways in Korea, which had different gauges.[6] He gathered support from Inosuke Watanabe, chief of SMR's manufacturing division, and from Sadaharu Fukumi, chief of the manufacturing division of Korea's government railway, in 1938.

The Technical Committee on Rolling Stock was established in July 1939 and held five large-scale meetings from November 1939 to December 1941(Nihon Kokuyū Tetsudō (JNR) 1958, 147). As Table 2.9 indicates, members of the committee were officials and engineers from JNR, the Ministry of Commerce and Industry, SMR, government railways in Taiwan and Korea, North China Transportation Co., Ltd., and Central China Railways Co., Ltd. Dependent on educational organizations, such as LIT and SMTC located in Dalian and Lushun with regard to the supply of engineers, railways within the Japanese empire were organized into an ellipse with JNR and SMR at its apex.

2.3.3 Study Group on Factory Practices

JNR had 22 railway factories in Japan during the war, ranging from mid-sized operations with 300 employees to large factories with 3,000 to 4,000 workers. As national factories exempt from market competition, JNR needed to pursue technological upgrading without input from the market. Among these measures we could confirm the mechanism that promoted technical interactions among the various kinds of workshops (Mukasa 1941, 96–98). At JNR, for example, a railway factory with 1,000 workers held about 10 workshops covering assembly, fitting, machine, cast iron, lathes, wood working, and painting. A factory director, engineers, assistant engineers, and foremen participated assembly. They inspected a workshop for three or four hours, then 20 or 30 persons discussed how to upgrade its efficiency.

In addition, the Study Group on Factory Practices (*Kōjō Gyōmu Kenkyūkai*) was started in 1927. Representatives of the same workshops at different factories met quarterly (Mukasa 1941, 99–104). For example, each machine workshop at a large factory was in charge of this study group once every two-and-a-half to three years. Among the activities of Study Group on Factory Practices, technical experts at each factory inspected the workshop concerned all day and discussed problems. Inspection and discussion topics included locomotives and air brakes, boilers and welding, casting, forging, lathes and other machine tools, electric machinery,

[6]JNR adopted a narrow gauge. Governmental railways in Korea and the SMR employed standard gauges.

Table 2.9 Attendants of the fourth technical committee on rolling stock (July 27, 1941)

Post	Division	Name
Chief of the sixth division of planning agency	Director of planning agency	Yaichirō Shibata
First section chief of the sixth division	Secretary	Masatake Tsutsumi
First section of the sixth division	Engineer	Sadanori Shimoyama
Third section chief of the sixth division	Investigator	Masanobu Yoshii
Third section of the sixth division	Secretary	Kunio Yoshizawa
〃	Assitant engineer	Yogorō Wakamatsu
Second section of the second division	Engineer	Michio Yamaza
〃	〃	Kazutsune Murata
Second section of the seventh division	〃	Kōhei Suzuki
Section chief of economy of the office for Manchuria		Haruji Yoshida
Economic division of Agency for development of Asia	Official	Yutaka Abiko
Technology division	Engineer	Tatsuo Kuribayashi
Transportation section of purchasing bureau of the Army	Lieutenant in the Army	Kōhei Eguchi
General affairs section of general affairs bureau of the Ministry of Commerce and Industry	Engineer	Naosaburō Torii
〃	〃	Kiyoshi Oda
First section chief of rolling stock of manufacturing bureau of the Ministry of Railways	Engineer	Kingo Mukasa
First section of rolling stock	〃	Hideo Shima
〃	〃	Ryōtarō Asamura
〃	〃	Michiaki Utashōji
First section chief of transportation of transportation bureau	〃	Nobuichirō Hamano
First section of transportation of transportation bureau	〃	Kazuo Okada
First section chief of purchasing of purchasing bureau	Official	Toshio Hata
First section of purchasing	Engineer	Gōzō Takigawa
Third section chief of railway investigation bureau	〃	Yoshitane Azuma
Third section of railway investigation bureau	〃	Ryōrō Yokoi
Section of industry of encouragement of industry bureau of the Ministry of Development	Official	Yasuhiko Toyomura

(continued)

Table 2.9 (continued)

Post	Division	Name
Section of commerce and industry of encouragement of industry bureau	Assitant	Genji Torii
Division chief of manufacturing of railway bureau of Governor-General of Korea	Engineer	San Aoki
Division of manufacturing of railway bureau	〃	Takashi Wada
〃	〃	Tōru Fujii
〃	〃	Shirō Yoshida
〃	〃	Hakuai Ōsaki
〃	〃	Naoya Maehara
Division of planning of railway bureau	〃	Shigeru Watanabe
Section chief of manufacturing of railway division of transportation bureau of Governor-General of Taiwan	〃	Kazuhiko Hayami
Transportation bureau of Agency of Sakhalin	〃	Tatsuya Murakami
Technical chief of Tokyo branch of South Manchuria Railway	Counsellor	Tomohiko Kimura
Division chief of manufacturing of manufacturing bureau of railway headquarters	Counsellor	Shintarō Yoshino
Marerial section of Tokyo branch	Vice-counsellor	Tadashi Yamada
Marerial section chief of Tokyo branch	Counsellor	Sumisaburō Kōzai
Research institute of railway technology	Vice-counsellor	Isamu Satō
Rolling stock section of trnbsportation bureau	Staff	Toshi Koizumi
Tokyo branch	〃	Yasuzō Koga
Chief of manufacturing bureau of North China Transportation	Advisor	Nakaji Katō
Mabufacturing bureau	Advisor of bureau	Yoshikazu Kagata
Technical chief of Tokyo branch	Vice-counsellor	Seiichi Miyake
Tokyo branch	〃	Kazuo Furuhara
〃	staff	Seiichirō Kaneko
Manufacturing bureau	〃	Fukujirō Okino
Transportation bureau	〃	Yoshiaki Sakato
Division chief of manufacturing of Central China Railways	Counsellor	Hajime Hirayama
Division of transportation	Vice-counsellor	Shigetake Iwasaki
Division of manufacturing	Assistant cousellor	Miyoji Yamamoto
〃	staff	Yūkichi Sakai
Technical chief of Tokyo office	Counsellor	Matsuchiyo Nomura
Kawasaki Sharyô Co., Ltd.		Bungo Shimoda

(continued)

Table 2.9 (continued)

Post	Division	Name
Kisha Seizô Co., Ltd.		Kiichi Asakura
〃		Kanichirō Hasegawa
Nippon Sharyô Seizô Co., Ltd.		Shōhachi Akiyama
Mitsubishi Heavy Industry Co., Ltd.		Mamoru Nakamoto
Hitachi Seisakusho co., Ltd.		Kiyoshi Hattori
Tanaka Sharyô Co., Ltd.		Hajime Satō
Shinuki Tekko Co., Ltd.		Eiji Asano
Teikoku Sharyô Co., Ltd.		Takasaburō Kanesaka
Sumitomo Kinzoku Co., Ltd.		Ryōkichi Kawamoto
〃		Harumitsu Suzuki
Sumitomo Kôkan Co., Ltd.		Kanichi Katō
Tokyo Kiki Co., Ltd.		Katsuyuki Nakabayashi
Mitsubishi Kôzai Co., Ltd.		Sōzō Hattori
Nippon Seitetsu Co., Ltd.		Itsuji Adachi
Rolling Stock Industry Association		Seiichi Akita
〃		Shinsuke Hashimoto

Source Tetsudō Sharyō Gijutsu Kyōgikai 1941

freight cars and wood, passenger cars and finishing, painting, by-products and stock, general affairs, and calculation (Nihon Kōgyō Kyōkai 1941, 57). The group's activities peaked around the mid-1930, just before the Japan–China War.

JNR held similar meetings with designated private factories. Its engineers inspected designated private factories and indicated areas for improvement. Each railway factory sponsored study groups. One study group named *Hatsukakai*, met monthly at JNR's Kokura factory. Around 15 members who were graduates of technical colleges or universities participated. Two members made presentations at each meeting (Kokura Kōjō of JNR 1951, 48).

2.4 Conclusion: Collaborative Research Project as a Measure for Technological Catching up

Governmental and private sector collaboration on research areas of mutual interest was commonplace in the rolling stock industry and other sectors in prewar Japan. The Conference on Machine Tools, mainly conducted by JNR's manufacturing bureau, continued from 1936 to 1940. The Conference on Wind Tunnels and Tanks, primarily sponsored by the science division of the naval aeronautics arsenal, met several times during the war. This conference facilitated collaborative research in

all fields of aeronautics, involving military engineers alongside scientists from imperial universities and aircraft and engine manufacturers. Research topics were announced in advance, research results were examined, and unresolved issues were discussed at following conferences.

As noted aeronautical scientist Ichirô Tani recalled (Tani 1982, 39),

> If presenters were naval officers, there was no diffidence or flattery. This openness seemed to be specific to naval aeronautics arsenal, therefore the Conference on Wind Tunnel and Tank was much balder than lecture meetings of academic societies and much more academic than them.

Research targets were specified, and the organizers were the largest consumers of their output. Therefore, this public–private collaboration could produce great achievements in a relatively short period. However, this "efficient" collaboration also presented problems. Private sector participants largely were constrained to designated manufacturers; there was no channel through which the largest users, such as JNR and the navy, could receive results of R&D activities of non-members. Although the manufacturers were "designated" because of their relatively high capabilities, this restriction widened the divide between designated and non-designated manufacturers because only the former obtained orders and revenues from the large and stable users.

The collaborative research between users and designated manufacturers able to produce high-quality products was one aspect of the efficient R&D adopted by a latecomer to industrialization—i.e., Imperial Japan. In this method of selecting qualified manufacturers, the state—the largest buyer—determined which manufacturers were candidates for optional contracts. For non-member firms excluded from collaborative research, the closed system of R&D composed of JNR, SMR, the military, and the Ministry of Telecommunication was a kind of "crony innovation system" that has great significance for scholars of economic and business history of East Asia in the 20th century.

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http://www.springer.com/978-981-10-4903-3

The Development of Railway Technology in East Asia in Comparative Perspective

Sawai, M. (Ed.)

2017, X, 153 p. 14 illus., 10 illus. in color., Hardcover
ISBN: 978-981-10-4903-3