URBAN TRANSPORT PLANNING IN SINGAPORE

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Reprint from
Planning Singapore: From Plan to Implementation
Editor: Belinda Yuen
Singapore Institute of Planners
August 1998
INTRODUCTION
Transportation has always played an important role in the economic and physical development of modern Singapore. When Sir Stamford Raffles landed in Singapore in 1819, his intention of establishing a trading post on the island was to facilitate transportation between China and Britain and to expand British commercial interests in the Malayan archipelago. Modern history of Singapore began with Raffles' vision to transform the small fishing village to a great commercial hub and a free port. Within a few years of his arrival, Raffles had laid down plans and principles for the development of Singapore into his "pride of the East". With careful planning and great foresight of the founder, Singapore soon became one of the major transportation and distribution centres that attracted both people (immigrants and traders) and goods from nearby regions as well as the Far East and Middle East.

The spirit of Raffles in forward planning continued in the leaders of Singapore even after Singapore’s independence from British rule in 1965. In the last three decades, the political leaders, as planners and architects of the nation, have developed Singapore into a modern city state with state-of-the-art transport facilities. In the area of international transportation, Singapore is one of the busiest seaports in the world and one of the leading airports in Asia. Domestically, the land transport system is both well-planned and efficiently operated, to the envy of many major cities that are plagued with serious transport problems.

This chapter discusses the practice of urban transport planning in Singapore with the view of drawing out the principles that have contributed to the success in planning the land transport system of Singapore.

From the point of view of land transportation, three periods of development may be identified. The era prior to the 1960s may be considered to be one which had little or no systematic transport planning. From the 1960s to the 1980s which roughly coincided with the early period of nation building, transport planning was mainly problem-driven. In the 90s, transport planning has become more vision-driven.

ERA WITH NO SYSTEMATIC TRANSPORT PLANNING (before the 1960s)
Singapore in the 19th Century and the first half of the 20th Century was marked by rapid growth derived from its importance as a trading post. The population grew from several thousand in the days of Raffles to 227,000 by the turn of the century. Most of the commercial activities as well as the dwelling places were concentrated near the expanding city centre at the mouth of the Singapore River.

Forms of transportation
In the early years, land transportation was heavily dependent on bullock carts, horse carriages, jin-rickshaws and bicycles (Archives & Oral History Department, 1981). These animal-powered and man-powered vehicles met the transport needs well as most trips were short. Pedestrians also shared the road space with these rather slow moving vehicles.

With the introduction of mechanised vehicles, a greater mix of transport modes was seen on the road. First, there were the steam trams, introduced in 1867 and then the electric trams in 1905. The first motor car imported in 1896 ushered in the motorised age and by the 1930s the motor vehicle population comprising cars, buses and lorries amounted to a couple of thousands.

Trolley buses started operation in 1925 with the setting up of the Singapore Traction Company (STC) replacing the trams as the primary means of public transport. By 1929, there were 90 trolley buses serving a total service distance of 30.5 km. While STC was given a 30-year monopoly to operate trolley and motor buses within the city, a number of smaller Chinese bus companies, many of which managed by individuals, provided bus services for the fringe and rural areas. By virtue of their size, the Chinese companies had great flexibility in operating the routes. These buses nicknamed “mosquito buses” because of their manoeuvrability became so popular that by 1927 had increased to 456.

Transport Planning
No formal transport study was reported until 1938 when the Traffic Conditions Committee was formed “to consider the present traffic conditions in the town of Singapore including parking and the trial of traffic offences and to make recommendations for their improvements” (Trimmer, 1938, para. 22). The Committee reasoned that there was more than sufficient traffic capacity on the roads as “most of the roads in Singapore were planned when less than half the volume of
traffic now using them was in existence.” In fact based on their estimation, most roads were able to carry “some three times the highest rate of flow which has been observed at any point in Singapore.” Apparently, the Committee was more concerned with facilitating motor car movements than meeting transport needs of the populace as seen from their suggestions such as the extensive removal of road obstacles (including street vendors), segregation of pedestrians and cyclists from the motor traffic, provision of better road signs and markings as well as the creation of more parking space.

ERA OF PROBLEM-DRIVEN TRANSPORT PLANNING (the 1960s to 1980s)
In the post-war years, Singapore faced formidable problems, notably serious unemployment and acute housing shortage. In 1960, the population has already exceeded 1.6 million and by 1968, it passed the 2-million mark. The urgent task faced by the leaders who had obtained self-rule from the colonial rulers in 1959, was to embark on a massive crash building programme to house the people as well as to set out a large-scale industrialisation programme to create jobs for the populace (PAP, 1984). Furthermore, to sustain the efforts of industrialisation, the leaders wisely saw the need to educate the young and to train the work force. A crash programme to build new schools was therefore also launched.

Transportation was not given the priority largely because heavy commitments were already placed on housing and industrialisation. As observed by Dimitriou (1992) about ex-colonial cities, Singapore inherited “an urban transport system predominantly designed to service colonial economic, administrative and residential needs, developed and operated separately from the local transport system predominantly utilized by indigenous populations.” This, together with the massive developments in housing, factories and schools in the 1960s and 1970s which resulted in increased travel volume and longer travel distances put a great strain on the land transport system. The successful economic policies adopted by the government also meant rapid economic growth, with the Gross Domestic Product doubling within eight years from $2,016 million in 1960 to $4,091 million in 1968 (Karni & Chen, 1969). This raised the propensity of the people to own and operate private vehicles.

The inadequate transport supply, coupled with increasing transport demand due to growth and development resulted in mounting traffic problems for the government. It soon became clear that unless these transport problems were tackled systematically, the overall development of Singapore would be hampered. This came in the midst of complaints that the government were tackling the transport problems in a piecemeal manner (Seah, 1975; Tan, 1979).

Singapore’s traffic problems in the 1960s were typically those experienced in many developing cities: poor traffic management and serious congestion in the city centre, inadequate and inefficiently operated public transport services, poor infrastructure maintenance, poor driver discipline and enforcement resulting in high road accidents. Perhaps one of the most serious problems was the lack of proper transport planning as whatever attention given to domestic transportation was in the form of road widening, construction and the provision of car parks (Seah, 1975). This in part was due to the absence of an authority to oversee the planning of transport facilities. It was only in 1968 that the Ministry of Communications was formed when the importance of the transportation issue was formally acknowledged by the political leadership (Seah, 1975).

The following sections discuss the transport problems encountered in the 1960s to 1980s and the actions taken to resolve these problems. These problems were associated with inadequate infrastructure development, rising vehicle population, inefficient public transport operations and poor traffic congestion management.

Transport infrastructure development
Some form of physical planning was done by the Master Plan Committee under Komlosy as early as 1951. The statutory Master Plan, covering a period of 20 years from 1953 to 1972, was approved by the colonial government. The Master Plan was formulated to promote new growth areas on the island and to reduce the population in the central area. Although a network of roads was part of the Master Plan, transport planning was incidental as it did not anticipate the phenomenal growth in traffic that was to come. Consequently, much of the subsequent developments under the new self-rule government did not conform to the guidelines of the Master Plan.

A rather low budget was allocated for road development in the 1960s. Hence, despite the increase in capital expenditure on roads from 1.4% of the total public
sector development expenditure in the 1950s to about 4% in the 1960s, an Economic Development Board study concluded that Singapore was spending a far smaller proportion of the public sector development expenditure on road development compared to other neighbouring developing countries (Karni and Chen, 1969).

To solve the massive housing demands, the urgent need was to build a substantial number of housing units within a relatively short time and this favoured the construction of high-rise dwellings. The high traffic generated from such buildings, made worse by their high spatial density, added tremendous pressures on the road system which was already inadequate from the beginning.

The limitations of the 1958 Master Plan and the rapid developments in the 1960s prompted the call for a comprehensive land use and transportation plan. This was set up with the help of the United Nations Development Programme under the charge of the newly formed State and City Planning Project, which later became the Planning Department under the Ministry of National Development (Wardlaw, 1971). This resulted in the 1971 Concept Plan, basically a Land Use and Transportation Plan which looked at the land use developments along designated corridors projected to the year 1992 for a population of 3.4 million. Included in the Concept Plan was a comprehensive network of expressways and arterial roads to facilitate transportation between zones of high traffic generation together with a mass rapid transit system circling the central portion of the island as well as an airport at the eastern end near Changi.

Arising from the Concept Plan, there was substantial expansion in the road infrastructure from the end of 1960s to the end of 1980s. In 1960, there were about 800 km of roads but the length of roads was more than doubled within ten years, and by 1990, the road network had grown to nearly 3000 km.

Within the framework provided by the 1971 Concept Plan, the expressway network was gradually developed. The first and longest expressway, the 35-km Pan Island Expressway (PIE) was completed in 1981. This was followed shortly by the 20-km East Coast Parkway. With the completion of the 11-km Bukit Timah Expressway and 14-km Ayer Rajah Expressway in 1987, nearly 80% of the expressway network under the concept plan was completed. The basic network of the Mass Rapid Transit system laid out in the 1971 Concept Plan was also built by the end of the 1980s.

**Vehicle ownership policies**
The phenomenal social and economic growth in the early years of nationhood resulted in a high demand for transportation. From the viewpoint of the people, driving in private vehicles was the most attractive solution to meeting their individual transport need. As pointed out by Seah (1975, p.31), “the proliferation in the number of private cars was the result of many factors: fast mobility and easy accessibility especially with regard to portal-to-portal service, the inadequacy of the public transport, social status symbol and affluence.”

In 1955, there were 53,000 cars on the road and this grew nearly three-fold to 156,000 by 1966. Despite the investment in road expansion programmes, it was impossible for road development to keep pace with the growth in car population as the nation had already one of the highest motor vehicle per mile of road ratio even compared to the developed countries (Karni and Chen, 1969). Taking into account the limited amount of land available for development, it became clear that some form of vehicle restraint would be necessary. The constraint in land space and the need to adopt vehicle restraint policies have been consistently repeated in all transport studies undertaken since 1958.

Initially, fiscal measures were taken to curb the growth in vehicle population. Import duty for cars was increased from 10% to 30% of the open market value (OMV) in June 1968 (see changes in taxation on new cars in Table 1). In October 1972, the import duty of cars was again increased to 45% of OMV along with the introduction of additional registration fees (ARF) and changes in road tax structure and petrol tax rates. An ARF of 25% ad valorem was imposed on new cars. Annual road tax on vehicles, which hitherto was at a flat rate of 10 cents per cc. of the engine capacity, was revised to a sliding scale of between 10 and 30 cents per cc, depending on the vehicle class by engine capacity (see Table 2).

The initial fiscal measures were not considered successful in controlling car growth, as seen from a jump in car registrations from 9,645 in the 12-month period before October 1972 to 13,745 for the 12 month period after (Tan, 1979). Further revision of road taxes was imposed in quick succession. In January 1974, the ARF was...
changed from 25% to 55% ad valorem and the annual road taxes increased to a range between 14 cents and 60 cents per cc. In March 1975, higher road taxes were again imposed on private cars. It was from then also that road taxes for company-registered cars were made twice the amount required of private cars, a policy that remained until today.

### Table 1 Changes in taxes imposed on new cars

<table>
<thead>
<tr>
<th>Date introduced</th>
<th>Import duties</th>
<th>Registration Fee</th>
<th>ARF (% ad valorem)</th>
<th>PARF (% ad valorem)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>C1</td>
<td>C2</td>
</tr>
<tr>
<td>Before 1968</td>
<td>10% OMV</td>
<td>$15 for all vehicles</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Jun 1968</td>
<td>30% OMV</td>
<td></td>
<td>10 to 25% depending on origin</td>
<td></td>
</tr>
<tr>
<td>Oct 1972</td>
<td>45% OMV</td>
<td></td>
<td>25 %</td>
<td></td>
</tr>
<tr>
<td>Jan 1974</td>
<td></td>
<td></td>
<td>55%</td>
<td></td>
</tr>
<tr>
<td>Jan 1976</td>
<td></td>
<td></td>
<td>100%</td>
<td>35%</td>
</tr>
<tr>
<td>Mar 1978</td>
<td></td>
<td></td>
<td></td>
<td>125%</td>
</tr>
<tr>
<td>Feb 1980</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oct 1983</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nov 1990</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feb 1991</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

§Capacity of engine - C1: up to 1000cc, C2: 1001 to 1600 cc, C3: 1601 to 2000cc, C4: 2001 to 3000cc, C5: more than 3000cc

(Source: Singapore Year Book, 1968 to 1992, Singapore)

Further changes in road taxes were made in January 1976 along with the introduction of a progressive surcharge on road tax ranging from 10% to 50% above normal rates imposed on vehicles more than 10 years old. The policy of imposing a surcharge on older vehicles was aimed at keeping the car population young. Coupled with this change in road taxes, a Preferential Additional Registration Fee (PARF) ranging from 35% to 55% ad valorem was introduced to induce car owners to replace old cars with new ones. Under this scheme, car buyers scrapping a car with less than 10 years registration could enjoy a PARF benefit that could be used to offset the ARF payment for the newly imported car of same engine-capacity group.

### Table 2 Road tax on private vehicles based on engine capacity

<table>
<thead>
<tr>
<th>Date introduced</th>
<th>up to 1000cc</th>
<th>1001-1600 cc</th>
<th>1601-2000cc</th>
<th>2001-3000cc</th>
<th>&gt;3000cc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before 1972</td>
<td>$0.10 per cc</td>
<td>$0.10 per cc</td>
<td>$0.10 per cc</td>
<td>$0.10 per cc</td>
<td>$0.10 per cc</td>
</tr>
<tr>
<td>Oct 1972</td>
<td>$0.10</td>
<td>$0.12</td>
<td>$0.15</td>
<td>$0.20</td>
<td>$0.30</td>
</tr>
<tr>
<td>Jan 1974</td>
<td>$0.14</td>
<td>$0.15</td>
<td>$0.22</td>
<td>$0.35</td>
<td>$0.60</td>
</tr>
<tr>
<td>Mar 1975 †</td>
<td>$0.20</td>
<td>$0.25</td>
<td>$0.30</td>
<td>$0.40</td>
<td>$0.65</td>
</tr>
<tr>
<td>Jan 1976</td>
<td>$0.33</td>
<td>$0.40</td>
<td>$0.45</td>
<td>$0.50</td>
<td>$0.80</td>
</tr>
<tr>
<td>Mar 1980</td>
<td>$0.40</td>
<td>$0.60</td>
<td>$0.70</td>
<td>$1.00</td>
<td></td>
</tr>
<tr>
<td>Oct 1983</td>
<td>$0.52</td>
<td>$0.78</td>
<td>$0.91</td>
<td>$1.30</td>
<td></td>
</tr>
<tr>
<td>Nov 1988</td>
<td>$0.60</td>
<td>$0.75</td>
<td>$0.90</td>
<td>$1.05</td>
<td>$1.50</td>
</tr>
</tbody>
</table>

† From 1975 the road tax on company vehicles would be twice the rate of private vehicles

(Source: Singapore Year Book, 1972 to 1989, Singapore)

Within a short span of less than 4 years, the tax rates on cars were increased so much that motorists were paying between 3 to 16 times of the rates before. Seah (1975, p.41) reported that “the rapid series of sanctions against car drivers had led to bewilderment and resentment among a section of the car-owning population.”

Despite the unpopularity of such measures, the authorities continued to use fiscal measures and other traffic restraint measures to limit the growth in car population. Further changes to the road tax rates were made in March 1980, October 1983 and March 1985 but the increases were less steep than before, especially in the later adjustments.
Traffic Congestion Management
The effect of traffic congestion was felt greatest within the central business district. There were several reasons for the concern of escalating congestion in the 1970s. Besides the rapid growth in car ownership which meant that a higher proportion of people would be driving into the city, the city was also growing with many of the older structures giving way to tall commercial buildings. Undoubtedly, the higher plot ratios generated higher traffic rates. Furthermore, even though changes were being made on the road system, the road capacity within the city could not be significantly expanded because of old city layout.

Given the severity of the congestion problem in the city centre, an inter-ministerial committee known as the Road Transport Action Committee (RTAC) was set up in 1973 to coordinate the transport planning efforts and to formulate transport policies on managing the traffic demand, particularly within the city. The RTAC comprised permanent secretaries of several ministries, i.e., Finance, Home Affairs, National Development and Communications. Seah (1975) noted that the high level of representations in the RTAC reflected the government’s resolve in tackling the traffic problem in a coordinated manner. In studying the traffic problem, RTAC took into account public feedback as well as responses from specific interest groups.

Staggered work hours and car pools
Several measures were recommended by the RTAC. These included reducing the peak demands by encouraging staggered work hours and car pooling as well as discouraging the use of private transport into the city in favour of public transport.

The staggered work hours scheme was taken up in January 1974 with an experiment in which civil servants adopted different work reporting times. It was an attempt to lengthen the peak period from 2 to 3 hours. The impact of the civil service experiment on relieving peak hour traffic was found to be small because, it was reasoned, only 10% of the work force was in the civil service. To follow up on the civil service scheme, a 6-month National Campaign (Loke, etc., 1975) was launched in July 1974 to induce private sector employers to adopt flexible work hours. The scheme received some support with about 1140 firms adopting staggered work times by April 1975. This accounted for about half of the 120,000 workers that adjusted their reporting times. It was suggested that the staggered work hours had some limited success (Tan, 1979). However, despite some enthusiasm shown, not all firms or personnel could adopt flexible work hours. Moreover encouraging staggered work hours actually discouraged car pooling as the opportunities for forming car pools were reduced.

Car pooling as a means of reducing peak hour traffic demand was considered at the same time but the initial response to the scheme was rather cool. There were inherent problems which were difficult to resolve. Forming a suitable pool with sufficiently common reporting times as well as reasonably nearby origins and destinations was not easy to achieve. Distribution of cost, participants’ discipline on punctuality as well as vehicle insurance coverage were some of the problems faced. To facilitate car pooling, the Ministry of Communications set up a Car Pooling Management Unit (CPMU) in January 1975 to coordinate the formation of car pools and to recommend rates of financial compensation for the driver. At the end of the year, 1295 car pools were registered with CPMU. The role of CPMU diminished greatly with the introduction of the Area Licensing Scheme in mid 1975 as car pools were formed to gain exemption from paying the supplementary licence. Many of the passengers in car pools were bus commuters seeking a faster and perhaps free ride into the city rather than former drivers who had given up driving into the city. The car pool scheme was an early example to show that drivers and commuters are more sensitive to financial incentives than mere persuasion.

The rapid rise in traffic flow within the city, coupled with the exponential growth of car ownership led the RTAC to conclude that some form of restriction on traffic was necessary within the city. In considering various measures of limiting traffic, RTAC adopted several guiding principles: that a scheme should be easy to understand by the motorists, be enforceable without a cumbersome administrative structure, be effective in reducing peak hour traffic and be equitable to all users (OECD, 1988). Various forms of congestion pricing were considered and these included having toll roads and metered vehicles as well as area licensing and paying for parking.

Area Licensing Scheme
A vehicle restriction package involving an Area Licensing Scheme (ALS) and a Park-and-Ride System (PRS) was considered most suitable in maintaining accessibility and mobility within the city. The Motor Vehicles (Restricted Zone and
Area Licensing) Rules 1975, came into effect in June 1975. Under the scheme, an area of 620 hectares covering the Central Business District (CBD) was cordoned and declared a Restricted Zone (RZ) for private vehicles on weekdays from 7:30 to 9:30 am. Vehicles entering the RZ via the 27 entry points must either display a supplementary licence or carry at least 4 persons. Vehicles were manually inspected without stopping by police personnel as they entered the RZ.

To provide an alternative for driving into the CBD, the PRS was introduced for commuters to leave the cars outside the RZ at one of the 10 fringe car parks and transfer to shuttle buses into the city. Shuttle fares were set at 50 cents while the combined park-and-ride fare was $1.50 with monthly rates at $20 and $30 respectively. The PRS, however, was not received well. Motorists seeking alternatives of travel into the city chose to transfer to the trunk bus routes rather than opt for the PRS.

Being the first area licensing scheme in the world, many of the parameters of the system could not be worked out before hand. Consequently the authorities made several changes to the ALS system to achieve the desired results. These included changes in licence fees, operating hours and exemption conditions.

The multiple-entry daily licence was initially charged at $3 while the monthly licence at $60 for all private vehicles. To promote alternative modes of travel and to maintain commercial activity as well as facilitate emergency services, taxis, buses, motor-cycles, goods vehicles, police, military and fire vehicles were exempted from the restriction rule. Three weeks into the scheme, taxis not meeting the car pool criterion were charged like other private vehicles. In January 1976, 7 months into the scheme, the fees were increased to $4 for a daily licence and $80 for a monthly licence for all private vehicle including taxis. Together with changes in the tax structure, company cars were charged twice the rate of private cars for their licences from January 1976. Taxi licenses was subsequently reduced to half the rate of private cars in April 1977 following the reluctance of taxis to serve city-bound passengers. Further adjustments were made in March 1980 when the licence fees for private vehicles were raised to $5 per day or $100 per month (see Table 3).

There were also changes in operating hours. Initially, the operational period of the restricted zone was from 7:30 am to 9:30 am. Because a significant amount of vehicle trips shifted to the period immediately after 9:30 am resulting in a new peak, the restriction period was subsequently extended to 10:15 am. The RZ was also extended in February 1984 to include two more adjacent streets. Further changes in the ALS have taken place since 1989 and these will be discussed in the following section.

<table>
<thead>
<tr>
<th>Date introduced</th>
<th>Private cars Daily/Monthly</th>
<th>Taxis Daily/Monthly</th>
<th>Company cars Daily/Monthly</th>
<th>MC Daily/Monthly</th>
<th>Others Daily/Monthly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jun 1975</td>
<td>$3 / $60</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apr 1977</td>
<td>$4 / $80</td>
<td>$2 / $40</td>
<td>$8 / $160</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mar 1980</td>
<td>$5 / $100</td>
<td>$10 / $200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jul 1989§</td>
<td>$3 / $60</td>
<td>$6 / $120</td>
<td>$1 / $20</td>
<td>$3 / $60</td>
<td></td>
</tr>
</tbody>
</table>

§ From Jul 1989, the ALS has been changed to WALS, (see following section)

Under ALS restriction, the traffic flow during the operational period fell by 45% with a reduction of car trips of 76% (OECD, 1988) The proportion of car pools also increased to 45% of all cars entering the RZ. The shift in travel pattern was so significant that even after 5 years, the traffic flow into the RZ was still about 25% below the pre-ALS level, although goods vehicles had increased to more than 30% above pre-ALS values.

Parking controls
Along with the ALS, parking controls were applied to discourage trips by car especially work trips into the city. This was done in two ways: raising parking charges differentiated between CBD and non-CBD areas and imposing a charge on each lot owned by the private car park operators. To favour short-term parking and penalise long-term parking, a “step-up” fee structure was introduced in May 1975.
Within the CBD, parking charges were increased from 40 cents per hour to 50 cents for the first hour, $1 for the second hour and $2 for each subsequent hour. Outside the CBD, parking charges were at 40 cents per hour.

To normalise the charges between private car park and public car parks, a surcharge on private car park operators was imposed. This amounted to $20 per month per lot for car parks within the core area of the RZ and $10 per month for lots elsewhere in the RZ. However, the higher rates for long-term parking was shortly discontinued and parking charges of CBD lots during working hours were set at twice the level of non-CBD lots.

Traffic Engineering measures

In the 1970s, several traffic engineering measures were undertaken to improve traffic movements, particularly at congested intersections. Some of these measures were also designed to instill better driver discipline and promote safety on the road.

One of the simplest forms of engineering measure was the yellow box junction, introduced in the mid-1970s. During peak hours, under over-saturated conditions, queues spilled back beyond the upstream intersections and the junctions were used as temporary queuing space for vehicles with right of way. This queue became a barrier to the cross street traffic when the signal right-of-way changed and caused a reduction in the capacity of the junction. To overcome this, the junction area were marked by a yellow box to prohibit vehicles from queuing within the area even when they had the signal right-of-way. The innovative idea reduced the risk of a gridlock in the city.

Another congestion management measure was the reserved bus lanes introduced in February 1974 to operate during peak hours of the day. These bus lanes were only installed on kerb lanes of one-way streets and buses were given exclusive use from 7:30 am to 9:30 am and 4:30 pm to 7:00 pm on weekdays and from 7:30 am to 9:30 am and 11:30 am to 2:00 pm on Saturdays. Buses were allowed to use other lanes on the roads for overtaking. Initially some 16 km of bus lanes affecting 23 junctions were set up within the CBD. The success of bus lanes in the CBD led to the installation of another 15 km of bus lanes on dual carriageways outside the CBD. Travel time of buses were found to improve by 20 to 40% (Chin, etc., 1985). Other vehicles were found not to be adversely affected by the loss of a kerb lane to buses largely because alternative routes for other vehicles were opened simultaneously when the bus lanes came into effect.

In 1981, Singapore introduced computer control to coordinate the traffic signals within the city area. The system which was based on TRANSYT was one of the state-of-the-art signal optimisation packages then. It allowed pre-determined signal phases and timings to be changed at specific times of the day thereby giving the effect of being responsive to traffic demand. Initial studies showed that the average speeds of vehicles improved by more than 20% during the morning as well as evening peak period and by about 15% during the off peak period (Tan, etc., 1981).

Other traffic engineering measures include the conversion of roundabouts to signalised intersections. The unpopularity of roundabouts among Singapore’s transportation engineers has resulted in eliminating almost all roundabouts from the road network. Within the CBD, many two-way streets were also converted to one-way pairs to form clockwise loops for vehicle movements. This not only simplified the junction designs and improve junction safety but also facilitate the introduction of the bus-lanes. However, they tended to result in long travel distances and access distances to bus stops. Some 54 km of roads amounting to about 60% of roads in the central area were involved (Chew, 1982).

Public transport operations

In meeting the transport demands, the colonial government saw their function merely in the construction of roads and car parks. Public transport planning was left in the hands of a few private bus operators and the government’s role was mainly in vehicle licensing and even so checks on road worthiness of vehicles was in large measure perfunctory (Seah, 1975).

In the early years of self-rule, the government continued to allow the public transport service to be undertaken by private operators, concentrating only on controlling private vehicles. Consequently, while space was planned for car parks and road expansion, little considerations were given to waiting areas for bus passengers and buses (Tay, 1975). However, with economic growth, it became evident that there were serious inadequacies in the public transport system and that progress in other
sectors of development would be greatly impeded by the poor public transport service.

*Bus Services*

Arising from this concern, a study to look into the reorganisation of motor transport services in Singapore was made and this culminated in the release of a Government White Paper in 1970 (Singapore Parliament, 1970). Various problems of the bus operations associated with poor quality of service, inefficient management and lack of coordination were highlighted in the White Paper. To improve the overall public transport service, the 10 Chinese companies of varying fleet sizes were merged into 3 major bus companies with clear territorial dominance. At the same time, the bus network was revised along with a newly designed uniform fare structure for all 3 merged companies and the Singapore Traction Company (STC).

While the reorganisation did rationalise the service network and fares, there remained problems of staff management and fleet maintenance. The STC which was not affected by the physical reorganisation went into financial difficulties and eventually ceased operations because much of the concessions they previously enjoyed were removed when fares were standardised. Seah (1975, p.21) noted that “the failure of the STC prompted the government to give more thought to the future of bus transport”. To improve bus operation, the three remaining bus companies were further merged into the Singapore Bus Service (SBS) in November 1973.

Because some of the problems faced by the bus operators involved dissatisfaction of bus workers, the government also set up in October 1973 the Bus Service Reorganisation Committee (BSRC) with representatives from the workers, the owner operators and the government authorities. By carefully selecting the members of the committee, open conflicts between employers and employees of the bus company was avoided (Seah, 1975). This arrangement also helped the government in that measures taken by the authorities were more likely to enjoy greater success because support from the workers as well as the management was secured even before public announcements and implementation.

BSRC also instituted a crash programme of repairs for the ailing bus fleet inherited by SBS. This was aimed at reinstating broken-down buses back to service. Complaints against the operators as well as discipline of workers were also to be handled by the committee. Despite the intervention of the BSRC, many management shortcomings remained untackled. These problems arose because the new management of the company with the enlarged fleet size and personnel was still using management methods previously adopted for small bus companies. The deficiency in the SBS’s operation and management led the government to appoint a team of government officials to study the operations of SBS. Eventually some 100 civil servants, police officers and military personnel were seconded to SBS to revamp its operations. This resulted in dramatic improvements in productivity and profitability of the company (Tan, 1979).

Under the new management, SBS continued to improve its operations reducing costs as well as raising the quality of service. These included the introduction of air-conditioned coaches, semi-express services and one-man operated services. However, insufficient peak-hour capacity remained one of the major public transport problems in the 1970s and this was further aggravated by the mode shift of commuters from car when the Area Licensing Scheme was introduced.

To tackle the problem of inadequate capacity two supplementary public transport schemes were introduced in 1974. Scheme A was for licensed lorries, school buses and private hire buses under monthly contracts, to carry adult workers to and from their work places. Scheme B allowed licensed school buses and private hire buses to operate on routes parallel to the SBS routes during the peak hours. This was to increase the public transport capacity on major corridors for travel to and from the city. The success of Scheme B services saw the approval by the Registry of Vehicles (ROV) in July 1978 of 18 more services plying between the rural areas and the city to boost the number of routes to 45. ROV estimated that the combined fleet of 646 Scheme B vehicles of which 75% were school buses, carried nearly 40,000 passengers daily that year. At the same time, 1976 licences were given to Scheme A vehicles of which 1489 were school buses.

One way to ensure that SBS would not fall into inefficient operations as seen in many bus companies in developed countries was to introduce some competition. In March 1982 a second bus company, the Trans-Island Bus Service Pte Ltd (TIBS) was formed for that purpose. TIBS took over 12 routes from SBS, concentrating its
services in the northern sector of Singapore with an initial fleet of 250 vehicles. When TIBS started its operation in April 1983, it boasted itself of being the first to introduce a host of new features on for passenger safety and comfort its buses. The company made its mark quickly that by 1987, it had increased its fleet to 333 buses operating on 24 services (of which 5 were feeders) and carrying more than 0.2 million passengers a day. This performance is comparable to that of SBS with its 2,581 buses operated 225 bus routes and carried 2.2 million passengers per day in the same year.

Competition also led SBS and TIBS to consider many cost cutting measures such as the use of higher capacity double-decker buses, the introduction of feeder services in new towns and the conversion of many of their services to one-man operation.

To facilitate network planning, coordination and approval of reorganisation in bus routes as well as revision of fares for the two companies was handled by the Bus Service Licensing Authority of ROV. However with the advent of the Mass Rapid Transit System, the Public Transport Council (PTC) was formed in 1987 to look into fares and services provided by all road-based as well rail-based public transport operators.

**Taxi services**

One form of public transport service which was prevalent in the 1960s was the pirate taxis and school taxis. These were private, usually old vehicles used for transporting personnel without a taxi licence. It was estimated that in 1956, there were already 5,000 of such vehicles in operation. They were considered as competitors to and one of the woes of the early bus operators. Since they provided some form of employment as well as served as a supplement to the public transport system during the peak hour, the government had allowed to let them operate in the 1960s.

Prior to 1966, the government issued taxi licences to any individual or company that can operate a taxi. To encourage individual ownership rather than to allow the taxi service to be dominated by several rich fleet owners, a change was made to issue licences only to individuals (Seah, 1975). However, few taxi drivers were able to own taxis even though they had the vocational licences. Thus, in 1970, there were only 3,800 taxis but 13,500 vocational licences to operate the taxis.

To correct the unfortunate situation and to provide continuing employment opportunities for the former pirate taxi drivers, the NTUC Workers Co-operative Commonwealth For Transport Ltd (NTUC COMFORT) was formed in 1970 with a $13.5 million loan from the government. Members of the cooperative could take up vehicle loans allowing them a 4-year period to repay the loans. With this, taxi operations improved as drivers took personal interest in maintaining their own vehicles.

The taxi operators adopted different strategies to cope with the increasing taxi demand. In the 1970s, the rise in demand was met with larger fleet size but in the 1980s, use of radiophones was encouraged to reduce empty cruising times. In 1976, there were about 5,500 taxis with only a small percentage equipped with radiophones. Within five years, the number of taxis which by then were organised into 3 companies; NTUC Comfort, Yellow Top and Singapore Airport Bus Service, grew to 10,000 with only about 3000 equipped with radiophones. By 1990, the total number of taxis, managed by 5 taxi groups, grew slightly only to about 11,000 but the number using radiophones has gone up to nearly 6,000. Three revisions of surcharges for radiophone bookings had encouraged operators to provide radiophone services.

The fares of taxis were also adjusted a number times to deal with specific problems arising from the operation. To encourage the use of larger taxis, taxes on taxis were revised in August 1978 to a standard annual rate of $1100 and the ARF for taxis was reduced from $5000 to $2000 in January 1978. Taxi flag-down fares were also increased in 1979 by $0.20 while the cost of waiting in queues was adjusted from $0.20 per 8 minute to $0.20 per 4 minute to reduce demand on taxis. To encourage greater use of radiophones, a surcharge of $0.40 was allowed for all taxi bookings through radiophones in October 1980.

In October 1982, a $1 surcharge was allowed for trips originating from the CBD from 4 pm to 7 pm on Mondays to Fridays and 12 noon to 3 pm on Saturdays. This was to induce more taxis to serve the CBD area during those peak hours. Taxi fares were again revised in 1985 to cope with the high demand for taxis and to correct the deteriorating level of taxi service. The revised fare structure was a complicated one with a number of surcharges, for example, CBD surcharge of $1, midnight surcharge of 50% of metered fare for trips made between midnight and 6 am and luggage
surcharge for any luggage placed in the boot.

As the number of taxi trips increased, their contribution to congestion became pronounced. Consequently, the government decided to make the cost of taxi trips closer to that of private car trips. A hefty jump in diesel tax was imposed in 1988, amounting to a raise from $1,100 to $6,600 for newly registered taxis. To help existing taxis to bear the sudden increased burden, taxes was first set at $4,400 for one year and raised to $6,600 in the following year. Furthermore, to ensure that the income of the taxi drivers were not affected, an increase in flag-down fare by $0.20 was also approved.

Further increases in flag-down fares as well as distance-related fares with a higher surcharge of $2 on radiophone bookings were made in 1989. At the same time passenger and luggage surcharges were abolished to simplify the fare structure.

To deal with the imbalance between taxi supply and demand, attempts were made to allow sharing of taxis. In July 1980, the share-a-cab scheme was introduced on two routes between two new towns and the CBD during the peak hours from 6 am to 10 am, Mondays to Saturdays. Initially passengers were allowed to board only at the new towns. Subsequently, in May 1981, boarding along the route was allowed and passengers were allowed to bargain for the fares. The scheme was further modified to allow boarding and alighting at any point along the route between the new towns and the CBD. However, the scheme died a natural death largely because the scheme was not demand driven.

Mass Rapid Transit service
While SBS and TIBS were successful in providing inexpensive and reliable public transport services to the population, the need for a mass transit system to cater for future demand was always considered necessary since the first transport study in 1970. For a number of years, the question of whether and when to build a Mass Rapid Transit (MRT) system was raised. The important recommendation from the Mass Transit studies in 1974 and in 1976, conducted with assistance from United National Development Programme and the World Bank, were not sufficient to forced a decision from the government. In fact, alternatives to the rail-based system were considered towards the end of 1970s and this included a proposal by Hansen for an all-bus system (Hansen, 1980). However the all-bus system was not accepted following a Comprehensive Traffic Study in 1982 (Wilbur Smith and Associates, 1982) which confirmed the need for a MRT system.

Once the decision to have an MRT system is made, construction of the system was swiftly carried out from 1983 under the newly formed Mass Rapid Transit Corporation. The basic system was fully completed in 1990 at a project cost of $5 billion which was fully borne by the government. The basic system was made up of an east-west line and a north-south line with interchange facilities between the 2 lines at two stations in the central area. With a network of 67 km track and 42 stations of which 15 were underground, the system was designed to have 40% of the business and industrial areas as well as 30% of the residents within the catchment of the MRT.

To operate the system, the Singapore Mass Rapid Transit Ltd (SMRT) was set up as a private company in August 1987 with an authorised capital of $200 million and initial paid up capital of $150 million. The MRT network was opened in November 1987 serving five stations in the North-South line and by December that year, the 19 km of the route on the MRT system with 14 stations was in use.

To accommodate the change in travel pattern of the people, SBS abolished 22 bus services, adjusted the route of 75 other services and introduced 19 new services in 1988. At the same time, TIBS removed two services and rerouted 10 other services and added 6 new services to their network. The MRT services also affected 72 Scheme B buses forcing 13 of the bus routes to be relocated. There was also a reduction in the number of Scheme B routes from 43 to 37 in 1988.

ERA OF VISION-DRIVEN TRANSPORT PLANNING (1990s and beyond)
In the first 30 years of self-rule, the government of Singapore has developed the city state from an island plagued with serious socio-economic problems to a metropolis thriving with urban life. The concern of population growth has reversed from the threat of uncontrolled population explosion in the 1960s to one of potential declining growth in the 1990s. The population is becoming more educated and better trained. The nation has also made great economic strides emerging from one facing serious
problems of survival at the end of colonial rule to becoming one of the Asian economic tigers within less than 30 years of independence. These changes which influence the values of the people, have a great impact on individual’s mobility as well as expectation of the transport system.

Faced with a different set of problems encountered by its predecessors in the first 25 years of nationhood, the new generation of leaders which entered the government in the 1980s announced in 1990 a 25-year vision for the nation (Singapore Government, 1991). The vision covered all aspects of life in Singapore and promised to develop Singapore into “a tropical city of excellence” with “a world-class infrastructure and facilities”.

Strategic Transport Plans
In line with the overall vision of providing for a higher quality of living, the Ministry of National Development expounded the Revised Concept Plan (URA, 1991) to be implemented in three stages of physical development: up to Year 2000, to Year 2010 and to Year X projecting for a population of 4 million. In it was a Strategic Transport Plan aimed at broadly preserving and protecting those land required for domestic transport corridors. An improved transport system involving various modes of transportation to serve the transport needs of the citizens was given. Public transport is to be enhanced to become an attractive alternative to the car. The strategy is to extend the mass transport system to areas of intense developments. The MRT system serving the main corridors will be supplemented by the Light Rapid Transit (LRT) in less intense areas and passenger ferries along the coast. A network of expressways and semi-expressways will be developed along with the tunnel connections within the city area and bridge connections to the offshore islands. A network of segregated cycle routes is also planned together with pedestrian walkways to encourage the use of green modes of transportation.

The Concept Plan for Year 2000 envisaged the expansion of the expressway network including the completion of the second link with Malaysia and the completion of the Woodlands MRT line. With this, most of the island will be served by high-speed roads. Together with the MRT extension this will support residential and commercial developments in north and north-eastern sectors (Figure 1). A new downtown is also to be developed in the Marina area and served by a light rail/mono-rail system.

For the Year 2010, the expressway network within the island would be completed, the MRT network would be extended to the North east as well as to the airport in Changi and several LRT systems would be installed to complement the MRT system, including one terminating at the Amalgamated Jurong Island. The Concept Plan will allow further expansion of the north-eastern corridor (see Figure 2).

The vision for Year X is on the offshore developments in the East and South East. An MRT line will run along the reclaimed Long Island on the East Coast. Pulau Tekong and Pulau Ubin in the east safeguarded for recreational purposes will be linked to the reclaimed areas of Changi Bay by the MRT network (see Figure 3).

In response to the overall government’s master plan, the Public Works Department also published the road system and road transport policy for the future in a separate document in 1991 (PWD, 1991). It projected the completion of the Seletar and Kranji Expressways as well as the underground tunnels of the Central Expressway. The use of high-technology to combat transport problems was anticipated but apart from the anticipated Electronic Road Pricing system, it did not suggest any specific schemes for implementation.

Following its formation in September 1995, the Land Transport Authority (LTA) presented what is perhaps the most defined set of goals and action plan on land transport for Singapore to Year 2010. The White Paper (LTA, 1996) spelt out the mission of the LTA, the transport vision of Singapore, the operating philosophy of the vision and the short- and long-term initiatives to achieve a “world class land transport system” in Singapore.

Land Transport Authority
Established as a statutory board under the Ministry of Communications with the merger of four existing bodies: the Registry of Vehicles, Mass Rapid Transit Corporation, Roads and Transportation Division of the Public Works Department and the Land Transport Division of the Ministry of Communications, the LTA has the purpose of bringing together the various organisations involved in planning,
The objectives of the Land Transport Authority are:
(1) To deliver an effective land transport network that is integrated, efficient, cost effective and sustainable to meet the nation’s transport needs.
(2) To plan, develop and manage Singapore’s land transport system to support a quality environment while making optimal use of our transport resources and safeguarding the well-being of the travelling public.
(3) To develop and implement policies to encourage commuters to choose the most appropriate transport mode (Liew, 1996).

In the White Paper, LTA spelt out a number of initiatives to achieve a world-class transport system but four key areas of work to achieve the vision within 10 to 15 years were specifically highlighted:
(a) Integrating land use, town and transport planning,
(b) Expanding the road network and maximising its capacity,
(c) Managing demand of road usage through ownership and usage measures, and
(d) Providing quality public transport choices.

The White Paper crystallised the concepts of transport planning that was already in practice by Singapore planners since the late 1980s. It represented a more holistic approach to transport planning that is not only pro-active but more importantly, sustainable. When implemented, a better quality of life for all sectors of society is expected. The following sections present the development of the transport system in Singapore in the 1990s in line with the broad transport strategies set forth in the White Paper.

**Integrated transport system**
Singapore transport planners have always adopted an integral approach in planning. This lesson was learnt in the early years when inefficiencies were clearly manifested in poor coordination between different public transport operators, between different transport modes of service and between agencies involved in the decision making process. The solution adopted then was to put together working committees and regulatory authorities with representations from various affected bodies. Thus, the merging of the bus companies resulting in rationalisation of routes and fares was one form of integration that has proven to be successful.

Integration may be viewed in two aspects: integration of the transport system with the land use system and integration of operations within the transport system. The first is more akin to transport planning while the second to transport operations. Since travel is only a means to an end, it makes sense to integrate the transport system supporting travel with the land use system which gives the reason for the travel. At the same time, since movements within the transport system do not normally add value to purpose of the journey, it is also logical to minimise the inconvenience in travel by ensuring seamless travel from origin to destination.

**Integration between land use and transport planning**
Despite continuous schemes to reclaim land for developments, the scarcity of land resources remains one of Singapore’s most serious constraints on land use and transport planning. Out of the 640 km$^2$ of total land area, 12% are dedicated for roads and other facilities to support the road infrastructure. This is a sizeable proportion since only 13% is taken up for housing. This percentage is also comparable to major cities like Paris, Tokyo and Munich (Kenworthy, 1995). This may imply, therefore, that the limit of land utilisation for transport development may have been reached. Hence, spatial and transport planners will have to seek an integrated optimal balance in physical and transport developments in view of this constraint on land.

The need to integrate land use and transport planning expresses itself in the motivation to minimise the number and length of trips. Shorter trips tend also to be less dependent on cars. This strategy of integration to reduce trip lengths was employed by the early planners in the 1960s in designing housing estates in Singapore. To enable workers to live and work within the same estates, light industries which could be concentrated in “flatted factories” were located within housing estates. Primary and secondary schools were also built within close proximity of residential areas.

The Revised Concept Plan of 1991 adopted a “constellation concept” strategy of
setting up regional centres aimed at decentralising commercial activities (see Figure 1). Decentralisation is expected to result in a more uniform spatial distribution of traffic as well as a likely reduction in trip lengths. Four regional centres are planned at Tampines in the East, Seletar in the North East, Jurong East in the West and Woodlands in the North to relieve the activity load in the city centre. Each regional centre is expected to have developments with total gross floor areas of 1.5 million m² serving about 800,000 people. Smaller sub-regional centres are also planned near MRT stations.

For the transport system to be integrated with the land use developments, a hierarchical system with defined roles of each transport element must be designed. This will reduce the amount of inefficiency in transport supply and promote a more organised form of travel. For the public transport system, the MRT network is to serve the heavy transit corridors primarily for long-haul travel while the LRT will serve light corridors and provide feeder services to connect areas in housing estates to MRT stations. Scheduled buses are to provide comprehensive coverage of areas not served by the MRT and LRT. For the road network, a well-defined network of expressways and semi-expressways will serve as main corridors for efficient high-speed and high-capacity vehicular movements. In newer residential areas, roads for access will be calmed while arterial and major roads will serve as collectors to the road network.

Further integration can be achieved by encouraging high density developments at and around major transport nodes such as the MRT stations and bus interchanges. Integrating transport with developments is expected to benefit not only the commuters who will walk less in greater comfort and convenience but also the developments which will enjoy higher property values. A good mix of residential, industrial and commercial developments will also benefit the public transport providers because it will result in a more uniform traffic demand and hence a more economically sustainable system.

Following this strategy of integration, many of the future MRT and LRT stations will be constructed together with developments with high plot ratios. A good example of land use and transport integration is the new Dhoby Ghaut Station which will be developed together with a 10-storey and 6-storey retail and office tower blocks. The station will serve the North-South MRT line as well as the planned North-East MRT line and the future Marina LRT system. Expected to be completed by 2002, the station will have 5 underground levels with covered pedestrian links to nearby buildings and will handle a traffic of 22,000 people during the peak hour. It is planned to have commercial developments above half of the 15 stations on the North East line.

On the other hand, transport facilities will be integrated into the developments in future new town. The LRT systems in the new towns of Sengkang and Punggol 21 will be constructed in an integrated manner to maximise accessibility and to minimise intrusion to the residents. In Punggol 21 (Lim, 1996), most residential units will be designed to be within 300-metre walking distance from the nearest LRT stops and these connecting walkways will be sheltered to facilitate walking in all-weather conditions.

One excellent example of seamless transport system is the pedestrian network designed for the new Downtown (URA, 1996). This will be a comprehensive network of interconnected second-storey pedestrian links, underground walkways, covered ground-level walkways and travellators. The pedestrian network will be linked to the MRT stations in the downtown area.

Integration within transport network
The introduction of the MRT service provided a quantum increase in Singapore’s public transport capacity at the end of 1980s. To minimise overall wastage, it was necessary to redeploy transport resources on a national basis. Being more flexible in operations, naturally the bus services were the target of redeployment even though they had the major market share before the MRT era. One option was to allow the bus operators and SMRT to compete on a free-market basis. However, the government was concerned that this would lead to operators concentrating only on profitable routes and creating highly non-uniform levels of service. The adopted strategy which would be in the best interest to all was one of an integrated public transport system. This meant that the various transport operators must plan their system and market it as a single entity.

As in the 1970s when the merging of buses required government’s intervention, the
integration of the bus and MRT services saw the setting up in 1989, of a government inspired independent service company, Transit Link Pte Ltd to develop the integrated system for SBS, TIBS and SMRT. Four aspects of integration were identified: fare integration, information integration, physical integration and network integration.

Fare integration required a common ticketing system in the form of a common TransitLink farecard developed for use on all three public transport systems. To encourage commuters to use the farecards which had the advantage of cashless transactions, an incentive in the form of transfer rebates were offered to commuters transferring between MRT and buses. Fare integration was readily accepted as commuters saw the benefits of the scheme. One concern to the operators was the apportionment of revenue received from fare box. It was agreed that to encourage responsive deployment of resources, the apportionment of revenues be based on usage.

In promoting information integration, TransitLink put together in 1992, a common bus-MRT guide providing all the travel details of the public transport system including transfers between modes. Dissemination of integrated travel information was also implemented at MRT stations and bus stops as well as other strategic locations with high human activities. TransitLink also acts as a coordinated body for the public transport operators in that it handles all passenger enquiries, complaints and feedback.

In integrating physical facilities between the modes, TransitLink has recommended covered walkways and linkages to facilitate convenient and comfortable transfers between the MRT and other modes. Relocation of bus stops or taxi stands to minimise walking to and from MRT stations has also been proposed. To expedite the physical integration process, the government in 1993 approved $6 million to construct commuter facilities around 34 MRT stations. These include covered walkways, paved footpaths, overhead bridges, car and taxi lay-by as well as bicycle parks.

Network integration requires a fundamental evaluation of the role of MRT and buses in providing public transport services. In rationalising that the two modes would not compete but complement each other, the authorities decided that buses would be more suited for shorter haul journeys while MRT for long-haul corridor travel. At the onset, it was difficult to decide on the extent of the network restructuring needed. Eventually, the option of drastic restructuring was chosen and the entire bus network with 126 bus services were reorganised in 13 phases over a 2½ year period from January 1991. At the same time, 19 new services were added to the network.

Fong (1993) reported that the network integration has resulted in an all-round improvement in productivity of the operators as well as a better level of service for the commuters. Only 2.62% of the bus passengers suffered adversely due to the network integration. The integration also resulted in a drop in bus traffic into the CBD by about 20% thereby reducing city congestion. Furthermore, despite a 7% reduction in bus fleet, the bus companies reported increased profits from the fare box. The pre-tax profit from fares for SBS approximately doubled from $16.7 million in 1990 to $39 million in 1992 while TIBS enjoyed a corresponding increase from $6.4 million to $11.9 million. In the same period, MRT also reversed a fare pre-tax loss of $10.5 million to a profit of $10.4 million.

With the formation of LTA in 1995, the role of TransitLink has diminished, particularly in aspects related to physical and network integration. In fact, LTA in its role as the transport authority, is in a better position to integrate public transport services into the overall transport system. However, TransitLink as a service agent continues to represent the public transport service providers to the users.

Effective Demand Management
In August 1989, a Select Committee (Singapore Parliament, 1990) was appointment by the Parliament to obtain public comments on Singapore’s land transport policy. In particular, it was to examine various measures that were proposed to curb road usage and control vehicle population. Although the committee also examined aspects of public transport and road infrastructure supply, much of the report produced was on deriving suitable measures to limit car growth and usage.

The committee noted that the PARF system which was meant to keep the car population young had resulted in creating “a guaranteed minimum disposal value for a car at the end of 10 years.” Consequently, this has reduced the average capital cost of owning a car over the ten year period and in effect slowed down the depreciation
rate of cars. It recommended a scheme that would allow the full cost of ownership to be depreciated over the period of 10 years.

The committee also recommended the use of a quota system to supplement the usage measures so that car growth can be controlled more efficiently. Further, it suggested fine tuning the ALS, for example adjusting the restriction hours in the evening, to ensure that the desired impact of reduced road congestion could be achieved.

Following the report by the Select Committee, the government introduced several schemes involving the use of quotas to control vehicle population growth as well as the use of congestion pricing to limit vehicle usage on selected roads. These schemes are discussed below.

Controlling vehicle population growth
Changes to the PARF system was introduced in 1990 so that the terminal value of a car at the end of 10 years is pinned at 80% of the Open Market Value (OMV) at the point of registration. This rule was applicable to new car registrations. The PARF values of existing cars were fixed ranging from $9,200 to $49,300 depending on engine capacity. At the same time, tax charges of purchasing a new vehicle were left to market forces through the use of a quota system.

The idea of using a quota system to curb vehicle population growth was discussed even before the implementation of the ALS in 1975. Thomson (1978, p.292) noted that “the novel idea is that the government should decide upon a maximum number of cars to be owned on the island and should issue no more than that number of licences. Thus the market would see that the right of car ownership went to the highest bidders and the government would be free of any administrative burden other than the normal enforcement of licensing.”

This novel method was introduced in May 1990 as the Vehicle Quota System (VQS). The number of quotas is fixed by the government before hand for each quota year to keep the vehicle population growth rate at 3% in tandem with the growth in road capacity. Minor variations to the rate has been allowed, for example with changes in road pricing charges and taxes (see Table 4 for 1997 and 1998 projections).

A person wishing to register a vehicle must first obtain a Certificate of Entitlement (COE) through a bidding process that is conducted once a month. For the purpose of bidding, vehicles are classified into 7 categories:

1. Category 1: small cars, 2=medium cars, 3=Big cars, 4=Luxury cars, 5=Goods vehicles and buses, 6=Motorcycles, 7=Open (for all vehicles)

Table 4 Projected vehicle quotas for 1997 and 1998

<table>
<thead>
<tr>
<th>Vehicle category</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle Population (at 31Dec’96)</td>
<td>51,064</td>
<td>231,803</td>
<td>73,091</td>
<td>26,784</td>
<td>137,573</td>
<td>131,487</td>
<td>-</td>
<td>651,784</td>
</tr>
<tr>
<td>Annual 3% growth</td>
<td>1,531</td>
<td>6,954</td>
<td>2,193</td>
<td>804</td>
<td>4,127</td>
<td>3,945</td>
<td>-</td>
<td>19,554</td>
</tr>
<tr>
<td>Replacement for vehicle deregistration in 1996</td>
<td>383</td>
<td>4,475</td>
<td>1,237</td>
<td>485</td>
<td>4,433</td>
<td>3,806</td>
<td>4,934</td>
<td>19,733</td>
</tr>
<tr>
<td>Additional COEs</td>
<td>431</td>
<td>1,956</td>
<td>617</td>
<td>226</td>
<td>1,161</td>
<td>1,109</td>
<td>-</td>
<td>5,500</td>
</tr>
<tr>
<td>Expired COEs carried over from 1996</td>
<td>0</td>
<td>5</td>
<td>6</td>
<td>8</td>
<td>0</td>
<td>3</td>
<td>4</td>
<td>26</td>
</tr>
<tr>
<td>Total Quota for May 97 to April 98</td>
<td>2,345</td>
<td>13,390</td>
<td>4,033</td>
<td>1,523</td>
<td>9,721</td>
<td>8,864</td>
<td>4,938</td>
<td>44,813</td>
</tr>
<tr>
<td>Annual 3% Growth</td>
<td>1,584</td>
<td>7,080</td>
<td>2,346</td>
<td>883</td>
<td>4,260</td>
<td>4,033</td>
<td>-</td>
<td>20,186</td>
</tr>
<tr>
<td>Replacement (1997)</td>
<td>441</td>
<td>6,906</td>
<td>1,407</td>
<td>644</td>
<td>3,907</td>
<td>4,445</td>
<td>5,936</td>
<td>23,746</td>
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<tr>
<td>Total Quota for May ’98 to Apr 99</td>
<td>2025</td>
<td>13,986</td>
<td>3,753</td>
<td>1,527</td>
<td>8,227</td>
<td>8,478</td>
<td>5,936</td>
<td>43,932</td>
</tr>
</tbody>
</table>

(Source: LTA press releases, 1997, Singapore)
equivalent to half his bid and this can be done electronically through bank automated teller machines. All successful bidders within each category pay the lowest successful bid price of the category. The allotted COEs must be used to register the vehicles of the appropriate categories within 6 months of the bid. COEs are valid for a maximum period of ten years. A vehicle deregistered before the 10th year may obtain a pro-rated refund based on the original COE value. To extend the period of usage of the vehicle beyond the tenth year by another 10 years, another COE must be obtained and the price is governed by the prevailing quota premium, i.e., the average quota premium over the past 12 months. An intermediate 5-year extension will require a COE with half the prevailing quota premium.

COE prices rose rapidly from few hundred dollars in the first few months to around $50,000 in recent months (see Figure 4 for COE prices of category 2 and category 3 vehicles). Initially transfers of COE was allowed. However, accusations that motor dealers and speculators were profiteering from the transfers led the government to consider various measures to curb COE speculation. Measures include prohibiting motor vehicle distributors from bidding and making COE non-transferable.

The government (Mah, 1996a) acknowledged the unpopularity of the COE system “at the beginning” and despite disapproval from some quarters (SDP, 1995), the COE system has been considered the most effective means of controlling vehicle growth. The effectiveness in the COE scheme is seen in a freeze in taxes on new cars as well as road taxes for a number of years. In fact, a few months after the introduction of the COE scheme, the ARF of new cars were reduced twice in quick succession, from 175% ad valorem to 160% in November 1990 and further to 150% in February 1991.

The COE system has resulted in significantly increasing the cost of owning a car so that the car price per capita GDP rose from 2.7 in 1986 to 3.7 in 1991 and further to 4.7 in 1994 (LTA, 1996). Because of persistent criticism of the high cost of car ownership, the government has on many occasions explained the rationale of the scheme, citing the limitation of land space and the unacceptable condition of congestion-filled roads. Other methods of limiting car growth, such as allocation of ownership rights by need or by balloting were also examined but were considered to be inappropriate (Mah, 1996a). Pay-as-you-bid has been considered a more suitable alternative (Phang, 1993). Although the government is unconvinced of its advantages, this measure has not been ruled out as a means of fine tuning the existing COE bidding system (Liew, 1997).

To enable more people to own private cars for use outside congested periods, the Weekend Car (WEC) scheme was introduced in May 1991 as an interim measure until the implementation of Electronic Road Pricing (ERP). New registrations of a weekend car had only pay the prevailing quota premiums for a COE and would receive a further registration rebate up to a maximum of $17,000 and a reduction of road tax of 30%. It was planned that the rebate of later registrations be gradually reduced until the WEC scheme was replaced by ERP.

Distinguished from other vehicles by red licence plates sealed on to the chassis, weekend cars were allowed on the roads only during weekends and off-peak hours. A day licence had to be displayed if the cars were driven during the restricted hours (7:00 am to 7:00 pm on Monday to Friday and 7:00 am to 3:00 pm on Saturday). Each weekend car was allowed 5 free licences but additional licences could be purchased at a cost of $20 each. A high penalty was imposed on those who abuse the WEC scheme. First offenders found driving the car during the restricted hours without a licence were fined an amount of at least half the annual road tax while repeat offenders were fined up to the full annual road tax amount.

Because the cost of daily licences was the same for all categories of cars, larger cars with higher road tax rates benefited more from the scheme. Consequently, the government introduced the Off-peak car (OPC) scheme in September 1994 to replace the WEC scheme. A permanent feature to remain even after ERP, the OPC scheme operates under the conditions as WEC scheme. However, an OPC requires a COE premium similar to that of a normal car and is given a fixed tax rebate of $17,000 together with a fixed annual road tax discount of $800 subject to a minimum tax of $50.

During the interim period, before the remaining weekend cars were phased out, road tax discount was fixed for all categories of weekend cars. The annual road tax discount was fixed at $1,500 for the year from September 1994 but progressively
In recent years, the rationale for taxing vehicles is also being reviewed. This arises from the basic premise that vehicles should be taxed for their use of the road. Such a usage may be evaluated on the basis of contribution to traffic congestion or contribution to structural damage to the pavement. In the latter, the contribution of goods and heavy vehicles will no doubt be many times that of cars or two-wheelers. On the other hand, in assessing the contribution to traffic congestion, an appropriate measure of the vehicle’s use of road space must be determined. Where the space is used for storage, as in a car park, then taxation can be based on the physical dimension of the vehicles. If the space is based on capacity considerations, the use of passenger car equivalents can be a useful method of normalising the various vehicle types. However, the passenger car equivalents even for the same class of vehicles, may vary under different road conditions and vehicle manoeuvres, a simple conversion for the purpose of taxation may not be so straightforward. The government is currently evaluating the possibility of using passenger car equivalents to derive the road tax structure.

Controlling vehicle usage

The White Paper indicated that the ownership cost is about 60% to 70% of the total cost of operating a car in Singapore. Having incurred a high upfront cost of acquiring a car, Singaporeans tend to use the cars extensively because of the relatively lower cost of usage. The annual mileage of cars in Singapore in 1991 was 18,600 km. By international standards, this is a very high considering the fact that the size of Singapore is only 640 km².

While the 1975 ALS has been successful in dealing with the problem of congestion within the city, albeit with regular adjustments of the ALS fees, traffic into the city was increasing gradually. Traffic speed within the city was also deteriorating, particularly during the evening peak and along the ring roads. Goods vehicles and motorcycles which were exempted from ALS charges were entering the restricted zone (RZ) in larger numbers. The average speed in some areas of the city dropped from 30 km/h to 19 km/h. Consequently, the government announced in June 1989 a fundamental change in the ALS and this was followed by a series of further changes in the 1990s to move the pricing mechanism towards ERP.

Several changes were introduced in 1989. First, all vehicles including car pools and motorcycles, but with the exception scheduled public buses and emergency vehicles, were subjected to ALS charges. The charges for taxis and goods vehicles were made similar to private vehicles at $3 while motorcycles were charged $1 for the licence (see Table 4). Company cars continue to pay twice the private car rate. The restricted period was extended also to include the evening peak from 4:30 pm to 7:00 pm, Monday to Friday. Although it is logical to charge vehicles leaving the CBD during the evening period, logistical problems dictate that licences be inspected on entry into rather than exit from the RZ during the hours of restriction. Because the scheme inconvenienced those motorists returning home in the RZ, the evening restricted hours were subsequently shortened to end at 6:30 pm.

The rationale for charging all vehicles is that regardless of size, type or vehicle occupancy, all vehicles contribute to congestion on the road. In all probability, this change was a move towards charging all vehicles under the ERP since it would be difficult, for example, to detect the number of passengers in a vehicle even under camera surveillance.

The effect of the evening restriction was dramatic with evening inbound traffic dropping by 47% during the hours of restriction (Lew, 1996). However inbound traffic within 30 minutes after the restricted hours increased by 13%. The lower ALS charges on cars saw an increase in car flow by 10% in the morning restricted hours and this could have been higher if not for the removal of exemption in car pools. The effect of the new scheme was most significant on motorcycles and heavy vehicles; their flow falling by a range of 46% to 61% in both the morning and evening peaks.

In January 1994, because of substantial increase in traffic during the off peak when the ALS was not in operation, the Whole-day Area Licensing Scheme (WALS) was implemented. In this a two-tier fee structure was introduced. Vehicles entering the RZ during the peak times from 7:30 am to 10:15 am and 4:30 pm to 6:30 pm were charged at a higher rate stipulated by the Whole-day licence (WDL) while vehicles between the peaks, i.e., from 10:15 am to 4:30 pm were charged a lower rate requiring only a Part-day licence (PDL) (see Tables 4 and 5). As the licences are for
multiple entries, holders of WDL were allowed entry during the between-peak period. In introducing the WALS, the stage is set closer to the implementation of ERP when charges can be adjusted according to time of day to regulate the flow according to the varying traffic demand.

Table 5  Current WALS operational hours

<table>
<thead>
<tr>
<th>Day</th>
<th>Whole-Day ALS</th>
<th>Part-Day ALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mondays to Fridays</td>
<td>7:30 am - 7:00 pm</td>
<td>9:30 am - 4:30 pm</td>
</tr>
<tr>
<td>Saturdays and eve of 5</td>
<td>7:30 am - 2:00 pm</td>
<td>9:30 am - 2:00 pm</td>
</tr>
<tr>
<td>holidays</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sundays / public holidays</td>
<td>Not in operation</td>
<td>Not in operation</td>
</tr>
</tbody>
</table>

(Source: LTA Annual Report, 1997, Singapore)

The WALS resulted in the smoothening the traffic peaks. Traffic flow of the different types of vehicles dropped significantly by a range of 16% to 32%. The small differential in cost between the WDL and PDL resulted in an increase in morning traffic by 12% (Lew, 1996).

When the stretch of East Coast Parkway (ECP) leading into the RZ was getting congestion in the morning, the government decided to experiment with a manual Road Pricing Scheme (RPS) in June 1995. Under the pilot scheme, westbound vehicles on the ECP, whether their destinations were in the CBD or not were subjected to a road charge of $1 for cars and $0.50 for motorcycles from 7:30 to 8:30 am on Mondays to Fridays. No additional charge was required for vehicles with the ALS permits.

While the ALS and WALS were based on the concept of cordon charging, RPS was closer to point charging and therefore it is yet another step nearer to imposition of ERP. Although the RPS licence allowed multiple passing, the short duration in the operating hours meant that effectively most licences were for single passing.

The imposition of RPS on ECP resulted in a reduction of traffic during the restricted period by more than 40% but an increase of 80% half an hour before the restricted period and 34% half an hour after. Traffic flows also diverted to alternative routes. The RPS showed that even with a $1 price differential, traffic shifted significantly in time and then in space (alternative routes). Shifts to more efficient modes had not been significant.

The RPS was further extended to two other expressways, PIE and CTE in May 1997 with the restricted hours lengthened to 2 hours lasting from 7:30 am to 9:30 am. At the same time, the WALS hours were extended by ½ hour to end at 7:00 pm. Motorists with the WDL now pay $2 for the RPS while motorcycles pay $0.70 (see Table 6). To offset the increase in road usage charges, a rebate amounting to $10 for WEC and OPC, $20 for motorcycles and $60 for normal cars and other vehicles were given for 1997.

Table 6  ALS/RP charges

<table>
<thead>
<tr>
<th></th>
<th>MC &amp; Scooter</th>
<th>Q plate</th>
<th>All others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common Part-day ALS / RPS Daily / Monthly</td>
<td>$0.70 / $14</td>
<td>$4.00 / $80</td>
<td>$2.00 / $40</td>
</tr>
<tr>
<td>Common Whole-Day ALS / RPS Daily / Monthly</td>
<td>$1.00 / $20</td>
<td>$6.00 / $120</td>
<td>$3.00 / $60</td>
</tr>
<tr>
<td>RPS only Daily / Monthly</td>
<td>Use Common Licence</td>
<td>$2.00 / $40</td>
<td>Use Common Licence</td>
</tr>
</tbody>
</table>

(Source: LTA Annual Report, 1997, Singapore)

The charges imposed on the 3 expressways had a serious impact on residents in the eastern and north eastern sectors. Effectively there were no alternatives on the expressways for those heading south or west. A number of measures were taken to ensure good alternatives of travel were provided. Four new express bus services were introduced by SBS and TIBS from new towns in the north east and east. On the first day of the RPS, more than 1,100 commuters took the buses. At the same time, information on the availability of some 29 car parks near MRT stations were distributed widely to induce commuters to consider park and ride.

The lack of alternative routes and the unwillingness of many motorists to give up
A week into the RPS, traffic volume during the two hours of restriction was 27% lower on the PIE and 10% lower on the ECP but without much reduction on the CTE. Some motorists expressed frustration that having paid the toll, they had not enjoyed a congestion free ride on the CTE. To deal with the congestion situation on CTE, the RPS at CTE was further modified in July 1997. Another gantry point was added on one of the on-ramps to plug entry flows onto the expressway and motorists using the CTE with WDL were no longer exempted from the RPS fees. The results were more satisfactory. At the end of July it was found that about 7000 motorists had switched to alternative routes on the surface streets, while others have travelled at time outside the restricted hours or have car pooled or shifted to public transport. An increase of 40% in ridership on the express buses were reported (Lew, 1996).

Electronic Road Pricing
The ALS and RPS systems are labour intensive as they make use of station personnel to inspect vehicles passing the gantry points. The toll charges enforced manually are also not flexible enough to regulate traffic demand or to prohibit multiple crossings. ERP do not have these problems.

Considerations for an ERP system began in 1990 when 8 international companies were invited to develop an ERP for Singapore. A second tender was made in 1992 and eventually 3 consortium were awarded $1 million to develop a prototype system. Intensive tests were conducted from 1994 to 1995 to evaluate the systems developed. Finally a Japan-Singapore consortium led by Philips Singapore was awarded the contract to develop the $197 million system with a 5-year maintenance cost of $39 million.

The ERP system has three components: the In-vehicle units (IU), the charge point equipment at the roadside and a remote central computer system. The IUs are to be installed and made tamper-proof in all vehicles from September 1997 onwards. Foreign vehicles may either install permanent IUs as in local vehicles or mount detachable battery-powered IUs. An ordinary stored-value cash card must be inserted into the IU before the vehicle can drive on ERP roads during ERP operation hours.

At each ERP charge point are two overhead gantries both equipped with antennas, vehicle detectors and enforcement cameras. When a vehicle passes the first gantry, the antennas will interrogate the IU in the vehicle to verify its validity (e.g. vehicle type) and deduct the appropriate ERP charge from the stored value card. Various equipment will present information to the driver about the transaction. Illegal crossings will be photographed as the vehicle crosses the second gantry.

It was announced that ERP will be implemented in March 1998 and for the first two years or so, the area under the scheme will be the CBD currently under ALS and the 3 expressways already under RPS. The introduction of ERP will result in a more balance ratio of ownership cost to usage cost. It is expected that the current ownership to usage cost ratio of 70:30 will eventually be made closer to 50:50.

The government is expected also to make adjustments to the other taxes when ERP is implemented. In an attempt to squash suggestions that ERP scheme is designed to generate revenue, the government promised motorists rebates on road taxes for 5 years following the introduction of ERP. A higher number of vehicle quotas may also be released. Taxis which will be most affected by the ERP because the system charges for each passing may have lower ERP charges initially but are encouraged to use advanced technology fleet management systems to minimise empty cruising. The explanation for the rationale of the pricing system and the measures to reduce adverse impacts are likely to be served to the public at regular intervals in the run up to the implementation date.

Quality public transport system
Currently, of the 7 million trips made daily, about 5 million are public transport trips with 3.1 million on buses, 0.9 million on MRT and 0.9 million on taxis (Liew, 1997). Clearly, with the strategy of limiting car growth while not stifling travel, the only way for any transport plan to succeed is to promote public transport as the main mode of travel. Already Singapore’s public transport split is high compared to many cities in Europe and U.S. (Phang, 1997).

When the MRT system was opened in 1988, Singaporeans experienced a new mode of public transport that was previously unmatched in convenience, comfort and
Reliability. Rail transport is considered the way ahead to move large numbers of people at high speeds in a comfortable environment with a minimal utilisation of land, whether under or above ground (Mah, 1996a). Bus travel as well as taxi service have also improved significantly since the 1970s so much so that a quality public transport service with inexpensive fares has been taken for granted. It is against this rising commuter expectations that planning in the public transport service is to be undertaken.

Commuters evaluate the performance of the public transport service based on a number of service indicators such as economy, reliability, comfort, convenience and safety. The closer the gap between the service provided by public transport and private transport, the higher the likelihood of success in the public transport policy. Performance of public transport services, including the regulation of Scheme A and Scheme B supplementary services, is monitored by the Public Transport Council (PTC).

Public transport provision
By 1990, the MRT, SBS and TIBS together with supplementary bus schemes have formed a reliable and efficient public transport service for the Singapore commuters. To build the public transport system to a world-class status, a wider variety of transport modes and an increase carrying capacity must be provided. This section lists the spectrum of services that has been provided in the last few years.

With the completion of the Woodlands Line in February 1995, the MRT system has a total route length of 83 km, of which 19 km are underground, 3.8 km at ground and 60.2 km above ground. The network now has 48 stations, 15 of which are underground and 1 at ground level. SMRT operates a fleet of 85 trains, each with 372 seats and a maximum passenger capacity of 1920. Further expansion in the MRT network is expected in the next few years.

Scheduled buses are provided by SBS and TIBS and peak period capacities are boosted with Supplementary Scheme A and Scheme B bus services. Currently, SBS has more than 2400 buses operating on more than 200 routes which together carry about 2.5 million passengers per day. TIBS has a fleet of some 600 buses running on 45 routes, about 0.6 million passengers a day.

There are also shuttle bus services between private housing estates and MRT stations, between work pick-up points and MRT stations as well as shuttles with small communities such as university campuses.

Up-market semi-express bus services plying between private/public housing estates and the CBD have been in operation for several years. Currently, 3 companies provide such services, Bus-Plus Services Pte Ltd which is a subsidiary of TIBS, General Cars Rental Pte Ltd and SBS Leisure Pte Ltd under SBS management. Bus-Plus started in 1994 as a joint venture between TIBS and SMRT to provide scheduled, maxi-cab and chartered services. With a fleet of 45, its 14-seater buses provide more comfortable and pleasurable travel than the regular buses. SBS Leisure started operation in 1992 and provide specialised premium scheduled bus services particularly for the leisure business. Today, it has 4 coach services, one to the resort island of Sentosa and three Airbus services to the airport.

There are currently nearly 17,000 taxis, an increase of nearly 70% since 1990. They are operated by 4 taxi companies: NTUC Comfort, Yellow Top, TIBS Taxi Pte Ltd which entered the taxi market in 1990 and CityCabs which was a 1995-merger of the 3 previous companies: Singapore Commuter, Singapore Airport Bus Service Pte Ltd and SBS taxi service. The provision of 5.9 taxis per 1000 population and the utilisation of 53 trips per day are among the highest in the world.

To cater to a wider range of customers, a premier class of taxis was created. In 1995, TIBS introduced their TibsClassic to provide a higher level of comfort, convenience and reliability to customers willing to pay more both for fares and other surcharges. The higher quality of service includes a guarantee of taxi arrival for pickup within 15 minutes and the availability of choice music as well as newspapers and magazines within the taxi. CityCab also introduced a similar service at the end of 1996.

Public transport service standards
PTC has specified a set of standards for all public transport operators since November 1994 (Mah, 1994). These include aspects of route planning and design, service efficiency, hours of operations, affordability and service information. In route planning and design, PTC requires that major housing estates be provided with direct connections by either MRT and/or bus services to 3 major CBD corridors.
specified as Orchard Road (shopping area), Shenton Way (commercial area) and Chinatown. Furthermore, at least 95% of the trips are not to involve more than 1 transfer, with the exception of feeder connections. Bus stops are to be located no more than 400 m apart and sited within 150 m of MRT stations and major transfer interchanges. Long bus routes are discouraged so that no more than 20% of the services are to have round trip distances above 50 km and no more than 5% are to exceed 60 km.

In terms of service efficiency, PTC (1995) stipulates that no more than 70% of the trunk bus services are to have departure headways from terminals exceeding 10 minutes in the morning peak while the corresponding figure in the evening peak is 80%. Furthermore, no bus is allowed to have design peak hour load of more than 100%. Bus operators operating regular scheduled services must ensure that the first residential service must start before 6 am and that the last feeder service must not commence before midnight. For comfort, no less than 60% of the buses in the bus fleet must be air-conditioned. Furthermore, services with more than 12 minute peak headways and operating with non air-conditioned buses must schedule at least two air-conditioned buses between non air-conditioned buses. Standards on service information include requirements for display signs, telephone information assistance during periods of bus operations, route information at bus interchanges and major bus stops, headway information and time-tables for services with long headways (exceeding 15 minutes).

In an audit of bus operations in 1996, compliance to these standards were found to be generally good (PTC, 1996). This in part is because many of them are related to design standards which are easier to control. However bus operators have difficulties meeting operational standards that deal with headway adherence particularly during the peak hours. It was found that only 63% of services could maintain departure headways from terminals within 10 minutes. While 94 % of the trunk services adhered to the schedule during the off-peak, only 88% and 59% adhered to the schedule in the morning and evening peak respectively.

A similar performance scheme has also been set up for taxi operations (Mah, 1996b). This is aimed at motivating taxi companies to provide better taxi services through better management of their taxi fleet and hirers. However, these are less detailed the bus standards. Performance is measured based on 5 indicators pertaining to different operational and service aspects of the taxi companies. These are the daily engaged mileage per taxi, the utilisation rate of taxis, the taxi accident rates, the taxi radiophone despatch capability and complaint numbers. Two half-yearly evaluations have been carried out by LTA since mid-1996. The exercise which results in some competition among the various taxi operators, has prompted the taxi companies to improve their operations and focus on providing quality service. Some of the actions taken include the setting up safe driving programmes, offering financial incentives to safe drivers and investments in communications system to facilitate taxi bookings.

**Public transport fares**

PTC also regulates all public transport fares. Application for fare adjustments with justifications are initiated by public transport operators. The council, whose members include the transport operators, then deliberate on the application and has the option to approve none, some or all of the adjustments requested. Reasons for previous fare adjustments included higher operating costs, declining operator incomes and matching demand to supply, particularly for taxi services.

Since its formation, PTC has approved public transport fares several times. In recent years, bus and MRT fares were adjusted in October 1995 and June 1997 while taxi fares were revised in December 1995 and May 1996.

Flag-down taxi fares were increased in 1988 from $1.60 to $1.80. In 1995, the average MRT fare went up by 5 cents with the maximum single trip fare increasing by 10 cents to $1.60. In May 1996, a $0.50 peak period surcharge was further added to match commuters’ demand for taxis with taxi supply during the peak period.

In the latest round of fare revision, PTC (1997) introduced a formula for future fare adjustments to be implemented with effect from 1998. The purpose is to allow smaller incremental adjustment of fares rather than infrequent quantum increases. The fare increases allowed each year is to be capped to a certain percentage X above the Consumer Price Index. The small percentage X is to account for the various cost factors although further allowance for external conditions such as changes in fuel price can be made. Based on the trends of the last three years, X has been set at 2% until the turn of the century.
Compared to many developing cities, the cost of public transport to the commuters is low, especially when one takes into account the high quality of service provided. A recent comparative study (Kwok, 1996) showed that a 20-km journey in Singapore from Yishun to Raffles Place on an MRT costs $1.40 while the equivalent journey in Hong Kong from Tai Po to Tsim Sha Tsui costs $2.27. The same journey by bus costs $1.40 in Singapore but $1.55 in Hong Kong. In a comparison between taxi fares of 9 cities (LTA, 1996), the $4.90 fare paid for a 6.9 km journey in Singapore was the third lowest, with Hong Kong 1.5 times as much. However, unlike many cities, there are other charges associated with taxi fares in Singapore; CBD surcharge, airport surcharge and early morning surcharge. Nevertheless, taking into account the extremely high cost of travel by car, taxi fares can be considered to be comparatively low. Moreover, commuters are protected against indiscriminate rise in public transport fares since all fare adjustments must be approved by PTC.

Public transport reliability
A number of measures have been introduced to promote reliability of public transport services. Better despatch systems for taxis and vehicle location systems using global positioning satellites to locate taxis have been used in recent years to better manage vehicles in meeting customer demand. GPS systems which provide passenger information, such as bus arrival times have also been explored. In an attempt to provide better despatch facilities to the commuters, NTUC Comfort revamped the radio booking system at a cost of $600,000 in 1990 and equipped some 3,500 of its taxis with dial-a-cab system. The cost of the installing such systems and the operating cost is high for smaller operators. Because of this, the three smaller taxis operators (Singapore Commuter, Singapore Bus Service and Singapore Airport Bus Service) merged to form CityCab Pte Ltd, and as a result was able not only to provide a higher quality of service in booking but also to present a better corporate image.

In October 1995, the newly formed CityCabs under SBS management became the first operator in Singapore to have a vehicle location and despatch system for its 3,760 taxis at a cost of $20 million. With its CityNet system, it was claimed that commuter booking and despatch could be processed within 30 seconds from the usual 5 minutes when radiophones were used. The automatic tracking feature of CityNet also helped CityCabs to manage its fleet better. In quick succession, TIBS launched its vehicle location and despatch system called SkyTrek at a cost of $4 million in November 1995. As in CityNet, SkyTrek combines interactive voice response, satellite tracking of taxis using differential global positioning system and wireless data communication with a computerized despatch system. Requests for taxis, whether through a telephone, a computer dial up to the TIBS Taxi Control Centre or remote booking terminals at hotels or shopping centres, are automatically routed to the taxi nearest the call.

NTUC Comfort also computerised their despatch system to use satellite tracking on 8,000 of its taxis at a cost of $22 million. The system, Cablink allows 5 ways of booking: telephone using an interactive voice response system, a taxi order terminal, a computer modem, a fax machine or operator assisted system. The advantages promoted include faster response and waiting times. On the whole, it took the new technology for booking and vehicle despatch some time to gain popularity. Many passengers felt more comfortable with the radiophone service. To induce more taxi drivers to use the system, the taxi companies have reduced its charges on taxi passengers as well as the taxi owners.

The bus operators also made use of new technologies to improve their productivity. In September 1997, SBS launched the SBS OnTime pilot project for one of the routes at a cost of $9.5 million. The project provides all buses on the route each with an on-board computer, satellite receiver, radio transceiver and driver display unit to provide two-way communications between the driver and the control centre on the bus locations. The system allows the drivers to check whether they are travelling according to schedule and to provide the control centre with information on the operating status of the bus such as its location and condition of breakdown. Through the system, information on projected arrival times of buses are also displayed at bus stops. SBS intends to integrate the OnTime system with SBS crew and bus scheduling systems to better manage the vehicle fleet.

Another way of enhancing reliability is to ensure that buses are protected from congestion effect on the road. Along several stretches of congested roads with reserved bus lanes, traffic signals have been redesigned to allow buses to be
discharged from intersections ahead of other vehicles. Known as “B” signals, the system detects the arrival of buses approaching the intersection and gives a 8-second leading green to the bus movements. At the same time, to discourage other vehicles from using the bus lanes, some of the buses are equipped with surveillance cameras to photograph vehicles illegally using the bus lanes.

**Intelligent transport systems**

Intelligent systems have been increasingly used to maximise transport capacity as well as improve travel convenience and safety. Increasing capacity, whether on the road network or public transport network can be done by manipulating the system to minimise instances of operational inefficiencies, for example by dynamically adjusting transport supply to changing demand. On the other hand, intelligent systems can be used to provide quick and reliable information to transport users to facilitate decision making. Safety of transport systems has also been enhanced by automated control systems as well as surveillance and early warning systems.

The Singapore transport system has kept in tandem with developments in advanced technologies. Intelligent systems have been progressively employed in managing traffic on the road network as well as provide a higher level of service to the public transport user. Plans are being made to integrate these systems into an integrated Intelligent Transportation Management System (ITMS) for the general user. This section discusses the use of intelligent systems on the road network and the future ITMS.

**Intelligent systems used on road networks**

The use of TRANSYT to determine signal timings for intersections within the central area did brought improvements to the traffic conditions. However, one of the difficulties with TRANSYT’s fixed time plans was that the plans must be updated regularly so that the system can respond to the changing needs. To overcome such problems, a system that can respond more dynamically to changes in traffic demand was sought.

In 1988, a traffic responsive system named Green Link Determining System (GLIDE) was implemented. This was based on the traffic control system called the Sydney Coordinated Area Traffic (SCAT) system. GLIDE monitored traffic demand continuously, adjusting signal timings in real time. Working on a hierarchy system, traffic information received from individual inductive-loop vehicle detectors located from lane-by-lane stop lines are transmitted to the local controllers at each intersection and pre-processed before they are conveyed via telephone lines to the regional computers and subsequently to a central computer. The regional computer coordinates the signals and determines the optimal signal timings of the signal group while the local controller further adjusts the signal splits and stages according to the traffic demand at the intersection. The system is able to detect local congestion build up, for example due to an accident, and to adjust the control strategy to relieve the congestion. By 1996, the system was completed with 14 regional computers controlling all 1370 signalised intersections in Singapore.

When the Central Expressway (CTE) was constructed in 1991, an advisory system providing information on traffic conditions to motorists was installed within the two tunnels. The system monitors traffic flows on different sections of the tunnels using loop detectors and allows operators to identify the occurrence of incidents early. Using variable message signs, it then advises motorists heading towards the affected section on the best courses of action. Recovery crews are also alerted at an early stage of an incident to minimise the duration of the blockage in the tunnels. The effectiveness of the system has been assessed by comparing recovery times of incidents in CTE with those elsewhere not under any surveillance system (Sing & Parakasam, 1996). In 1995, 97% of the 2,433 incidents occurring in the CTE tunnels were detected within 15 minutes and 88% were cleared within 15 minutes. On average the traffic situation returned to normal within 14 minutes for the CTE as compared to more than an hour elsewhere.

In 1996, an automated version of the traffic and monitoring system, known as Expressway Monitoring and Advisory System (EMAS) was progressively installed along the CTE. To be completed in December 1997, at a cost of $9.5 million, the system receives video images from 48 detection cameras placed at about 500 m interval along the entire expressway. Incidents and queue formation are automatically identified from the video images through a set of incident detection algorithms. Once incidents are detected, operators in the control room may verify this through one of the 12 surveillance cameras along the expressway and transmit warning messages on variable message sign boards or broadcasting media to the
motorists. The traffic police, the GLIDE control centre and agencies involved in vehicle recovery are also informed. LTA plans to bring all expressways under EMAS within the next 5 years.

In July 1995, LTA implemented an Automatic Network Travel Time System (ANTTS) along Toa Payoh Lor 1 to Thomson/Balestier Road Junction as a trial project. Integrated with the GLIDE system, it collects travel time information from tagged vehicles (mainly buses) on the stretch of road. By identifying tagged vehicles coming within 50 m of the detectors which located in the signal controller at intersections, travel time information along various links can be computed and disseminated to the road users through various media. Various means of information dissemination are currently being explored.

Intelligent Transportation Management System
In September 1997, the government announced plans to develop an integrated Traffic Management System that will bring together various IT systems used in land transport applications. The system is to be developed jointly with the National Computer Board. Real-time traffic information of the transport network (such as flow levels and network abnormalities) may come from systems maintained by LTA, for example, EMAS, ERP and GLIDE and other information systems related to environment, road works and utility. Service and other travel information (such as arrival times of buses) may also be input from independent control systems of public transport operators such as the vehicle location systems of taxis and buses. The integrated data will be transmitted to passengers and road users who require real-time information on availability of modes, parking spaces, congestion of routes to make informed travel decisions. Such data needed for route planning are to be displayed at bus stops or interchanges or in terminals at shopping areas or may be posted on the Internet and other communication networks. Data from the ITMS will also be fed into the various control systems, such as SMRT and LRT control centres, GLIDE and ERP controls so that responsive transport supply can be provided in real time. Aggregated data may also be used for planning purposes among freight operators, public transport providers and land use planners.

Infrastructure expansion
While it has been well established that expanding road capacity alone will not solve the problem of congestion but rather create adverse impacts on the environment, it is not prudent to have a transport policy which does not include some amount of infrastructure expansion for both road and mass transit travel. In the Transport Plan up to year 2000, infrastructure projects include the extension of MRT lines, introduction of new LRT systems as well as construction of expressways and multi-tier intersections.

Road network
The road network in Singapore has grown from about 6,800 lane-km ten years ago to nearly 8,000 lane-km today. The island is also better served by an extended expressway network with the recently completed Tampines Expressway (TPE) and Kranji Expressway (KJE) and a section of Seletar Expressway (SLE). A number of major interchanges has also been completed. These include two 3-tier interchanges along the outer ring road of Adam and Farrer Road.

In the next 5 years, LTA has committed to spend $3 billion on road infrastructure projects of which $1.1 billion on road network expansion (Liew, 1997). The $168 million extension of the Ayer Rajah Expressway to the second link to Malaysia and the $100 million extension of SLE is to be completed shortly. Together the existing expressways of PIE, ECP, CTE, TPE and KJE, the network will be more than 80% completed. The final network of 9-expressways with total length of 141 km will be achieved when the Kallang Expressway and Paya Lebar Expressway are built.

One of the coming road projects is the design and construction of the underground road network, known as Singapore Underground Road System (SURS). The system is a series of underground ring roads skirting around the CBD. It has 33 ramps at 8 major intersections and will cost $3.8 billion to construct.

A 4-tier interchange, the first of its kind in Singapore is to be constructed at the Braddell and Bartley Road intersection. The 4 tiers in the $120 million project are the existing ground level intersection, a flyover above Upper Serangoon Road, an underpass below Braddell Road and the rail tunnels of the North-East MRT line below the underpass.
Mass Transit network

The basic system of the MRT has also been expanded recently with the opening of the Woodlands Line. The 16-km extension completed in 1996 at a cost of S$1.3 billion has added some 60,000 passengers on the MRT network. In the next few years, plans are being drawn for the construction of 2 MRT extensions and 3 LRT systems.

Under the 1991 Concept Plan, the North-East Line (NEL) was planned for year 2010 but was been approved for earlier construction because of the new financing scheme proposed in the White Paper. In the new financing framework, the government will not only pay for the infrastructure costs but also help finance the replacement assets by requiring only costs of depreciation to be borne by fare revenues. This is considered fairer because in effect the operating assets will be paid by the generation of passengers using them. Given the financial viability of the project, the initial phase of 20 km of the NEL with 13 stations and 1 depot, costing a total of S$2.5 billion has started construction and is expected to be completed in 2002. Running from Punggol to the World Trade Centre, the NEL will connect to the rest of the MRT system at Dhoby Ghaut and Outram Park stations.

The shorter 6.4 km Changi Extension Line (CEL) is also expected to be completed in 2001. With the line connected to the existing MRT network at Tanah Merah Station, travel time from the city to Changi Airport will be reduced to 27 minutes on the MRT compared to the current 40 minutes by bus. To cater for the group of travellers to the airport, special considerations are made to take into account luggage storage and handling in train operations.

To complement the MRT network, LRT systems are being introduced. These are planned with several possible applications: (1) as feeders to the MRT network in housing estates or (2) short-distance links connecting two or more high activity centres, or (3) long-distance links and direct inter-town transit between new towns.

The first LRT system to be built in Singapore is a feeder serving Bukit Panjang New Town. The S$285 million system is 8 km long and has 13 stations or stops. The driverless LRT trains which are designed to run on rubber tyres along concrete tracks will operate at average speeds of 25 km/hr. Expected to operate by late 1999, the LRT service will have peak and off-peak headways of 3 and 6 minutes respectively.

CONCLUSION

The Singapore transport system has been planned painstakingly since the beginning of independence. Even though at the initial stage, planning was sometimes piecemeal and targeted only at solving specific problems, the transport plans generated did produce effective results. In some areas, the planners were not able to anticipate the outcome and this is particularly true when user response was not known a priori. Despite these uncertainties, the rate at which Singapore emerge from the potential transport nightmare is impressive. Within a short span of a generation, it has developed an efficient land transport system and is poised to make it a world-class system within the next couple of decades.

There are obviously lessons that can be learnt from the past experience. This section summarises the pertinent issues that have contributed to successful transport planning from one that is more reactive to one that is more pro-active.

Lessons from the past

The changes in the population profile and characteristics as well as growth in economic conditions could have exerted tremendous traffic problems on the young nation. It appears, the measures taken by the government have alleviated Singapore’s massive problems of transportation, particularly those related to traffic congestion.

There are several reasons why the transport problems have been effectively contained and transport planning has been successful. First, there is the political will to solve the transport problems. Although attention was not given to transportation during the initial stage of nation building, the government did identify the transport problems early enough to take definite corrective actions. Perhaps, the initial delay did facilitate the policy formulation and planning process since by the time actions
were needed, the problems had reached such an urgent level that the quick decisive actions were necessary. As Corey (1987) put it, planning and development in Singapore is “survival oriented”. The political will to act is based on the premise that delayed actions can be even more costly economically and politically.

Second, the ability of the government to formulate transport policies which are generally accepted by the populace is in no measure due to the people’s confidence in the leaders’ foresight; a trust which is nurtured over many years. This confidence has also enabled the political leadership to embark on innovative policies, such as the ALS and the VQS. The single level of government and the dominance of the government by a single political party also meant that policies can be approved without unnecessary hiccups and plans can be implemented quickly.

Third, consistent transport policies have been adopted. Having identified the causes of the problems, i.e., the limitation of land resources and the many aspirations resulting from healthy economic growth, the government has consistently pursued a transport policy of traffic restraint and vehicle population control while allowing reasonable expansion in road capacity. The reason that such policies can be maintained consistently is, to a large extent, because the ruling political party has been in government since 1959. The stability in the political leadership has enabled transport policies to be formulated with a long-term perspective. Moreover, continuity in leadership also ensured that formulated policies can be effectively translated into actual plans which are eventually implemented, evaluated and refined to the changing circumstances.

Fourth, a pragmatic approach to planning is found at all levels of administration. Unlike some countries where plans are buried in numerous studies and reports, Singapore enjoys the advantage that plans are actually implemented. This has a direct impact on the planning culture in Singapore, since civil servants are expected to work towards developing and realising the plans once the policies are laid down. The commitment of the top echelon in the civil administration in carrying out the plans and the diligence of the planners and engineers are key factors contributing to the success in planning.

Fifth, planning for success is expected. The need to ensure that schemes will work has motivated the planners to be thorough and sufficiently detailed in their plans and to actively seek ways to minimize the likely adverse impacts of the schemes. As a result, schemes were seldom implemented in isolation. Many of the schemes involved a package of measures. For example, when reserved bus lanes were introduced along Thomson Road, the scheme was accompanied by the opening of alternative routes along Marymount Road to compensate for the loss of road capacity.

Furthermore, for plans to work, flexibility is important since modifications to plans are expected. Flexibility will ensure that the desired results are achieved while unexpected adverse impacts reduced. Modifications to the operating hours and the fees charged in the ALS and RPS are good examples of how plans need to be flexible. In some instances, changes were introduced within a very short span of time. The quick response also indicates the determination of the government to achieve the objectives of the plans.

Sixth, successful planning involves choosing appropriate solutions according to needs. One observation on the transport plans adopted by Singapore is that solutions to transport problems at the early stage were generally not capital intensive. The purpose of planning then was to deal with the immediate problem of congestion and inefficient use of transport resources. They were also quick solutions, as time was the enemy. Once the basic problems of congestion were tackled, the focus in planning was on the quality of service. Inevitably, solutions became more costly as seen in the massive investment on rail and other infrastructure projects.

Another important reason for planning success is the good and stable relationships among the transport users, service providers, unions and the authority. The government’s action to set up committees and agencies to plan and manage transport operations as well as gather feedback and deliberate transport issues has develop a sense of responsibility among the various parties solutions are usually acceptable to all. It is worthy to note the absence of transport strikes in Singapore since independence. The government sees the growing need to explain policies and plans to inform and persuade an increasingly educated populace.

The lessons are perhaps best summarised in the words of Liew (1996, p.4), "For the
Transport policies to be effective, it is necessary to maintain a long term perspective, anticipate change, understand the forces driving demand and supply and adopt a holistic approach when responding to the challenges. In addition, policies have to take into account changing aspirations, new lifestyles and the psyche of the society. Not only must transport planning and policy formulation be rigorous, the process of reaching consensus or at least broad agreement should be widely settled through some debate and continual explanation of the rationale of even proven policies.

**Challenges for the future**

Singapore has made great strides to overcome the problems faced by many growing cities. Plans have been made to realise the Singapore Dream of a world-class transport system. Transport planning is never final and a planner needs to look beyond what is currently planned to anticipate the next phase of development. What are the challenges facing Singapore’s transport system? This chapter closes with a look into some of the possible future issues.

**Freight Movements**

Most of the policies and plans have been targeted at the movement of people. An efficient transport system is necessary to support the distribution process of goods. This is all the more important in view of the contribution of manufacturing to GDP and the dependence of the economy on trade. For Singapore to function as a global city, coupled with the need for sustainable economic growth, there is an urgent need for planning with respect to land freight transport.

While the demand for vehicular transport of people can be checked through effective measures, the demand for transport arising from the need to move goods cannot be easily curtailed because of the projected growth in cargo handled by Singapore’s ports. Even though a large portion of cargoes handled through the port are transhipment, the need to handle valued-added goods bound for re-export cannot be ignored. There are some evidence (Chin, 1996) that logistics operators in Singapore are locating their facilities away from the port to avoid high land prices near the port at modest transport operating costs. This phenomenon creates a higher but unnecessary level of traffic on the road network and to some extend a result of the efficient transport infrastructure provided.

**Recreational Traffic**

The traffic pattern in the past has been dominated by work and school trips with some considerations for shopping trips. This has influenced the way trips are modelled and facilities are provided. In future, there will be a greater need to consider recreational trips.

There are several reasons for the increase in importance in recreation trips. In time to come, there will be a greater proportion of the population, particularly among the retirees, that will spend an increasing portion of their time on leisure activities. All Singapore becomes more affluent and its people more leisure conscious, demand for leisure activities will increase. All these will result in more leisure trips. Moreover, those engaged in leisure activities are likely to be cash rich and therefore are more willing to pay for quality transport services. They will demand more personalised forms of transport. Consequently, congestion will no longer be confined to commercial areas in the morning and evening peaks but in recreational areas during the off-peak periods.

**Multi-modal transport integration**

As integration in the transport system develops, there will be a greater need to integrate travel between various modes to further enhance seamless travel. It will be insufficient just to integrate land transport modes. Links to air travel and sea travel will have to be more seamless. Coupled with the rise in recreational trips, there will be more air and sea trips to local as well as regional resorts.

To facilitate multi-modal operations, the integration of passenger information for all modes of travel in land, air or sea will be necessary. This is especially the case, if the air and sea trips are short. The Integrated Transportation Management System will likely be extended to include the air and sea networks. In this regard, the integration of information appears to be more advanced in movement of freight than in movement of people.

**Transport Safety**

As society becomes more affluent, a higher premium will be placed on safety. Recent rise in transport accidents worldwide, particularly in air and sea travel, has generated increasing awareness of the inadequacy in safety regulations and
Transport safety will of greatest concern to the transport system designer and provider as well as the transport authority. First, as human control is gradually replaced by the intelligent machine, the burden will be on the system designer to ensure designs that are safe under a wide variety of, if not all the possible, conditions. Also if public transport is to be encouraged, the transport system provider will have to assume a greater sense of responsibility of ensuring safe operation of the system. Other the other hand, the transport authority will have to take up the responsibility of ensuring safety standards are drawn up and adhered to during operation.

**Charging for the cause of congestion**

The motorists, being the direct users of the road system, have been required to pay for their contribution to congestion on the roads. Vehicle ownership costs have also been imposed as traffic generation can be attributed to vehicle ownership. Other contributors to congestion may have to pay for the cause of congestion and privilege of usage.

One group that may be subjected to further charges is the developers. Although developers pay development charges, there may be a need for them to pay for congestion alleviation schemes. This will ensure that developers will act responsibly to minimize the traffic impact on the road network adjacent to the developments. Traffic impact fees may not be limited to congestion costs but may be associated with environmental costs including safety costs.

**Sustainable transportation**

The concept of sustainable developments has been promoted in many countries since the early 1980s. The move towards sustainable transportation will mean a greater use of green modes such as walking and cycling. In the past, due to insufficient infrastructure, these modes have not been considered to be suitable for all weather conditions. However, with proper investment in the walkways and cycle routes, all-weather movements may be possible.

The challenge will be to provide a transport system that is sufficiently seamless between modes that will encourage less use of motorised vehicles especially for shorter trips. Traffic calming schemes which have been introduced in Emerald Hill, may be extended to other residential areas. (Yuen and Chin, 1997). Already, new towns are developed to have streets with 'calmed' traffic. The need is not just providing a traffic-calmed road environment but to a culture that supports traffic calming in residential areas.

Opportunities for sharing of transport facilities such as public cycles and cars for specific segments of the journey may be explored. Sharing of personal cars is being tried but given the high capital outlay, owners are unlikely to rent out the cars for public use. A more viable alternative would be to have agencies such as car rental companies undertake the scheme. However, more importantly, the sharing of less environmentally polluted modes such as cycles and personal rail transit should be explored.

To attain sustainable transportation, environmental impacts are likely to become important considerations in the future. As traffic increases on Singapore roads, concerns over noise pollution and deterioration in air quality will need to addressed. Transport providers as well as planners will have to offer transport modes and schemes that will be less environmentally damaging.

The challenges are many but given the astute leadership of the government with the continued support of the people as well as the prudent practice of comprehensive land use-transport planning and sound traffic management policies, Singapore is well poised to achieve its vision of a quality land transport system as it develops into a tropical city of excellence.
REFERENCES


Fong, S.K., (1993), The integration of bus and MRT services in Singapore, Asia Rail ‘93, Dec 1993, Hong Kong.


MITA (-), Singapore Yearbook, Information Division, Ministry of Communications and Information, Singapore. (from 1968 to 1996)


Seah, C.M. (1975), Some key issues in Singapore’s Domestic Transportation: who gets where, when and how., S.E. Asian Perspectives, No. 3, Singapore, 1975.


Figure 1: Transport Plan for Year 2000
(Source: URA, 'Living the Next Lap', 1991)
Figure 2: Transport Plan for Year 2010
(Source: URA, "Living the Next Lap", 1991)

Figure 3: Transport Plan for Year X
(Source: URA, "Living the Next Lap", 1991)

Figure 4: Fluctuations in COE prices