Feature

When will Japan Choose Light Rail Transit?

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Introduction

Interest in Light Rail Transit (LRT) as a viable urban transportation system has been growing worldwide since the late 20th century. Although there is no definite difference between trams and LRT systems, the latter is an evolved tramway system—tracks are often segregated from other traffic, cars run faster, and everyone has easy access due to level boarding. In Germany, where old tramway systems have been vigorously upgraded as LRT (Stadtbahn) systems since the 1960s, LRT systems have become the core of urban transport in many cities. Also new LRT systems have been constructed in France and the UK some 40 or so years after both countries closed many old tramway systems dating from the Victorian era. LRT systems are also starting to appear in the USA and Canada, two countries known for their love of the automobile.

Under these circumstances, although no new LRT systems have been built in Japan recently, some tramway systems have begun to introduce low-floor cars with improved ease-of-access and efficiency. This article reviews Japanese tramway systems and discusses the possibility of reviving them as LRT systems.

Short History of Tramways in Japan

The world's first commercial electric tramway opened in 1881, and ran 2.8 km from Lichterfelde (near Berlin) to the Anhalt Cadet School. Japan's first tramway was the Kyoto Electric Railway opened on 1 February 1895. In the early days, there were few alternative forms of urban transport and tramways were soon spreading to many other cities. Although the growth of bus services after WWI put some local tramways out of business, there were still 83 tramways with a total route length of 1480 km operating in 67 Japanese cities in 1932.

Aerial bombing during WWII caused tremendous damage to tramways and tram facilities but trams were the first form of public transport to reappear in the war-torn cities. For example, three tramcars—the last serviceable vehicles—were running again in Hiroshima just 3 days after the atomic bombing. Trams were soon carrying huge numbers of people in the early postwar years and contributed greatly to the reconstruction.

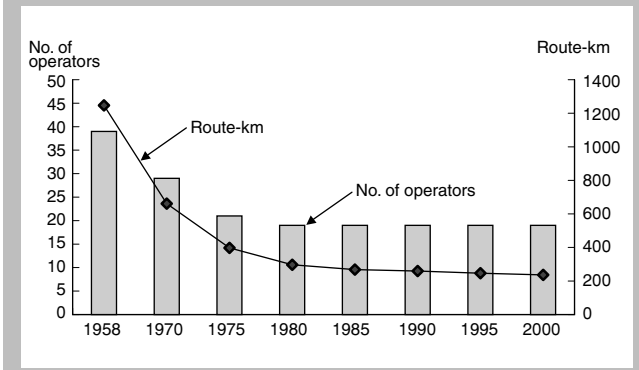
North America turned to the automobile for urban transport immediately after WWII and Europe was quick to follow suit, leading to the rapid decline of trams. However, private vehicle ownership did not begin to grow in Japan at the time, allowing trams to continue holding their own in the urban public transportation networks. In 1954, the Tokyo Metropolitan Government (TMG) introduced Presidents' Conference Committee (PCC) streetcars, which had been developed in the USA since the 1930s.

Japan's rapidly expanding economy in the 1960s led to more private car ownership and the increasing road congestion with resultant delays to tram timetables led many cities to start closing tram systems. As shown in Figure 1, between 1960 and 1990, the number of tramway operators dropped by nearly half, while the total length of track was slashed by about 80%. Lines serving local traffic in smaller centres were generally the first to be closed. Later, subways replaced trams in the three most important cities of Tokyo (except the Arakawa Line), Osaka, and Nagoya. Other smaller regional cities, such as Sendai, Fukuoka and Sapporo, also began planning subways in the 1970s and one tramway track after another was ripped up.

Some exceptional tramway operations managed to remain profitable. Hiroshima and Nagasaki are cities that see trams as a viable urban transit solution. So-called Light Rail Vehicles (LRVs) joined the tram rolling stock in both cities in the 1980s.

Series 5000 *Green Mover* of Hiroshima Electric Railway (Author)

Figure 1 Tramways Trends in Japan



Source: *Tetsudo tokei nempo* (Annual railway statistics), Ministry of Transport.

However, very little LRT track has been built since then and Japan seems to have fallen behind other countries where more LRT systems are being built.

Tramways in Japan Today

Overview

There are 19 tramway systems in 18 Japanese cities from Sapporo in the north to Kagoshima in the south (Fig. 2). Tokyo still has the 12.2-km Arakawa Line, a tramway operated by the TMG running on mostly segregated track between Waseda and Minowabashi stations; all other tramways formerly operated by the metropolitan government were closed. The only tramways still operating in Osaka are the Hankai (14.1 km) and the Uemachi (4.6 km) lines operated by Hankai Tramway.

In general, Japanese tramway systems follow the traditional model and most tramway operation are relatively small scale. However, some Japanese operators have recently introduced modern rolling stock, such as low-floor cars offering barrier-free access. Kumamoto City Transportation Bureau in Kyushu introduced 100% low-floor vehicles in 1997 using German-made bogies and equipment. At one time, the Bureau had planned to tear up all its tram tracks, but it changed course in midstream and now operates two lines totalling 12 km. German-built low-floor cars running past Kumamoto Castle have come to symbolize the city.

In 1999, Hiroshima City imported German low-floor tramways by air cargo, creating quite a stir among the news media. Other cities like Gifu, Kagoshima, Matsuyama, Kochi, Okayama and Hakodate have also introduced low-floor trams.

While many tramways face financial difficulties, trams in Okayama, Hiroshima and four other cities are profitable (Table 1). Okayama Electric Tramway and Hiroshima Electric Railway are the leading tram operators and they began attempts in the 1980s to attract more passengers by introducing new cars, installing tramcar approach indicators, and constructing roofed tram stops. Hiroshima Electric Railway's suburban Miyajima Line serving the famous Itsukushima Shrine used to operate independently of the

Figure 2 Japanese Cities with Tramways

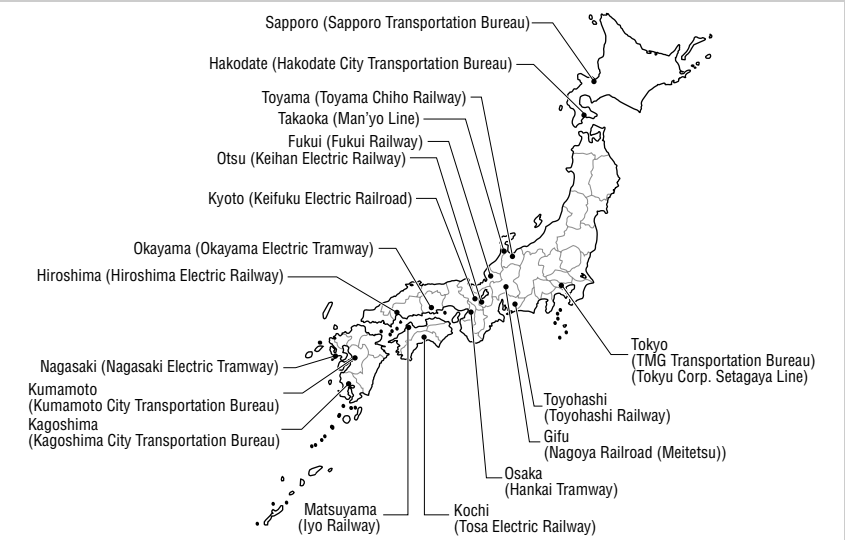


Table 1 Tramways in Japan

City	Operator	City population (1000)	Route-km	No. of lines	Ratio of operating expenditure to revenue (after depreciation)	Start of tram operations
Sapporo	Sapporo Transportation Bureau	1820	8.5	1	107.4	1918
Hakodate	Hakodate City Transportation Bureau	290	10.9	2	110.0	1913
Tokyo	TMG Transportation Bureau	8140	12.2	1	96.8	1911
Tokyo	Tokyu Corp.	8140	5.0	1	112.9	1907
Toyama	Toyama Chiho Railway	330	6.4	1	95.8	1913
Takaoka	Man'yo Line	170	12.8	1	132.3	1948
Fukui	Fukui Railway	250	21.4	2	109.1	1933
Toyohashi	Toyohashi Railway	370	5.4	2	112.1	1925
Gifu	Meitetsu	400	23.9	3	248.9	1911
Otsu	Keihan Electric Railway	290	21.6	2	249.0	1912
Kyoto	Keifuku Electric Railroad	1470	11.0	2	107.6	1910
Osaka	Hankai Tramway	2600	18.7	3	116.4	1911
Okayama	Okayama Electric Tramway	630	4.7	2	84.2	1912
Hiroshima	Hiroshima Electric Railway	1130	34.9	8	86.2	1912
Kochi	Tosa Electric Railway	330	25.3	2	119.6	1904
Matsuyama	Iyo Railway	470	9.6	4	102.5	1911
Nagasaki	Nagasaki Electric Tramway	420	11.5	4	96.6	1915
Kumamoto	Kumamoto City Transportation Bureau	660	12.1	2	123.1	1924
Kagoshima	Kagoshima City Transport Bureau	550	13.1	2	93.1	1912

Source: *Tetsudo tokei nempo* (Annual railway statistics), Ministry of Land, Infrastructure and Transport, 2000.
Notes: Numbers for Man'yo Line are for the predecessor Kaetsuno Railway.
Numbers for Fukui Railway include data from conventional railway operations.
Numbers for Meitetsu include data from operations on the Gifu-shinai and Minomachi lines.
Except for the ratio of operating expenditure to revenue, which refers only to tramway operations, numbers for Hiroshima Electric Railway include data from railway operations.

urban tram network, but now offers inner-city through connections for all trams. Nagasaki Electric Tramway is well known for running a profitable system. It was in the red but recovered by selling its bus business in 1970 and concentrating on trams, and by offering user-friendly services with fares as low as ¥100 (US$0.95).

International comparisons

More than 300 cities around the world have tram or LRT systems. Countries of the former Soviet Union and eastern Europe, where postwar car ownership remained low, still operate a lot of old tramways. The number of trams in Germany is exceptionally high in western countries, although this is partly due to the tramways inherited from the former East Germany (Table 2).

According to statistical data on tramway systems, excluding trams in countries of the former Soviet Union and eastern Europe, the average population of cities with a tram/LRT system is about 600,000 and the average route length is 32 km. Figures 3 and 4 show that cities with populations between 200,000 and 800,000 are typical candidates for trams. In terms of route length, typical tram/LRT systems have networks of about 20 km or 50 to 70 km.

On the other hand, although Japanese cities with tramways have a similar population size to the world norm, most tramway systems in Japan are shorter with fewer lines.

Table 2 Number of LRT Systems and Tramways Worldwide

Country		Country		Country	
Japan	19	Germany	59	Argentina	1
Turkey	2	Norway	2	Brazil	2
China	5	Hungary	4	Australia	3
India	1	Finland	1	Azerbaijan	2
North Korea	2	France	11	Armenia	1
UK	6	Bulgaria	1	Ukraine	25
Italy	5	Belgium	5	Uzbekistan	1
Austria	5	Poland	14	Estonia	1
The Netherlands	3	Bosnia-Herzegovina	1	Kazakhstan	5
Croatia	2	Portugal	2	Georgia	1
Switzerland	5	Romania	15	Belarus	4
Sweden	3	Egypt	4	Latvia	3
Spain	3	Tunisia	1	Russia	71
Slovakia	3	Canada	2		
Serbia	1	Mexico	1		
Czech Republic	7	USA	19	Total	334

Note: The table was compiled by the author using information from *A World of Trams and Urban Transit* by M. Taplin (http://www.lrta.org/world/worldind.html).

Analysis of tramway characteristics

Statistical analysis also clarifies the characterstic of tram/LRT systems worldwide into four groupings composed of: Germany and the Benelux; France and North America; the former countries of the Soviet Union and eastern Europe; and Japan. In Figure 5, systems with few lines and/or low passenger levels are plotted

Series 9000 100% low-floor tram of Kumamoto City Transportation Bureau (Author)

Series 1500 tram in Nagasaki City with advertising livery (Author)

Figure 3 Cities with Tram Systems (by population)

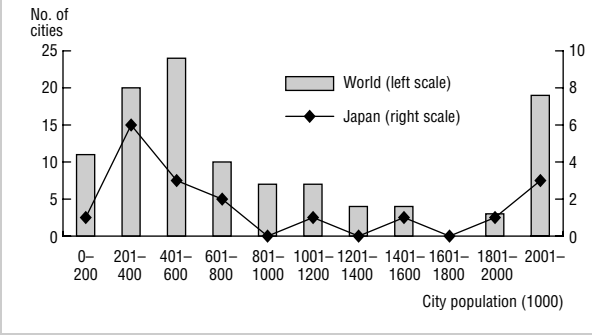
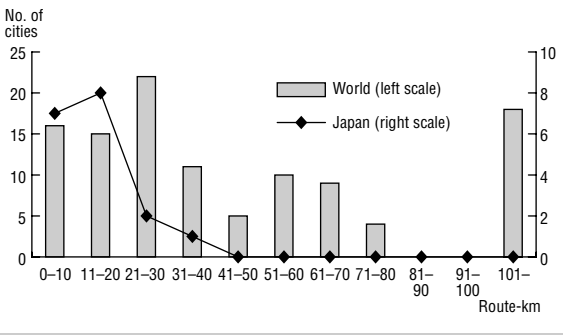


Figure 4 Cities with Trams (by route-km)



towards the right; those with long routes and/or those that began operations fairly recently are plotted towards the top.

For example, in the French and North American group, trams/LRTs do not follow the conventional model of a dense layout in the old city. Rather, they tend to represent newly built systems carrying relatively few passengers linking the centre and suburbs. On the other hand, systems in the countries of the former Soviet Union and eastern Europe are distinguished by large networks with many long lines and high numbers of passengers. The grouping of Japanese tram systems alone near the bottom right of the chart indicates that there is a Japanese type composed of comparatively old small systems, carrying relatively few passengers. This means that Japanese tramways do not serve as the main urban transportation mode.

Needless to say, these results do not imply that all tram systems in a country have the same characteristics. For example, in Japan, the Nagasaki tram network falls within the German grouping. Nagasaki has an extensive but small tram network with high passenger levels run by an operator focused exclusively on tram operations that offers convenient services.

Need for Policies Promoting LRT

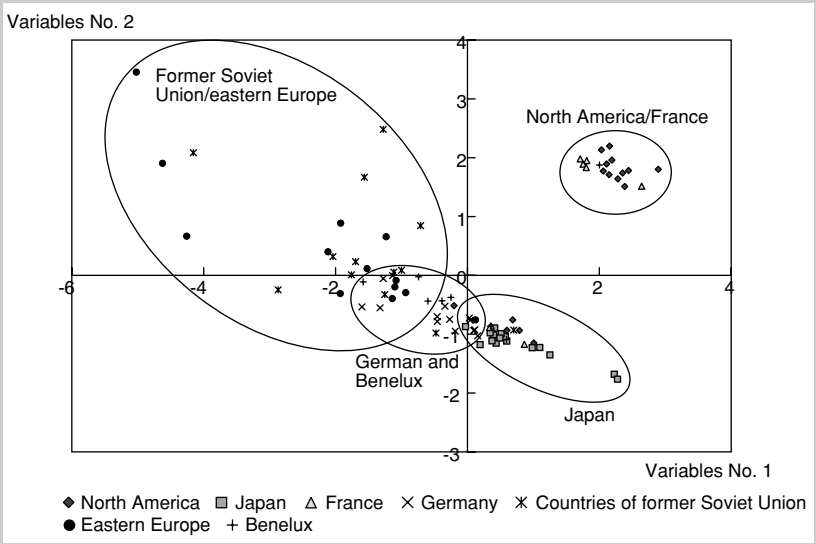
While Japanese tram systems still seem to follow the older model and have not evolved into modern LRT systems, other world cities subsequently constructed LRT systems after abandoning old trams decades ago. Under these circumstances, the widespread opinion today is that present tramways in Japan should be upgraded to LRT systems. Until recently, even medium-size cities in Japan have tended to build monorails or automated guided transit (AGT) systems, which have little effect on road traffic, instead of tramway systems. However, LRT systems have great potential for public transportation in the 21st century.

Advantages of tram/LRT

The governments of some countries—but not Japan—provide subsidies for building and operating trams/LRTs because they offer the following advantages:

- Reduced air pollution
  Cities that depend primarily on automobiles tend to suffer from traffic jams and high levels of air pollution. The degraded environment and far-reaching consequences of global warming are driving the urgent need for public transport systems that can ensure a sustainable environment.
- Medium-capacity public transport
  Many large cities have built subways as a partial solution to traffic congestion, but medium-size cities do

Figure 5 Features of Tramways by Countries and Area



Note: The figure plots each city according to two criterion variables obtained by discriminant function analysis.

not need large-capacity subways. The medium capacity of new LRT systems is an ideal solution for these needs.

- Better accessibility
  Monorails and AGT systems are similar to LRTs in being medium-capacity transport systems and some Japanese cities have built monorails, such as *Yui-rail* in Naha, Okinawa, and AGT systems, such as *Yurikamome* in Tokyo for this reason. However, passengers and operators soon discovered that monorails and AGT systems do not offer the street-level barrier-free accessibility of LRTs, especially for people with limited mobility, such as the elderly and disabled. High accessibility also contributes to faster schedule speeds because it makes boarding and disembarking fairly smooth.
- Low construction cost
  Subways are incredibly expensive (minimum of ¥20 billion per km) to build due to high engineering costs, elevated AGT guideways, etc., require purchase of expensive land and high construction costs for infrastructure (about ¥10 billion per km). LRT construction costs vary with the specific urban conditions, but they generally fall within the range of ¥1 billion to ¥2 billion per km. Moreover, LRT trains can run on existing suburban tracks. For example, in the UK, where construction of LRT systems receives only minimal government subsidy, the Manchester *Metrolink* required only 2.7 km of new track with the other 28.2 km coming from former British Rail commuter lines. The success of the Manchester *Metrolink* was the catalyst for the boom in UK tramway construction (see pp. 22–25).
- Greater flexibility for connections with existing rail lines
  Subways and conventional urban railway lines provide effective transport in large cities everywhere, but branch lines can be used as effective feeders to an LRT network. Since monorails and AGTs are closed transit systems they do not permit through connections with other types of rail. Trams have a very great advantage in this regard as demonstrated by the successful Verkehrsbetriebe Karlsruhe (VBK) tram network in the regional German city of Karlsruhe where trams are running through to the heavy-rail network to link the city centre and suburbs.
- Frequent services
  Removing physical barriers to travel improves accessibility and increases convenience. However, convenience can also be achieved through more frequent operations. Passengers find that one six-car train set running every 15 minutes is not as convenient as one two-car train set running every 5 minutes. All regional centres in Japan have public transport systems, but more and more people are commuting by car. In a 2001 survey in the cities of Maebashi and Takasaki in Gunma Prefecture, about 100 km north-west of central Tokyo, nearly 50% of current car commuters could commute by public transport if they wished, and said they would consider doing so if rail services were more frequent. The survey found that if trains ran each way once every 15 minutes, more than 60% of car commuters said they would use the train. The figure rose to more than 90% when trains ran every 10 minutes.
- Better urban environment
  Urban sprawl has caused hollowing out of city centres in many countries, including Japan. LRTs can help revive urban centres and create conditions that permit people to return there to shop and stroll. There were doubts that LRTs could revitalize cities, because it was assumed that people used to driving to suburban shopping centres would not return even if LRTs were built. Now it is obvious that new trams promote businesses and bring back people into the city centres. Once people return to the city centre, shops take on new life and new businesses appear. LRTs make a virtuous circle in urban development.

Financial incentives for LRTs in Germany and France

Germany has pursued LRT development more vigorously than any other country and it is worth looking at German subsidies for LRT systems.

A 1964 German report on transportation problems in various municipalities recommended putting priority on public transport and indicated that public financing and long-term planning would be necessary. The federal government accepted the recommendations and accordingly raised the tax on gasoline and diesel fuel in 1966 to partly subsidize trams and other forms of public transport based on a 1967 federal law defining federal subsidies to local municipalities improving their transport systems. The philosophy behind this approach of taxing fuel was that car drivers would enjoy better road conditions because of the switch to public transport. In other words, car users benefit indirectly from public transport and should shoulder some of the financial burden of providing public transport infrastructure.

In the early days, the 40% tax on gasoline and diesel fuel financed a limited range of public projects, such as relocating tramways underground. But in the 1970s, federal policies began emphasizing public urban transport. The 1971 Municipal Transportation Finance Law (GVFG) established federal guidelines for subsidies to municipal governments. One result was an increase in the proportion that public transport projects could receive

Series 8100 partial low-floor tram of Hakodate City Transportation Bureau (Author)

from the fuel tax. For example, the federal government paid 85% of the initial cost of the pioneering project in 1992 to modify the infrastructure to allow Karlsruhe city trams run on heavy track used by German Federal Railways. The local municipalities and their transportation bureaus only paid 15% of the cost.

Financial assistance for roads and public transport was apportioned according to a set ratio, but this ratio was abolished in 1992. Thereafter, the regional governments themselves determined how they would finance public transport projects under the GVFG scheme. In 1996, responsibility for planning, administering and financing short-distance public transport systems was handed to the regional governments. Since then, federal money that used to directly finance public transport systems has been given to the regions (Ländes) as grants to be added to regional funds for improving tramways and other public transport systems. The fuel tax has also begun to subsidize operating expenses.

In France, tramway construction is moving forward more energetically than in any other country in recent years. Like Germany, France also funds improvements to urban public transport by levying the Versement Transport tax (calculated according to salary) on corporations and government institutions employing 9 or more people in specific districts. The intent is to have people who benefit indirectly from improvements in public transportation contribute to financing. The tax was first levied in Greater Paris in 1971 and then spread to other regional centres from 1973. Some restrictions on how subsidies raised from the tax could be used were lifted in the 1980s, expanding the variety and scope of urban transport projects.

Subsidies from the Versement Transport tax are not limited to just trams, but tram projects are a significant proportion and the subsidies help with both construction and some operating expenses. For example, about 25% of the capital expenses of Line 1 of the Strasbourg tram network was financed by the Versement Transport tax.

The success of the LRT in raising revenue can reduce its need for public subsidies. Nantes, the first French city to bring back trams, depended on tax subsidies for 60% of capital expenses for the first phase of construction, but an increase in the number of passengers boosted farebox revenues, making it possible to lower the tax rate from 1.50% to 1.25%.

Financial incentives in Japan

Unlike Europe or North America, public transportation systems in Japan are supposed to be self-supporting, so tramways receive no subsidies for operating expenses. However, the tram revival in Europe and North America since the mid-1990s has prompted local governments in Japan to offer limited subsidies for capital costs involved in building or upgrading tram lines.

In FY1995, the former Ministry of Construction (MOC, now the Ministry of Land, Infrastructure and Transport) strengthened its Urban Transportation Improvement Program by using funds from the General Account to subsidize construction and improvement of tram stops, road beds and other facilities. The subsidies come under the category of 'relocation of traffic impediments.' In FY1997, the MOC launched the Tramway Reconstruction Program, offering subsidies from Road Improvement Special Account. These subsidies encourage tramway modifications that will reduce road congestion on seriously congested roads. In Toyohashi City in central Japan, subsidies paid part of the cost of extending the tram track 150 m from a location near the central station to a concourse just beside it.

In FY1998, the government expanded the scope of the Tramway Reconstruction Program to permit subsidies for construction, improvement and extension of tram track beds if it can be shown that such work will facilitate road traffic flows. Since that year, the Ministry has expanded the Subsidy Program for Railway and Track Modernization to include subsidies for low-floor vehicles that replace older rolling stock. These incentives promote safer transit for the elderly and have had the indirect effect of promoting development of low-floor cars in Japan.

New movement—Man'yo Line

While financial incentives have been gradually introduced by the national government, local governments and ordinary citizens have begun to change old tramways. The establishment of Man'yo Line Corporation in 2001 symbolized this new movement in Japan.

Tram on Man'yo Line at Takaoka during the *Tanabata* festival (7 August) (Author)

Santa Clara Valley Transportation Authority (VTA) tram in San Jose built by Kinki Sharyo (Author)

The 12.8-km Man'yo Line is a tram line linking the two cities of Takaoka and Shinminato in Toyama Prefecture on the Sea of Japan. When the line was on the verge of closure, a new public–private venture partly capitalized with funds from local citizens rescued the old tramway. The biggest surprise was that although railways in Japan are expected to be self-supporting, the decision to keep the tram open was made with the full knowledge that it would be loss-making and would require financial support from the local community. Projections showed that ordinary expenditures would be more than 10% higher than ordinary revenues 10 years after establishment of the public–private venture. Despite this gloomy outlook, the local community decided to go ahead. This determination was based on the idea that the line offers an effective means of public transport for an aging society, reduces local (and therefore global) pollution, and revitalizes the region as a symbol of urban design.

The required capital of ¥499 million was raised as two grants of ¥150 million each from the Toyama Prefectural Government and the municipal governments of Takaoka and Shinminato, plus an investment of ¥49 million from local businesses and citizens. A further ¥100 million was collected as donations by citizens to buy new low-floor cars and other equipment. The first new car entered service in January 2004 and attracted a lot of attention.

Conclusion

LRT or tram systems could improve transit in the 21st century. So far, unfortunately, no new LRT system has been constructed recently in Japan. Financial problems of regional urban centres are growing due to the increase in public spending for the aging society and a 10-year recessionary economy. Even so, there are nearly 20 tram systems in Japan and recent trends suggest a gradual revival of LRT systems. Following Man'yo Line, JR West is moving ahead with plans to introduce LRT cars on the 8-km Toyama-ko branch line in Toyama Prefecture, where the Man'yo Line is located. The plan is to have LRT cars running through Toyama City centre from the suburbs by the end of FY2006. Other than these projects, more than 20 projects are on the drawing board in various Japanese cities.

Cities such as Kyoto, Yokohama, etc., abandoned tramways in the past but are now exploring the possibility of reviving tramways as LRT systems. Some of Japan's rolling stock manufacturers, such as Kinki Sharyo Co. Ltd. and Kawasaki Heavy Industries, Ltd, have also built and sold light rail vehicles to a number of US cities, including San Jose in California. Hopefully, it will not be too long before they can play a major role in helping LRT systems to spread throughout Japan as well. ■

Further Reading

N. Aoshima, S. Mita, M. Kanai and N. Suzuki, Possibility of Converting Automobile Commuters in Local Areas to Railways (in Japanese), Transportation and Economy, Vol. 61, No. 10, 2001.

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