Japan's Railway Technologies Serving on Overseas Railways

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Geographical Features of Japan

As many JRTR readers know, railways only grow in line with social and geographical conditions. Consequently, before delving into the topic of overseas expansion of Japanese railway industry, we need to know a little about their situation, so this article starts with a simple introduction to Japan's geography.

Japan is a mountainous country and one could go so far as to say that there would be no Japanese archipelago without the mountains. The archipelago is a great system of mountain ranges rising out of the northwest Pacific, and more than 60% of the country's area is mountainous. The remaining 40% is plains, including hilly areas and other topographical features, but most of the plains are the by-products of mountain formation as the mountains are eroded by rivers and carried to the shores and basins.

In social terms, 90% of the population lives in old cities on the coastal plains. Before railways, walking was the main transportation mode for city dwellers. Even under such conditions, Edo (today's Tokyo) is said to have had a population of 1 million in the 18th century.

Railway Business in Japan

Japan's first railway opened in 1872 with a single line between Shimbashi and Yokohama. New lines soon followed in parallel with land development and industrial growth. Progress was rapid in the latter half of the Meiji era (1868–1912) and a network spanning 20,000 km had been built by 1940. Early lines were built using British technology and locomotives along with engineers were also imported from Great Britain.

On the other hand, urban railways in Japan are said to have started with the first electric train in Kyoto in 1895. Thereafter, urban railway networks were built in cities nationwide, mainly running trams. These railways contributed greatly to Japan's modernization and development.

Railways are still an important part of Japan's social infrastructure and are essential for day-to-day life. An example of how closely railways are linked to daily life is the *Norikae-Annai* (transfer guide) PC application. With this system, one simply enters the departure, destination, and desired arrival time to search for various possible routes and transfers. However, such software is useful only if the operation schedule is maintained.

One could probably summarize Japanese railways today using keywords like high quality, reliability, and perfected railway system.

Moreover, it is worth mentioning that many densely populated cities—Tokyo, Nagoya, and Osaka in particular—are located on the coastal plain due to Japan's mountainous interior. As a result, various guided urban transport systems are used in large urban areas for commuting to work and school, including so-called heavy rail, metros, linear metros, straddle-type monorails, suspended monorails, high-speed surface transport (HSST), and automated guideway transit (AGT); Japan is a real showcase for the world in urban rail transport systems.

Japan's railway industry has embarked to take on the world with its diversity in railway systems and advancement in high-speed railways.

Features of Japan's Railway Industry

According to a 2012 report by the German transport consultants SCI Verkehr, the world market for rolling stock is about ¥8.6 trillion, rising to ¥14.3 trillion when system technology and infrastructure are included.

The scale of Japan's railway industry for rolling stock, parts, and signals is about ¥500 billion, or about 5% of the country's automobile industry. However, the global railway market has been expanding recently but Japan's 10% share of this market is shrinking despite the rapid growth of railway industries in emerging economies.

Conventional urban railway markets in Japan have matured and are predicted to grow slowly in the future. In freight, bulk freight is limited mostly to coastal transport because major cities are on the coast. Containers are the main method for both sea and rail transport. Japan's railways have been most successful in passenger markets and an extensive high-speed network is already in place, so significant further short-term expansion is unlikely.

More than anything else, Japan's railways are

characterized by high quality in reliability, frequency, and punctuality as a result of the long-term outlook of regulators, operators, manufacturers, and others. Because these parties do not take a short-term outlook, they can deliver high quality to customers in terms of design, planning, maintenance, manufacturing, etc. For example, excellent communication between rolling-stock designers, manufacturers, operators, and maintenance personnel, results in provision of top-class services to passengers.

Applying these features of Japanese industrial structure to exports creates the best results for customers.

Overseas Expansion of Japan's Railway Industry

Japan has exported railway rolling stock since the mid-1950s and the nation's railway technology is highly acclaimed globally. The government, the Japan International Cooperation Agency (JICA), and the JR group of operators, provide international assistance as technical cooperation in Asia, Africa, and South America.

So, although it makes up less than 10% of the global market, why is Japanese railway industry well accepted? The reasons and some specific examples in each region are described below.

Morocco

In the first example, three types of electric locomotives totalling 42 units were exported from 1977 to 1984 to the Morroccan Railways (ONCF). These units are now 30 to 35-years old but are still hauling trains hundreds of kilometers each day with an overall operation rate of better than 90%. With the appropriate maintenance these locomotives will be usable for another 30 years, fully demonstrating ONCF's satisfaction with their high reliability. These words are more than hearsay; they were said by ONCF's deputy director, the African representative at the 2010 UIC General Assembly in Tokyo. As life cycle costs (LCC) have become a key issue, this example is even more important.

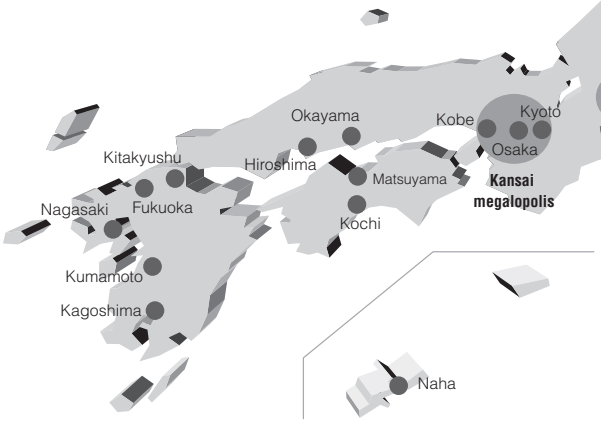
Egypt

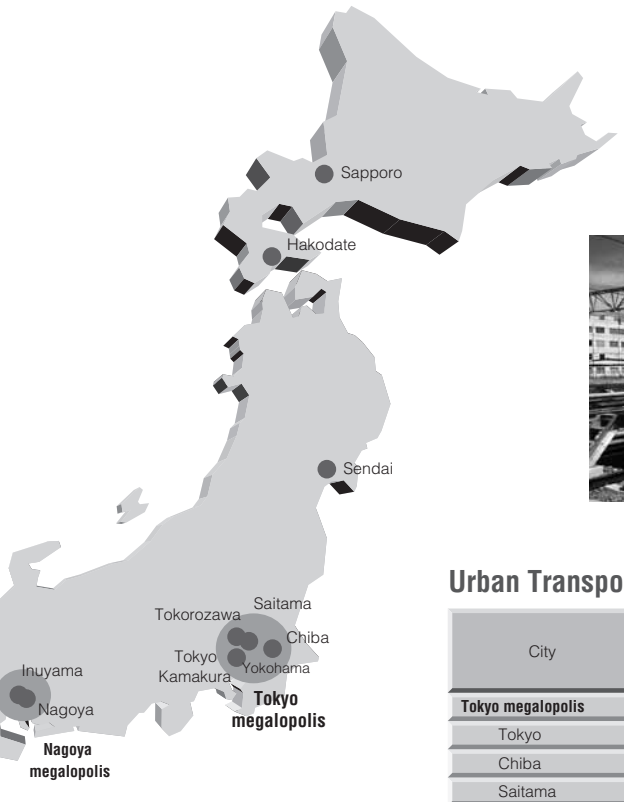
The second example is the export of more than 1000 tramcars since 1962 to Cairo (Cairo Transportation Authority, CTA and Heliiopolis light rail, now controlled by CTA) and Alexandria in Egypt. The tram rails and overhead lines were in poor condition and reduced the equipment life when new orders were placed in 1977. JICA provided assistance to CTA in establishing a training centre for electric train operation at the request of the Egyptian government. Dispatching experts and lending equipment helped increase the operation rate of Cairo city trams, leading to orders for

Electric Locomotive for Morocco (JORSA)

Figure 1 Diverse Urban Transport

Japan also has metropolitan transit systems: subway systems for mass transit, medium-capacity linear motor subways, High Speed Surface Transport (HSST) systems, monorails, automated guideway transit (AGT) systems, and light rail transit (LRT) systems.





Urban Transport Systems in Major Cities

City	Population (thousands)	Heavy rail (Surface)	Heavy rail (Subway)	Linear metro	Monorail	AGT/APM	LRT	HSST
Tokyo megalopolis								
Tokyo	8,969	●	●	●	●	●	●	
Chiba	963	●			●	●		
Saitama	1,231	●	●			●		
Tokorozawa	342					●		
Yokohama	3,692	●	●	●		●		
Kamakura	174	●			●			
Nagoya megalopolis								
Nagoya	2,267	●	●					●
Kansai megalopolis								
Osaka	2,672	●	●	●	●	●	●	
Kyoto	1,474	●	●				●	
Kobe	1,545	●	●	●		●		
Other areas								
Sapporo	1,906	●	●				●	
Hakodate	279						●	
Sendai	1,052	●	●	○				
Okayama	711							
Hiroshima	1,179	●			●	●	●	
Matsuyama	517						●	
Kochi	343	●					●	
Kitakyushu	974	●			●			
Fukuoka	1,482	●	●	●				
Kumamoto	737						●	
Nagasaki	441						●	
Kagoshima	607						●	
Naha	318				●			

Notes: ● In operation ○ Being constructed or planned
Other 6cities also have LRT system

Tram for CTA in Egypt (JORSA)

more cars for Cairo Metro Line 1 and Line 2.

The government of Egypt also asked for Japanese assistance in building its own tramcars in Egypt. Many engineers from Japan provided assistance resulting in the first domestic production of Cairo city trams in 1979.

Venezuela

A Japanese/Italian/Venezuelan international consortium received contracts for a double-tracked AC electrification project near Caracas in 1992 and 2004. Japanese rolling stock was supplied for a 42-km line between Caracas and Cúa, and a rolling-stock maintenance factory, depot equipment, signals and communications equipment, station services equipment, spare parts, and more were delivered. The line started in 2006 and it is the only line of Venezuela's State Railways Institution (IFE) running as planned. Venezuela is proceeding with a project to build a national 13,000-km railway system and construction is proceeding under Italian direction. The Japanese management, finance structuring ability, and excellent rolling-stock design and production technology for the suburban line projects are highly acclaimed. Lines are operating smoothly, and passenger transport volumes are increasing, leading to an order in 2012 for 52 more cars for 13 train sets.

Taiwan

Any description of Japanese railway exports cannot overlook the Taiwan High-Speed Rail Project.

Japanese and European consortiums competed from the early 1990s to win the order for a high-speed rail project covering the 340 km between Taipei and Kaohsiung. The project was full of twists and turns, changing from a national project to a build-operate-transfer (BOT) project, and it seemed to have been finalized in 1997 when the European consortium was chosen as the preferred bidder. However, the Japanese consortium worked hard to convince Taiwan to adopt the shinkansen system, gaining preferred bidder status in 1999. This surprised the European consortium and led to a lawsuit.

There were several reasons for the dramatic reversal. First, the European consortium suffered a German ICE derailment and rollover killing more than 100 people just after Taiwan railway personnel visited in 1997 to observe. Concerns about the safety of Europe's high-speed rail technology increased along with requests for more information on Japanese shinkansen technology.

In response, the Japan Overseas Rolling Stock Association (JORSA) held seminars in Taiwan on high-speed rail in April and September of 1999, creating a sensation. Then, a major earthquake struck Taichung just 2 weeks after the seminar. As a result, earthquake countermeasures became a major issue and Japan was the only bidder with

Electric Cars for Venezuela (JORSA)

Taiwan High-speed Rail Line (JORSA)

UK's Class 395 high-speed commuter train (JORSA)

experts in earthquake resistance. A specialized seminar on earthquake countermeasures for railways was held in December at the request of Taiwan side, and most speakers were from Japan. That earthquake seminar was the final push for Japan's high-speed rail system receiving the order, attesting to the excellence of shinkansen technology and making Japan's presence in the railway industry felt worldwide.

United Kingdom

The last example is from the UK's Class 395 high-speed commuter train in suburban London.

Japan's railway industry has considerable experience in exporting rolling stock and equipment to European markets. Electric locomotives and equipment for metro rolling stock have been exported to Spain along with complete EMUs and DMUs to Ireland. Moreover, Japanese manufacturers ship many large-current semiconductor devices to Europe's major railway manufacturers.

However, the circumstances were slightly different for delivery of complete trainsets to the UK, which no longer has domestic rolling-stock manufacturers. Railway privatization has not always been smooth in the UK; in the early days, the network suffered from frequent delays and train breakdowns, as well as signalling troubles. Delivery delays and breakdowns of rolling stock from European makers were prominent issues, dealing a blow to their reputation. In an attempt to enter the UK market, Hitachi, Ltd. started efforts to win orders in 1999. However, it suffered from the disadvantage of not being widely recognized as a railway manufacturer, but more as a manufacturer of TVs, refrigerators and other home appliances. Hitachi believed it had developed a good feel for the market by participating in bids in 2000 and 2001, but their trains were mocked

as being 'paper trains' due to a lack of actual results. Eventually, Hitachi proved its reliability through efforts to promote understanding, such as participation in international conferences and exhibitions as well as by fitting British conventional trains with Hitachi controllers free-of-charge for operational tests.

In a third attempt in 2003, Hitachi won the bid for the Channel Tunnel Rail Link (CTRL) high-speed commuter train. A ceremony attended by Queen Elizabeth II was held on 7 November 2007 at London's St Pancras Station, which had been newly renovated for the CTRL extension, ahead of the start of extended operations into central London later in November. The UK railway industry was stunned by Hitachi's Class 395, hailed as 'the first train to be delivered on schedule' in a country where delays were the norm.

Japan's first railway in 1872 was introduced using British technology and now 140 years later, high-speed rail technology from Japan had returned to support the original home of railways—Great Britain.

Outlook

Railway equipment centring on rolling stock is unlike computers and other electronic devices because it has many moving parts that eventually fail due to wear, consumption, and aging. Passenger railways in particular have an important mission because they are tasked with ensuring people's safety. Railways depend on experience amassed over time and lasting engineering technology. Even when newly industrializing economies (NIEs) and other countries introduce the latest railway technologies on a turnkey basis, maintaining safety in the long run is no simple task. The same applies to the railway industry. Accumulation of engineering capabilities based on many years of operating railways is what backs up the technical abilities of the railway industry.

Japan's shinkansen has a miraculous record of no fatal passenger accidents due to operations in almost 50 years. With up to 14 trains running at 300 km/h in each direction each hour on some lines, the shinkansen is really a high-speed mass transit system. In 1964, when the fastest trains in Europe and North America ran at 160 km/h, Japan's shinkansen was running at 210 km/h. Japanese industry has continued to meet the exacting demands from shinkansen operators for technical innovation, higher speed, improved comfort, and more.

While ensuring safety is always the top issue for railways in any country, many NIEs and other countries do not yet need sophisticated, Japanese-style on-time operating systems. Provision of appropriate technology is important, taking into account the target country's environment, culture, and social background.

Demands for railways worldwide are on the rise from the viewpoints of environmental issues and energy, as well as in terms of the necessity for economic and social development, and railways are being built in many regions with such objectives in mind.

Japan's railway industry is good at detailed customer service, and in the future we would like to further meet the needs of individual countries and regions by optimizing rolling stock and systems and increasing satisfaction for individual customers. We will continue contributing to global social development through these efforts. ■

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