

# Light Rapid Transit in Singapore : Transportation Demand Management and Urban Environment

著者	Koiwai Hironori
出版者	Institute of Comparative Economic Studies, Hosei University
journal or publication title	Journal of International Economic Studies
volume	17
page range	43-58
year	2003-03
URL	<a href="http://hdl.handle.net/10114/694">http://hdl.handle.net/10114/694</a>

# Light Rapid Transit in Singapore

## — Transportation Demand Management and Urban Environment —<sup>\*</sup>

Hironori Koiwai

*Graduate School of Social Sciences, Hosei University*

### 1. Introduction

In the new millennium, urban policy has the mission of accomplishing the migration to a cyclic-type society from the conventional socio-economical system, which drove the so-called great economic growth of the 20th century, based on the underlying concepts of mass-production, mass-consumption, and mass-disposal. In brief, urban policy must ensure that the concept of “sustainable cities” can be translated into reality. It goes back to the 1992 United Nations Conference on Environment and Development (UNCED — commonly called the Earth Summit), where the concept of sustainable cities was formulated. The conception is one of fruits of the summit, and more specifically, one of several policy methods stipulated in the “Plan of Human Activities for Sustainable Development” as instruments for implementing sustainable development, which was the consensus of the members. In other words, it may be said that the conception of sustainable cities is an instrument for building cities in which urban planning is based on harmonization with the environment, and in which both environmental conservation and economic growth are assured<sup>1</sup>.

From the perspective of environmental conservation, the industrial activities and lifestyles of cities must be converted into those allowed in the context of the concept of sustainable cities. Against this background, there have been increasing attempts such as to reduce the use of automobiles and improve transportation efficiency to reduce environmental load, especially in the countries in Europe and U.S. To promote the elimination of the use of automobiles, alternative means of transportation must be established, and related knowledge-based countermeasures must be taken. To attain this goal, public transport facilities are being consolidated for users’ convenience, and measures for transportation demand management are being taken to reduce the load on the environment.

In Japan, cities such as Yokohama, Kitakyushu, Osaka, and Hamamatsu are some of the municipal governments that are taking on the challenge of building cities with the aim of reducing the transportation load<sup>2</sup>.

The environmental problems surrounding urban areas, and in particular, the challenge of urban transportation, including the need to go beyond the boundaries of a society that is

---

<sup>\*</sup>I offer my acknowledgements to: Prof. Junnya Matsunami (Hosei Univ.), who gave me useful advices in preparing the report; Mr. Kyouhei Maruyama (The Japan Singapore Association), who provided me with various information, suggestions for investigation method, and materials; Mr. Kazuo Sugino (The Japanese Association, Singapore), who gave me valuable information on MRT and LRT and suggestions for investigation methods; and Mr. Leong Yim Sing, Director, Singapore LRT Ltd., who was kind enough to grant me an interview. Note that any errors or mistakes contained in this report all the author's responsibility. The thesis is based on “Environmental Change of South East Asia,” published by Hosei University on May 10, 2002.

excessively dependent on automobiles, have been extended to the global level, beyond the frameworks of cities. In order to implement sustainable cities, activities for expanding the public transport facilities must be carried out.

For this reason, in this report I will present an overview of the policy for transportation demand management, which the Singapore (considered to be a leading laboratory, where transportation demand management is being studied, throughout the world [Aoki, 2000]) authority is making great efforts to achieve, and introduce the urban transportation system in Singapore, focusing on Light Rapid Transit (hereafter, simply referred to as LRT), a public transport facility opened to traffic in November 1999.

First, in Section 2, I will give an overview of the current status of transportation in Singapore. In Section 3 I will verify the relationship between the policy for transportation demand management and the actual public transport facilities in the City, and will introduce MRT, a main public transport facility in the City. Second, I will describe the differences between LRT, the latest public transport facility opened to traffic in November 1999 and so-called LRT (Light Rail Transit) facilities in other cities, in order to introduce LRT in Singapore. Finally, from the aspect of urban environment planning policy, I will look at the future prospects of transportation demand management.

## **2. Current Status of Transportation in Singapore**

Singapore, which is situated on the Southern tip of the Malay Peninsula, has a land area of 648.1 km<sup>2</sup> (as of 1998). Many small islands surround the Main Island of Singapore.

Of the entire land area of Singapore, residential/commercial and industrial areas occupied 49.9%, agricultural area 1.6%, forest area 4.4%, and marsh area 2.4%, respectively, in 1998.

The population in Singapore was 3,163,500 in 1998, and according to *The 2000 Population Census*, had risen to 4,017,733 in that year.

Since gaining independence from Malaysia in 1965, Singapore, which flourished as a transshipment station for international trade in colonial times, has promoted a policy of giving favorable treatment to foreign direct investments. As an essential factor for economic development, large efforts have been made to improve the standard of living by means of the supply of public housing<sup>3</sup>, the enlargement of the education system, and so on.

The main characteristic of Singapore is that it is a city-state. Another feature is that policies have been planned under the control of a government with strong powers. These policies include the urban transportation policy, which offers a proactive challenge to the infrastructure and environment establishment on a schedule basis<sup>4</sup>.

## **3. Urban Transportation Policy and Transportation Demand Management in Singapore**

### **3.1 Optimization of Urban Transportation and Transportation Demand Management**

In place of the method where an elicited transportation demand is addressed by establishing public facilities such as roads, a method in which transportation is controlled di-

rectly by optimizing transportation demand itself, through control of the usage of the land, human activities, traffic behaviors, and car ownership, for example, has been increasingly promoted. This concept is referred to as Transportation Demand Management (TDM)<sup>5</sup>. In addition, recently, TDM has been introduced from an aspect of improved urban environment to optimize urban transportation.

The underlying idea of TDM has been actively driven, for example in the U.S. by means of the preparation of main roads, since the 1950s. In the 1970s, the focus of the policies shifted to the effective use of existing facilities, on the assumption that this was a useful method, which could achieve the goal in a shorter period at a lower cost compared with a policy of large-scale investment, considering the energy and environmental problems. This resulted in the promotion of Transportation System Management (TSM), including signal controls, the arrangement of bus lanes, and high occupancy vehicle (HOV) lanes<sup>6</sup>. Subsequently, while energy and environment conservation policies were bolstered, new transportation and air pollution problems attracted public attention in the 1980s, due to the further extension of urban areas to rural areas. These problems could not address by conventional TSM. This triggered the promotion of TDM, which focused on control over transportation demand<sup>7</sup>.

Recently, from the perspective of environment conservation, flows of automobiles into urban areas have been suppressed, and transit malls<sup>8</sup> and streetcars have been actively promoted.

The methods and policies of TDM are specifically described below<sup>9</sup>.

### **(1) Guiding System for the Reasonable Use of Automobiles**

The guiding system decreases car traffic – which in general is the major factor causing traffic jams and environmental pollution – by means of direct flow restrictions and guidance of automobiles, and controls on the amount of automobiles flowing into urban areas by applying parking rules.

Concrete policies for implementing the guiding system include: (1) road pricing, under which fees are levied for the use of roads<sup>10</sup> (2) one-way traffic regulation within urban areas, which aims at reducing car inflows into the areas and: (3) inflow restrictions, which limit car inflows into the designated areas using permits.

### **(2) Guiding System for the Reasonable Use of Public Transport**

This system improves policies covering both the knowledge-based and physical aspects and transport means other than automobiles, and in particular public transport facilities, facilitates the shift from an automobile-dependent concept to a different concept, and a reduction in car traffic, and minimizes the load on the environment. To implement this system, the following practical policies have been carried out: (1) Park & Ride<sup>11</sup>, in which parking areas are built within or around railway stations in the vicinity of urban areas, from which users can have convenient access to urban centers by means of public transport facilities; (2) bus operation condition improvements, whereby higher level of services than those by buses are provided; (3) fare system improvements, in which the railway and bus fare systems are improved to increase inter-availability; and (4) the introduction of new transportation systems, with the LRT railway system positioned between streetcars and urban rapid transit railways or AGT (Automated Guideway Transit)<sup>13</sup>.

### **(3) Improving the Efficiency of Transportation Demand**

Under this system, in order to improve the mobility of automobiles, the authority exercises ingenuity in using cars and leveling time- or geography-dependent concentrations of car inflows to minimize traffic jams and the load on the environment. To implement this system, the following practical policies have been worked out: (1) multiple pickup, in which automobile commuters who drives alone with no accompanying passengers are minimized to increase efficiency in the usage of automobiles and: 2) streamlining physical distribution, in order to reduce the volume of motor trucks.

In the light of these descriptions, TDM in Singapore was driven by combining two methods, one being guidance toward the reasonable use of automobiles, and the other guidance toward suitable means.

### **3.2 Transportation Demand Management in Singapore**

Singapore's urban transportation policy was initially planned as part of the infrastructure arrangement essential for facilitating investments by foreign companies rather as a way to solve environmental problems<sup>14</sup>. In other words, improvements in the efficiency and convenience of transportation were assumed to be important for allowing Singapore's global competitiveness to increase.

This assumption has had a large effect on urban planning in Singapore. Its land has been divided into several regions. Each region has a center, and public housing<sup>15</sup> under the management of the Housing Development Bureau (HDB), where 89% of Singapore people live, is interspersed around the regional centers.

The Singapore authority aims, in accordance with urban planning, at the implementation of an efficient transportation system with no traffic jams by preventing the excessive concentration of car inflows into the central commercial area<sup>16</sup> situated in the heart of Singapore.

Based on the policy target described above, the authority has initiated the development of TDM. The actual policies are described below in detail.

#### **3.2.1 Road Network Arrangements and Countermeasures for Automobile Problems**

Serious traffic jam problems would hinder the provision of desirable transportation services, which in turn would have harmful effects on the promotion of investments by foreign companies. For this reason, countermeasures to traffic jams caused by the increase in car ownership became necessary in order to improve transportation efficiency.

To smoothly connect the central commercial area and the peripheral areas, highways (about 150 km) and road networks, including main roads (3,122 km) of which 3,038 km are paved, have been arranged<sup>17</sup>.

Nevertheless, it was not until the beginning of 1970s that considerations of road management were taken (Chin [1999]).

In 1975, the Area Licensing Schema (ALS), which defined the central commercial area as a restricted area, was introduced as a practical policy for the use of automobiles. In addition, in 1998, the Electronic Road-pricing (ERP) schema<sup>18</sup> was introduced, and is still in effect.

Conventionally, as a measure to deal with increased car ownership, registration taxes and import taxes have been imposed. In 1990, the car assignment system was introduced.

Under it, a certain number of Certificates of Entitlement (COE) are issued on a monthly basis to limit the increasing number of automobiles. The price of COEs is determined using the bidding system. For reference, the bid prices of COEs in July 2000 dropped for two categories: Category A including automobiles of 1600 cc or less displacement, and Category B, including automobiles of 1601 cc or more<sup>19</sup> (Table 1).

**Table 1** COE Bid Prices in July 2000

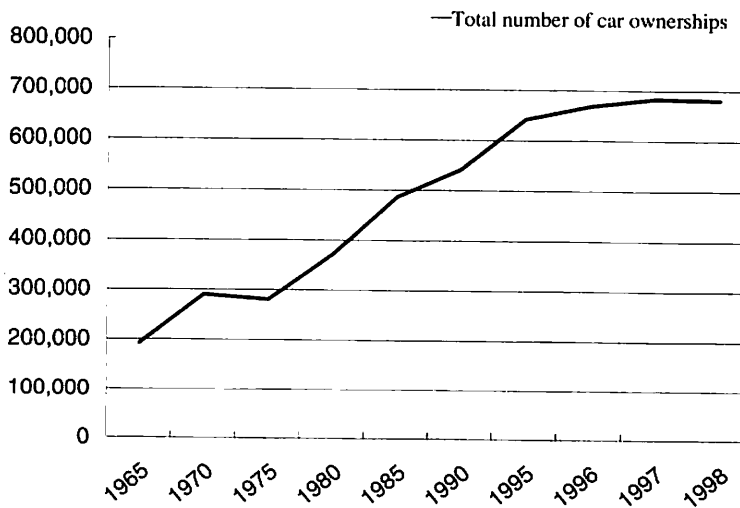
category	bid price (\$)		rise and fall (\$)
	July	June	
A (1600cc over)	38,499	39,348	-849
B (1600cc under)	35,880	41,680	-5800
C (commercial vehicles/bus)	19,832	17,052	+2780
D (motorcycle)	990	888	+102
E (open)	35,008	34,590	+418

Source: "Singapore" Issue 4, 2000

As described above, the TDM system, which provides guidance for the reasonable use of automobiles, has been introduced.

Using only policies for suppressing the increase in the number of automobiles, arranging road networks, and managing the usage and ownership of cars, sufficient effects could not be achieved in reducing the total number of automobiles and solving traffic problems, such as jams (Figure 1).

In this context, TDM, including public transport facilities, has attracted special attention.



Source: Economic Survey of Singapore 1990–1998  
Extracted from "Transportation Policy in Singapore"

**Figure 1** Total Number of Car Ownerships

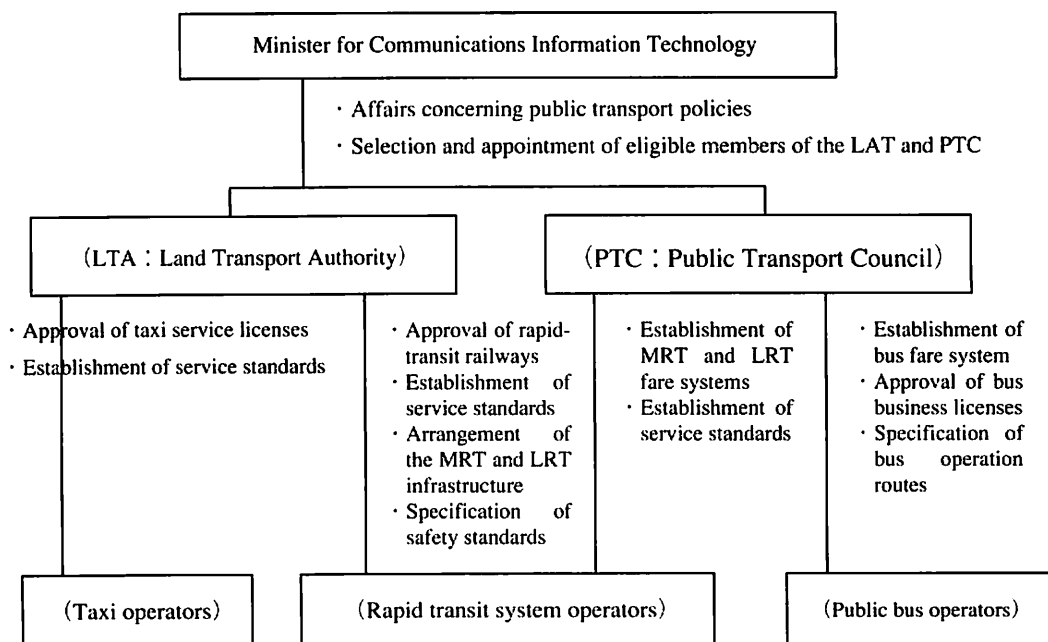
### 3.2.2 Arrangement of Transportation Facilities

According to Anthony T.H. Chin, the Singapore Government is preparing public transport facilities in accordance with the following policies in order to improve the comfort, convenience, reliability, and ease-of-use<sup>20</sup>.

- (1) Enlargement of subway networks (Mass Rapid Transit) for the routes with a large density of users
- (2) Introduction of LRT for completing subway facilities
- (3) Introduction of buses into routes with low user densities for completing subway and LRT facilities
- (4) Introduction of a higher level of bus transportation services
- (5) Taxis providing the same level of comfort as private cars

More specifically, in 1987 MRT was opened to traffic with the aim of expanding networks with bus facilities, improving convenience, building Park & Ride facilities around railway stations, and improving taxi services.

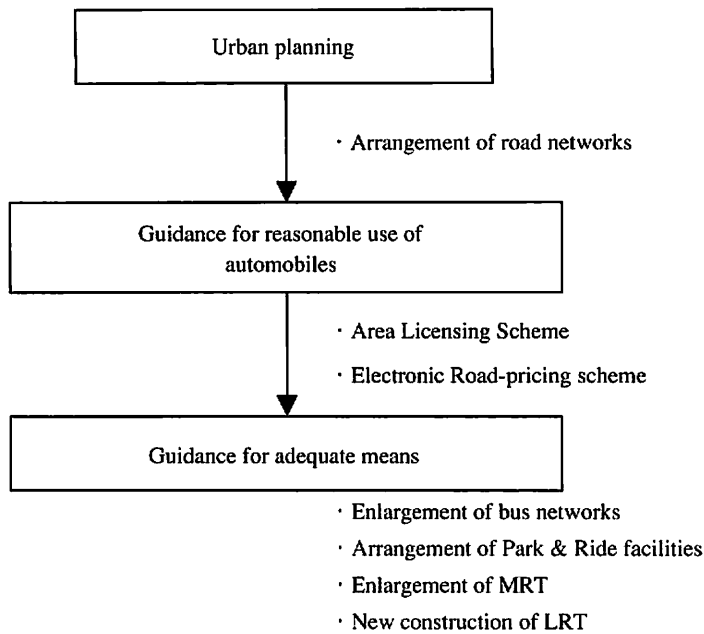
In cooperation with the Minister for Communications Information Technology, the Land Transport Authority (LTA) and Public Transport Council (PTC) are responsible for managing MRT, LRT, taxi, and bus fare systems and specifying safety and service standards in order to promote policy implementation. The LTA also arranges the infrastructure of transportation facilities including MRT and LRT railway networks. The relationship among these policies can be represented as shown in Figure 2.



Source: Our Business

Figure 2 Relationship among Policies

While MRT connects the regional centers, LRT plays a role connecting the MRT railway stations to HDBs interspersed around the stations. The first LRT was opened to traffic in 1999. The further enlargement of public transport facilities such as MRT, LRT, and buses is currently being planned<sup>21</sup>. MRT and LRT are described in detail in the following sections.



**Figure 3** TDM Classification in Singapore

TDM in Singapore is summarized systematically in Figure 3.

## 4. MRT in Singapore

Further efforts for enlarging MRT, which was opened to traffic in 1987 in accordance with the policy “Enlargement of subway (MRT) networks concerning routes with large density of users” as described in the preceding section, is in progress for connections to other public transport facilities.

### 4.1 MRT

In August 2000, the Singapore MRT line connecting the southern and northern areas was opened to traffic and its transportation service was commenced.

In Singapore, the MRT system is designed as an urban rapid-transit railway<sup>22</sup>, which runs on underground rails in the central commercial area, and elevated rails in the suburb areas (Figure 4).

The infrastructure for rails and transport facilities were constructed and arranged by the Mass Rapid Transit Corporation (MRTC)<sup>23</sup>. The MRTC was then reorganized into the present LTA, which has been responsible for managing the provisions of the construction and operations of MRT. In 1990, all the initially scheduled lines were opened to traffic at a total construction cost equivalent to ¥318.8 billion<sup>24</sup>.

MRT is operated by Singapore MRT Ltd. (SMRT) under a License and Operating Agreement (LOA) with the LTA. The license reached its expiry date on March 31, 1998 (ten years full term) and a new license was granted on April 1, 1998 permitting further operations<sup>25</sup>.





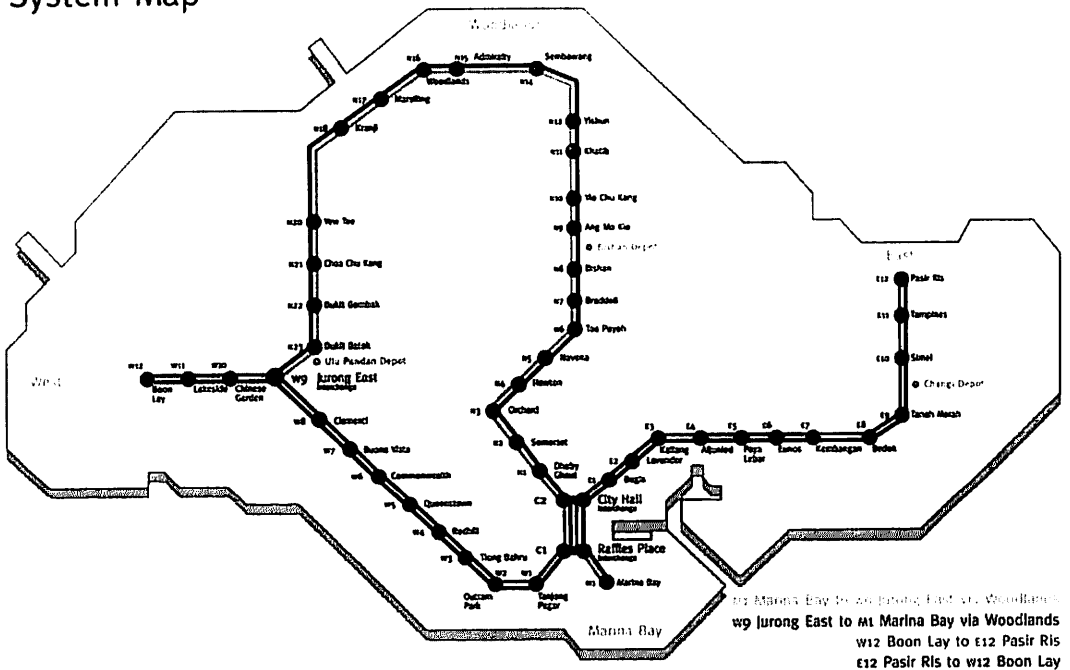
Source: Supplied by the author

Figure 4 MRT in Singapore

**(1) Coverage and operating routes**

Covering about 90 km, MRT services are provided on two routes, one the South-North Line and the other the East-West Line (Figure 5).

**System Map**



Source: Singapore MRT Ltd. Annual Report 97/98

Figure 5 MRT Route Diagram

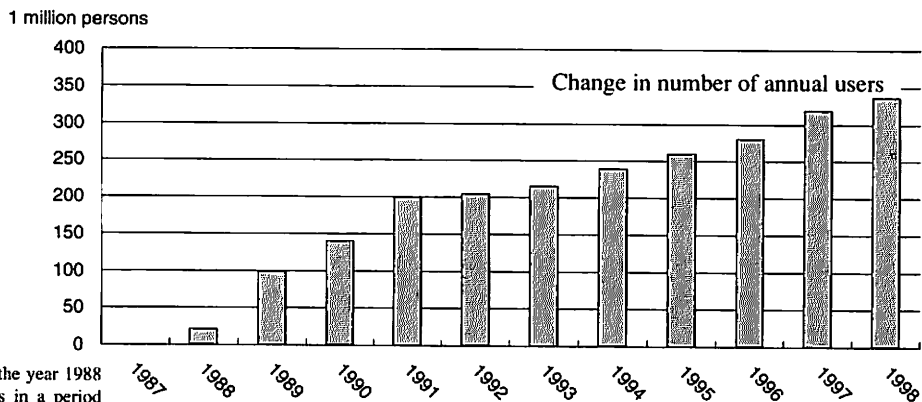
## (2) Scheduled Operating Time Zone and Intervals

The scheduled operating time is from about a.m. 5:00 to about a.m. 00:50.

Assuming that the time zones from a.m. 8:00 to 9:00 on weekdays and a.m. 8:15 to 9:00 on Saturday are peak zones in the morning, MRT vehicles run at an interval of 2-6 minutes. In the off-peak time zones, it runs at an average interval of 6 minutes.

## (3) Annual Number of Users

In 1988\* when MRT was opened to traffic, the total number of users was 21.5 million (Figure 6) and has increased year after year reaching 337 millions in 1998 (Figure 6). The average transportation coverage is 12.6 km/user<sup>26</sup>.



\* The figure for the year 1988 includes the users in a period ranging from November 7, 1987 to March 31, 1988.

Source: Singapore MRT Ltd. Annual Report 97/98

**Figure 6** Changes in Number of Annual MRT Users

## (4) Safety Standards

The LTA has defined the safety standards for public transport facilities in order to improve comfort, convenience, reliability, and ease-of-use.

### 4.2 MRT and Park & Ride Facilities

To reduce car inflows into the central commercial area, Park & Ride (P&R) facilities were constructed around 18 MRT railway stations.

To improve the ease-of-use of P&R facilities, "Park & Ride Set" tickets combining P&R facility tickets and "season parking tickets" are available at MRT stations and other places, for 72 Singapore dollars (as of 2000).

As an actual example, an overview of the P&R facility at Pasir Ris Station, a terminal of the MRT East-West line, is shown in Figure 7. Pasir Ris Station is an Eastern terminal of the MRT East-West line. The parking area set up in the Pasir Ris Town Park, which is situated to the east of the station, is used as the P&R facility. The bus interchange was arranged in the vicinity of Pasir Ris Station, forming a network with the MRT station for greater convenience.

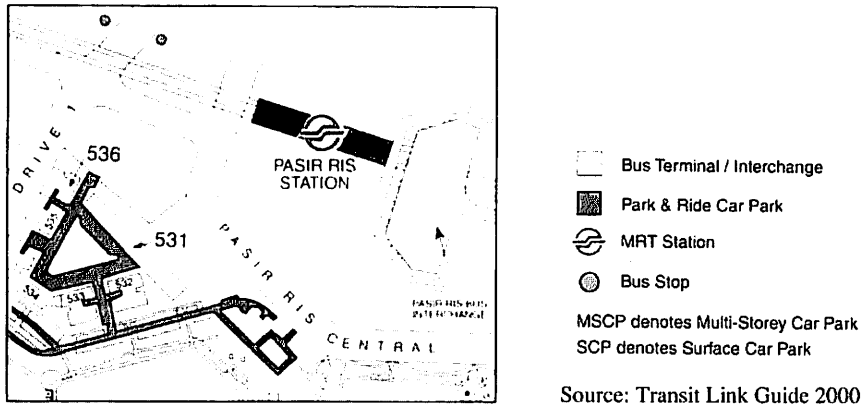


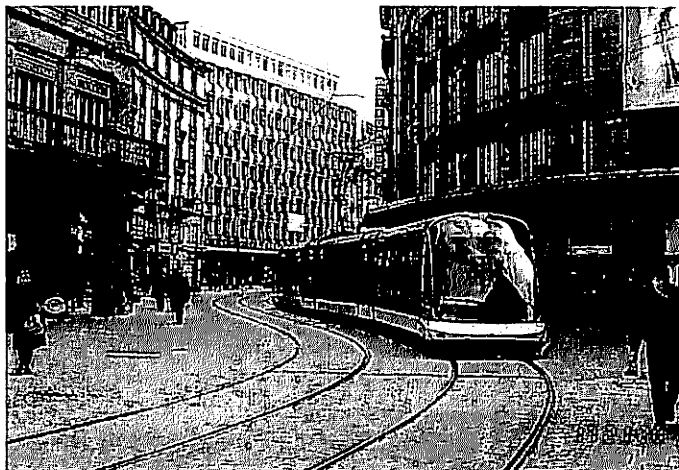
Figure 7 P&R Facility around the Pasir Ris Station

## 5. Singapore's LRT and Common LRT (Light Rail Transit)

### 5.1 Common LRT (Light Rail Transit)

Recently, in European countries and the U.S., road-cars similar to those found in Japan have been improved and reborn as so-called LRT (Light Rail Transit), a new type of urban transportation facility.

It is difficult to define LRT<sup>27</sup>, but according to the Society for the Study of Urban Transportation [1997], it is a form of rail system positioned between road-cars and urban rapid transit railways, and usually runs on special rails along streets. The operating speed may reach 25 km/h or more. This type of urban transportation facility is generically called LRT<sup>28</sup> (Figure 8). Thus, LRT in general is different from Singapore's LRT in terms of both vehicle features and mode of operation.



Source: LRT WORKSHOP '97

Figure 8 Schematic of LRT

## 5.2 Singapore's LRT

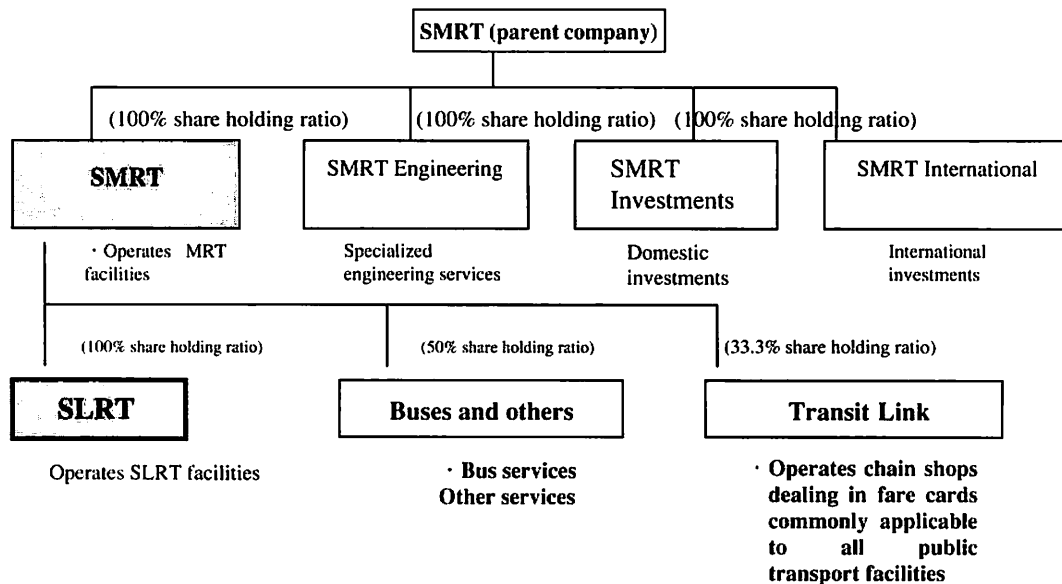
### (1) Overview

In Singapore, the first LRT (Light Rapid Transit) line was introduced in 1999 in the Bukit Panjang region, starting at Chao Chu Kang Station on the MRT South-North line, in order to complete the subway network<sup>29</sup>. The construction of LRT was commenced in 1996 and completed in 1998.

In Singapore, unlike the general type of LRT vehicles running on special rails along the streets, as described in the previous section, LRT involves a new type of vehicles with rubber wheels, called Automated Guideway Transit (AGT). It is an unattended transportation system running along special guideways. In Japan, this type of transportation system is referred to as a new transportation system<sup>30</sup>.

The underlying concept of introduction of LRT as a new public transport facility for completing MRT includes the following considerations: (1) environmentally friendly, (2) no emission of exhaust gas, and (3) noise minimization<sup>31</sup>.

The establishment of infrastructure, definition of service standards, and other management affairs are planned and carried out by the LTA along with MRT. The company operating the LRT facility, Singapore LRT Pte. Ltd. (SLRT) is a fully-owned affiliate of Singapore MRT Ltd. (SMRT), which operates MRT (Figure 9).



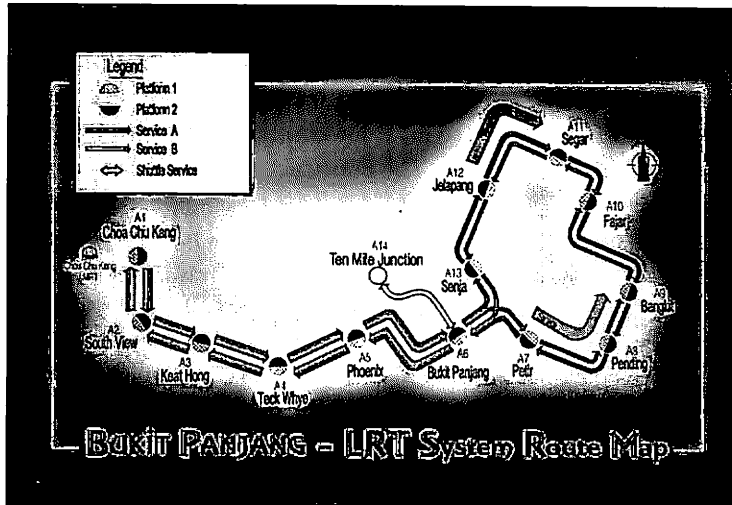
Source: Our Business

Figure 9 Organizations of SMRT and SLRT

### (2) Railways and Vehicles

At present, LRT vehicles operate over a total of 78 km, and stop at 14 stations on three routes: Service Area A (outward turning), Service Area B (inward turning), and Service Area C (a loop line connecting to Ten Mile Junction Station) (Figure 10).

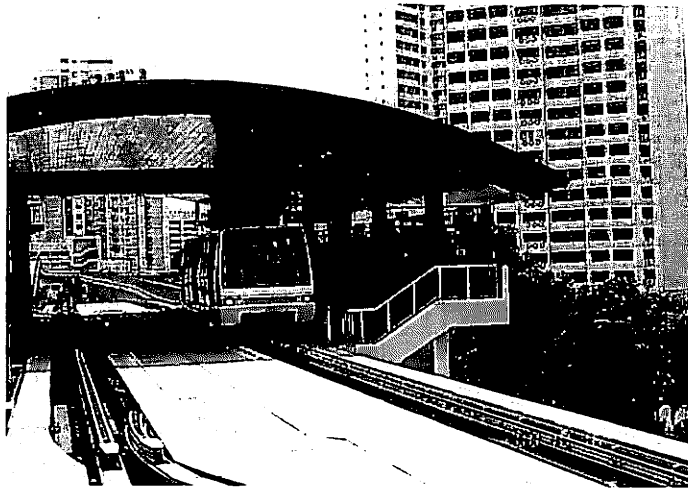
Each LRT vehicle, with Japanese-made rubber wheels, has a total length of 12.8 m and a weight of 15,000 kg. The average running speed of LRT vehicles is 25 km/h, with the highest speed reaching 55 km/h. At present, 19 vehicles are being operated.



Source: Bukit Panjang LRT Guide

Figure 10 Operating Routes

As shown in the figure, the vehicles run along guideways employing a center guiding system, in which a pair of guiding wheels are mounted on both sides of a single rail lying at the center of the rail area<sup>32</sup>, in fully unattended mode (Figure 11).



Source: Supplied by the author

Figure 11 Singapore's LRT

Since the rails were laid down as an elevated line surrounding HDB housing complexes, the windows of the vehicles can be misted (“misting window”<sup>33</sup>) in the vicinity of housing to prevent commuters from seeing inside the rooms of apartments.

All the LRT stations are situated within 400 m of HDB complexes, allowing users to get to them on foot. Each of vehicles has small LCDs which provide LRT traffic information and other interesting information. Each vehicle has 22 seats and is able to carry up to 105 commuters.

The accumulated number of LRT users since it opened to traffic in 1999 exceeded 10

million in August 2000<sup>34</sup>.

### (3) Operating System and Safety Management

The operating time of LRT vehicles runs from about a.m. 05:00 to about a.m. 01:00. During the peak time zone, they are operated at intervals of two minutes while in the off-peak time zone, at an average interval of six minutes. It takes about 18 minutes to run the total length of the line.

From the perspective of ensuring safety, emergency facilities including emergency telephones are installed in the vehicles running in fully unattended mode. In addition, monitors as well as emergency buttons and telephones are installed in the station yards. Vehicle operating and safety management and monitoring tasks are controlled from the centralized Operating Control Center at Ten Mile Junction Station.

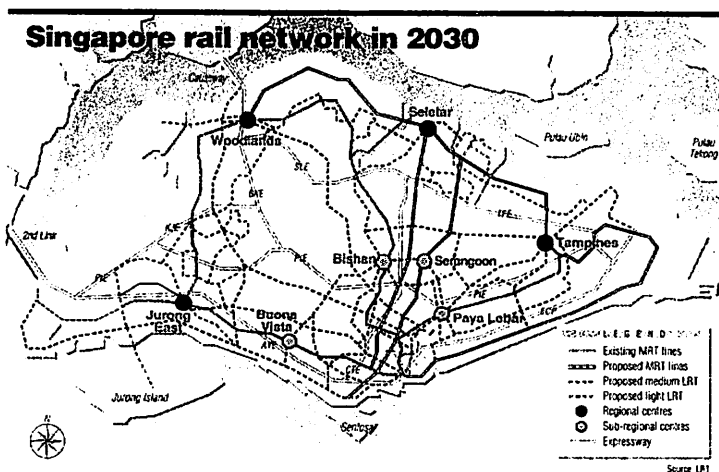
## 6. Prospects of TDM and the Urban Environment in Singapore

In order to suppress traffic jams while maintaining urban functions, the Singapore Government plans to implement a policy of reasonable use of automobiles, while proactively introducing a TDM policy, which is expected to lead to adequate methods for enlarging and arranging public transport facilities such as MRT and LRT.

For example, MRT currently operates on a total of 90 km. It is scheduled to construct an additional Changi Airport line of 6 km in 2001 and an additional area and extension of the North-East line of 20 km in 2002<sup>35</sup>. For LRT, new lines in planning include the 10-kmenkang line in 2002 and the 13-km Punggol LRT<sup>36</sup>.

In addition, the MCIT aims to further enlarge the MRT and LRT networks to cover a total of 540 operating kilometers as a long-term objective, since the construction of highways has limitations such as in acquiring sites (Figure 12)<sup>37</sup>.

These transport facilities are also expected to play important roles in implementing Singapore's policy focusing on DTM in the future.



Source: *Business Time*, 29 June 2000

Figure 12 gure 10. Envisioned MRT and LRT Networks in 2030

## 7. Conclusions

In a situation where special attention is being paid to global environmental problems, in particular, advanced countries must plan and implement policies for reducing CO<sub>2</sub> emissions from automobiles and realizing cities that are in harmony with the environment. To establish such ideal cities, we must take on the difficult challenge of converting conventional transportation policies that place a high priority on automobiles. To address this problem, the concept of TDM, which combines a policy of reasonable use of automobiles with one of restricting the usage and ownerships of automobiles by functionally arranging public transport facilities, on the assumption that they are popular and easy-to-use vehicles, has emerged as an essential philosophy. I have already mentioned that Singapore's transportation policies were not always planned out from the perspective of compatibility with the environment.

The concept of TDM introduced proactively by the Singapore Government, however, has resulted in the evolution of Singapore into an environmentally harmonious city. Due to it being a so-called city-state, as well as having strong political power, Singapore might be able to promote these types of policies under absolute authority. Apart from that, however, its achievement may provide significant hints to advanced countries including Japan, which are being forced to convert from existing transportation policies focusing on automobiles to new policies based on compatibility with the global environment, to induce the solutions.

In the report, from an aspect of guidance to an appropriate transport means, one component of the TDM conception, I introduced the current status and future blueprint of public transport facilities in Singapore, focusing on LRT opened to traffic November 1999. The LRT in Singapore has not been in depth introduced to Japan.

Further study is needed on the roles of the public transport facilities in implementing TDM and the urban environmental policies in Singapore.

### Notes

- 1 For more information on sustainable urban transportation systems, see Aoki [2000].
- 2 In Japan, for example, Yokohama City distributes urban information from its Eco Management Center with the purpose of minimizing traffic jams and thus improving the urban environment. Hamamatsu City manages individual transportation facilities and traffic information from its own Eco Management Center, and promotes a zone system planned by the National Land and Transportation Ministry as a countermeasure against traffic jams, traffic accidents, and other traffic problems in the central urban district. Under the zone system, the central urban district surrounded by circumferential roads is divided into smaller zones. Passage across the boundary roads defining the zones is restricted in order to stop ordinary cars from running through the central urban district, and access to individual zones is allowed only from circumferential roads. The introduction of this zone system has produced some good results, such as a moderate reduction in traffic jams and accidents. Source: Eco City Arrangement Steering Committee [2000].
- 3 From an interview by the author.
- 4 *do.*
- 5 Toshikotsu Tekiseika Kenkyukai [1995].
- 6 *Ibid.*

- 7 *Ibid.*
- 8 *Ibid.* “Transit Mall is intended to improve the attraction of the central commercial area by establishing compatibility between pedestrians and public traffic.”
- 9 *Ibid.* “The three methods and their related measures were described as ‘transportation policies, which may be implemented while ensuring convenience for urban activities and civil lives.’”
- 10 *Ibid.* “Fees are charged for the use of roads to cut down traffic jams, reserve financial sources for infrastructure establishment, and resolve traffic problems.” *cf.* Shibata Tokue et al. [1995].
- 11 Park & Ride (P&R) is a system in which commuters generally go to a railway station or bus stop in the suburbs by car instead of driving directly to their destinations, park in the parking area constructed there, and go by LRT vehicle (or bus) to their destination. This policy is intended to provide persons who do not receive sufficient benefits from public transportation facilities with improved transportation services, and to reduce direct car inflows into the urban areas in order to prevent traffic jams and solve environment problems.
- 12 LRT has been defined as follows. “LRT is spelled out as ‘Light Rail Transit’ and LRV as ‘Light Rail Vehicle.’ Light Railway has its root in tramways in the U.K. The former is different from the latter, which is constructed along streets paved with stones, in that its vehicles run on special rails on the roadsides. For this reason, the new term ‘Light Railway’ was created instead of the old term ‘tramway’” Satoh [1997].  
 “LRT stands for light rail transit. The concept of LRT includes physically light vehicles, as well as feelings of lightness and freeness, in opposition to the term ‘heavy railway,’ meaning ordinary railways. LRV indicates light rail vehicles, which are vehicles for LRT” Sone [1998].  
 “It is a railway system positioned between road cars and urban rapid-transit railways. The whole system is generally called LRT (Light Rail Transit), and the special vehicles are called LRV (Light Rail Vehicles). This new transportation system, which incorporates conventional road-cars, can run anywhere, for example, at ground level, elevated, or underground rails. It allows routes to be selected depending on the regional characteristics, and may contribute directly to smoother traffic flows and regional vitalization” Toshikotsu Tekiseika Kenkyukai [1995].
- 13 “A modified personal rapid transit system, in which light-weight, small vehicles with rubber wheels run on elevated rails along guide-ways” Urban Transportation Study Group [1997].
- 14 See note 3.
- 15 “Overview of Singapore” [2000].
- 16 See Kanoh [1997].
- 17 Department of Statistics, Singapore [1998].
- 18 *cf.* Shibata Tokue et al.[1995].
- 19 “Singapore Issue 4, 2000” [2000].
- 20 See Chin [1999].
- 21 *Business Times* — 29 June 2000.
- 22 Toshikotsu Kenkyukai [1997].
- 23 The Japan Singapore Society, Chamber of Commerce of Japan in Singapore [1983].
- 24 See Kanoh [1997].
- 25 Singapore MRT Ltd [1998].



- 26 *Ibid.*
- 27 See note 12.
- 28 Toshikotsu Kenkyukai [1997].
- 29 See Chin [1999].
- 30 Toshikotsu Kenkyukai [1997].
- 31 From an interview by the author.
- 32 Toshikotsu Kenkyukai [1997].
- 33 The window glasses are quickly misted to cut off the view of the commuters.
- 34 "Singapore Issue 5, 2000".
- 35 Economic Survey of Singapore 1998.
- 36 *Ibid.*
- 37 *Ibid.*

### References

- Aoki, Mami [2000] "Urban Transportation and Environmental Problems," *Study on Urban Problems*, Vol. 52, Issue 10, pp.52-63.
- Business Time, 29 June 2000
- Chin, T.H. Anthony [1999] "Transportation Policies in Singapore," *Transportation and Economy*, Vol. 59, Issue 2, pp.74-79.
- Eco City Arrangement Steering Committee [2000], *Eco City: Towns Compatible with the Environment*.
- Kanoh, Toshiyuki [1997] *Kotsutengoku Singapore*, Seizanndoh.
- Ministry of Trade and Industry [1990-1998], *Economic Survey of Singapore*.
- Satoh, Nobuyuki [1997] "Creation of LRT Culture in Europe," *Transportation and Economy*, Vol. 57, Issue 11, pp.65-76.
- Shibata, Tokue, Nagai, Susumu, Mizutani, Yoh'ichi [1995] "Kuruma izon Syakai," pp.342-360, Jikkyo Shuppan.
- Singapore LRT Ltd. [2000], *The Bukit Panjang LRT Guide*.
- Singapore MRT Ltd. [1998], *Singapore MRT Ltd. Annual Report 97/98*.
- Singapore MRT Ltd. [1998], *Our Business*.
- Sone, Satoru [1998] "LRT and LRV," *Transportation and Economy*, Vol. 58, Issue 3, pp.51-59.
- The Japan Singapore Society, Chamber of Commerce of Japan in Singapore [1983], "Law of Public Rapid Transit Corporation."
- The Japan Singapore Society [2000 a] "Overview of Republic of Singapore" April 2000.
- The Japan Singapore Society [2000 b] "Singapore" April 2000.
- The Japan Singapore Society [2000 c] "Singapore" May 2000.
- Toshikotsu Kenkyukai [1997] "New Urban Transportation System," Sankaidoh.
- Toshikotsu Tekiseika Kenkyukai [1995] "Toshikotsu Mondai no Shohosen," pp.3-17.Taisei Shuppan.
- Transit Link Pte Ltd. [2000], *Transit Link Guide 2000*.
- T.S.N.R.I [1998], *Proceedings of International Workshop on New Urban Design by Introducing Light Rail Transit Systems LRT Workshop '97*.