Chapter 9

Traffic Demand Management and Traffic Control System

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9.1 Traffic Demand Management

As one of the important components of the Master Plan study, this section addresses the issues of Traffic Demand Management (TDM) of KL's urban transportation.

9.1.1 Methodology and Selection of Traffic Demand Management Technique

(1) Basic Understanding for Future Urban Transport Policy Formulation

The recent statistics of vehicle registration indicate that the number of private car ownership has been increasing at more than 10% per annum. It is the inevitable experience the world over that demand for private car ownership increases in accordance with growth of economy and increase in population. According to the previous JICA transport study in 1986 (The Klang Valley Transportation Study) the share of private modes of transport (including cars and motorcycles) was about 66% in 1985. On the other hand, the results of the Home Interview Survey conducted by SMURT-KL in 1997 show that around 80% of the motorised mode trips are made by private modes. Thus, during the past ten years, the Klang Valley region has been transformed into a more "private mode driven society". Consequently road traffic congestion has become one of the critical plagues of urban life in the rapidly growing KL metropolitan area. In order to overcome the problem, massive investments such as LRT's and new urban expressways have been made in recent years. Provision of such infrastructure, however, cannot keep pace with the rapidly increasing traffic demand in the urbanised area due to various reasons including physical, technical and historical development backgrounds of the city and limited financial and institutional capabilities of the responsible governmental agencies and private sectors. Besides, other types of urban problems have been identified by public, such as air quality deterioration, and noise problem along with roadside and greenhouse gas effect caused by vehicular traffic gas emission. Confronting these problems, one should have a basic proposition that no effective progress will be made in urban life without the application of traffic demand management concepts for the safe and efficient movement of people and the creation of good quality living environment in KL.

(2) Policy Direction: Target Group Approach

Figure 9.1.1 illustrates a conceptual framework in order to understand the KL society. There are two types of transport mode users: Public and Private, and their income level is divided into three categories: Low, Middle, and High. Furthermore, this diagram suggests general policy directions to be considered in formulating an urban transport strategy by the "Target Group" approach, and also a function / role of TDM as a part of integrated urban transportation policy set is illustrated.

Through a comparative analysis of the two transport studies sponsored by JICA, it was revealed that most of the people in the Klang Valley region have been following Shift 1 and 2. In conclusion, the KL metropolitan area has been characterised by a "Car driven society". In this society mobility of cars is given priority rather than that of people. Besides, since there may be many good business chances for toll road investors, the traffic congestion problem may never be solved in this society.

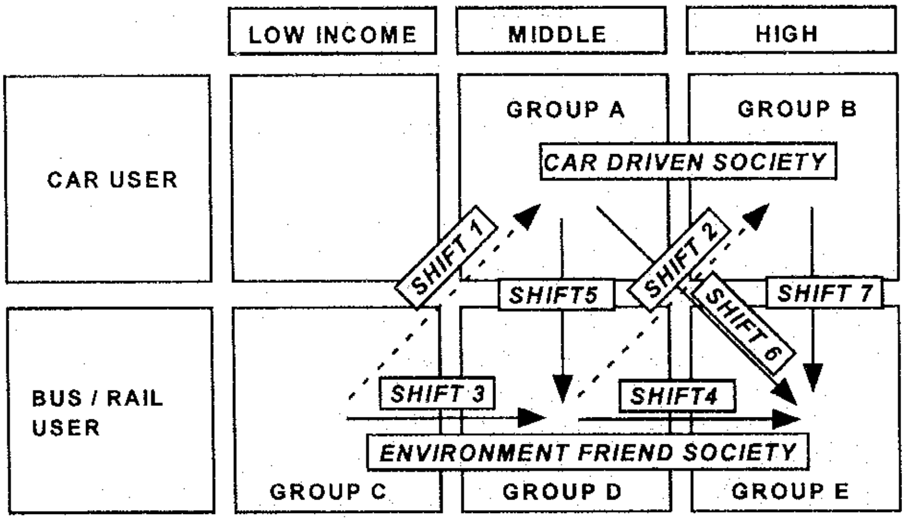


Figure 9.1.1 Types of Urban Transport Strategy by Target Group

If a society geared toward public transport is to be promoted in KL, "Shift 1" and "Shift 2" should be avoided as much as possible. On the contrary, "Shift 3" to "Shift 7" should be promoted to divert the KL society into a more people friendly environment.

Policies for Target Group C, D and E

According to the Home Interview Survey, there has been a strong trend toward either Shift 1 or Shift 2 in the last decade, resulting in a tremendous decrease of public transport mode users. It would be very difficult to change this movement by just upgrading the public transport system itself because, as seen in the results of the survey, people are very likely to use cars for commuting purposes once they are available for their own use. Therefore, other types of measure should be found out. Some of them will be found in the field of city planning. For example, allocation of housing developments near railway stations would be effective in providing the best access for them. Obviously it is very important to improve the current public transport system as well. The ideal target stated by the samples of the Opinion Survey in terms of the level of services is a maximum of 10 minutes waiting time and less crowded bus or railway coaches. Another option to avoid the Shift 1 and Shift 2 movements is a restriction policy on car ownership. But, this would be difficult to apply because such a policy would have very severe negative impacts on the domestic automobile industry which is one of the very important engines of the economy.

Policies for Group A and B

Policies for Shifts 5, 6, and 7 must be the most difficult / ambitious ones. According to the Opinion Survey, time savings achieved by using public transport modes is not effective in diverting people to become public transport mode user. Types of pricing policies revealed to be very effective, but this effect is limited in proportion to increase of personal income. If this type of policy is adopted, part of Group A will shift to Group D, although, Group B will still remain. Besides, a pricing policy may have a negative impact on the society in terms of equity. For example, if a person in Group A has no alternative modes of transport, adoption of the pricing policy on car or car usage simply leads to a severe loss in his income. Therefore, when this type of policy is implemented, effective and reasonable alternative modes of transport should be provided at the same time. Other solutions to avoid such an unfair situation include "Cordon pricing for low occupancy vehicle" and "High occupancy vehicle lane", which are effective policies among different income groups. These measures are regarded as being part of physical constraint techniques.

As discussed here, restraint type techniques in the traffic demand management strategy are necessary to realise Shifts 5, 6, and 7 in near future. At the same time, subsidy provided in the form of parking allowance should be re-allocated to public transport mode users in the context of fair income distribution.

(3) TDM in Major Cities in the World

Many traffic demand management techniques have been considered / implemented in major cities of the world. This section summarises the characteristics of major TDM techniques that might be candidates for the city of KL.

1) Route Pricing System

Route pricing system imposes charges on passenger car users passing through designated roads, in order to minimise unnecessary utilisation of passenger cars and divert users to public transport. Usually this measure is combined with a high occupancy vehicle lane technique.

2) High Occupancy Vehicle (HOV)

Priority lanes for high occupancy vehicles are provided and only HOV can pass the designated route without obstruction. Sometimes this system is used as a car pooling system.

3) Car Pooling System

People practice car pooling and usually cars with high occupancy get to pass through priority lanes without obstacles and thus arrive at their destinations easily.

4) Three in One

This system has been introduced in Indonesia. Only cars with three passengers or more including the driver can pass through designated routes or arterial roads where the system is applied. Offenders cannot pass through the designated routes or arterial roads.

5) Area Licensing System

This system has been adopted in Singapore. A charge is imposed on cars to enter a designated area. Sometimes this system is also called an area cordon pricing system.

6) Staggered Working Hours

People commute at different hours compulsorily or voluntarily to avoid an overlap in commuting activity during the same peak hour band.

7) Parking Policy

a. Park and Ride System

Parking facilities are provided at near the stations of rail-based systems, and users from houses go to the stations to park their cars and transfer onto the rail-based systems.

b. Parking Restraint Policy

Any special method can be implemented but there are two typical methods from the viewpoint of the passenger car restraint. One is to control the construction of parking facilities to fit the policy to be introduced, and the other is to impose a surcharge fee to curb car parking in order to divert people from passenger cars to public transport.

Table 9.1.1 Traffic Demand Management Techniques

Technique	Descriptions	Cities/Countries where Implemented
Traffic Restrictions for Residential Areas	On-street parking controls, street closures, road humps, elimination of curbs, etc. are used to improve the residential environment	Copenhagen, Netherlands (Harlem, Delt, Enschede), Sweden (Vasteras)
License-Plate Numbering System	Vehicles with odd-numbered plates are not permitted to enter controlled areas on odd-numbered working days and Vehicles with even-numbered plates are not permitted to enter on even-numbered days.	Nigeria (Lagos), Seoul, Greece (Athens)
Planned Congestion	Capacity restrictions and time delays using traffic signals are applied to achieve planned congestion.	Nagoya, Nottingham, Ottawa - Carleton
Traffic Cell System	Division of an urban area into zones which are only mutually accessible by public transport or by a circuitous route. Pedestrian streets are used to prevent vehicular traffic from passing through an area.	Gothenburg, Besancon, Dijon, Nottingham, Gronigen, Delft, Geneva, Nagoya, Bremen, Ottawa
Auto-Restricted Zone in CBD	Zones where automobiles are totally eliminated; a new circulation system for buses, pedestrians, taxis and delivery trucks with priority given to buses.	Boston
Area-Licensing/ Congestion Charging	Vehicles are charged for entering a congested area during peak periods, excluding public and emergency vehicles.	Singapore
Vehicles Ownership Restraints	Vehicle ownership is inhibited by high import taxes, purchase taxes, vehicle registration fees and annual licensing fees.	Hong Kong, Singapore, Seoul
User Taxes	Vehicle use is restrained through user taxes imposed on fuel, tires, spare parts, etc., thus adding to the operating cost in relation to the distance traveled.	Seoul
Cordon Toll Gates	Toll gates installed at cordons around a controlled area.	Bristol, Bergen
Tolls placed at particular facilities to control movement	Toll gates are placed at particular facilities, like tunnels and bridges, to control movement	New York, Southhampton, Seoul, Hong Kong
Pedestrian Streets	Selected streets are closed to vehicles to promote pedestrian use and safety and a pleasant environment	UK (London, Nottingham, Glasgow, Norwich, Liverpool, Leeds, Durham Coventry), Germany (Mainz, Munic Stoved, Essen, Stuttgart, Cologne Dusseldorf, Hanover, Frankfurt), France (Paris, Besancon), USA (Boston, Menneapolis, Madison, Minnesota, California), Netherlands (Hague, Gronigen), Copenhagen, Brussels, Ottawa, Tokyo, Rome, Geneva, Vienna, Gothenburge.
Pedestrian/Bus Street	Pedestrians and buses share road space to reduce traffic congestion and to promote a pleasant environment.	Germany (Trier), UK (Derby, London, Leeds)

Source: H.C. Park, 'Traffic Demand Management: Some Possible Techniques for Bangkok', Master's Thesis, Asian Institute of Technology (AIT), 1989, adapted

(4) Likely TDM Measures in the Context of KL

As discussed in the previous sections, the introduction of TDM is necessary not only for the actualisation of Shifts 5, 6, and 7 but also to maintain Shifts 3 and 4 within the context of KL.

1) Two Major Objectives of TDM in KL (CPA)

Two major objectives can be set in formulating the TDM strategy for the city of KL. As stated in the objectives, TDM in KL will be applied not only as a technique for mitigating traffic congestion but also as a very important policy to change the current society into a better world for the people.

- To remove excessive vehicular trips (especially SOV) during the peak period in order to avoid economic losses and to achieve economic efficiency in a short- or medium-term.
- To alter the direction of the society from a "Car-Driven Society" to an "Environment-friendly (Public transport advantageous) Society".

It should be noted that there are two premises in applying TDM in KL (CPA), these are as follows:

- Maximum utilisation of the existing facilities should be achieved through traffic control techniques before applying TDM (few additional infrastructure is assumed within the CPA).
- Alternative transport modes both for commuting (peak-hours) and for intra-CPA travel (business communication) should be provided at the same time.

The traffic control technique will be discussed in Section 9.2, while public transport systems as effective alternative modes of transport are given in Chapter 8 of this report.

2) Preliminary Appraisal of TDM Techniques

Based on the above objectives and premises, a preliminary appraisal on TDM techniques for KL was made. In this discussion, TDM techniques are categorised into five fields: 1. Peak-period Dispersion Technique, 2. Ride-sharing Technique, 3. Parking Demand Control Technique, 4. Public Transport Improvement Technique, and 5. Traffic Restraint Technique.

a. Peak-Period Dispersion Technique

The table below shows three major peak-dispersion techniques. In order to change the pattern of traffic demand in time, these techniques can be applied in KL. Staggered working hours have eventually been applied to government staffs. The effect, however, seems to be very limited because there is a total of 737,700 job opportunities in KL, out of which only 95,600 are governmental, in 1997. Thus, this type of technique should be expanded to the private sector as well. However, it should be remembered that these techniques normally do not contribute toward reducing the number of vehicles used during commuting hours or, to make matters worse, they may even increase the number of single-occupancy vehicles.

Table 9.1.2 Peak-Period Dispersion Technique

Techniques	Area Suitability		Impacts on Travel to/in CPA			
	CPA	Outside CPA	SOV reduction	Peak Car Trip Reduction	Veh-km reduction	Transit Impact
Staggered working hours	○	○	×	○	×	×
Flextime working hours	○	○	×	○	×	×
Shortened work week (4 days week)	○	○	×	○	◎	×

◎ Very Effective ○ Effective △ Slightly Effective × No impact or Negative

b. Ride-sharing Technique

Van pooling and/or Bus pooling type technique is normally applied to those who live in the same vicinity and work at the same place, for example, factory workers. Thus, for the commuters to the CPA, this technique is not suitable. Although the car pooling technique is suitable for CPA workers, its impact is very limited.

Table 9.1.3 Ride-sharing Technique

Techniques	Area Suitability		Impacts on Travel to/in CPA			
	CPA	Outside CPA	SOV reduction	Peak Car Trip Reduction	Veh-km reduction	Transit Impact
Van Pooling (8 - 15 employees living in the same vicinity)	×	○	×	×	×	×
Car Pooling (2 -3 commuters)	○	○	△	△	△	△
Bus Pool (Independent Commuter Club)	×	○	×	×	×	×

c. Parking Demand Control Technique

On-street parking restriction has been already introduced in the CPA. This technique is essential to avoid obstacles for a smooth traffic flow.

Parking charge and/or parking supply control technique is a very strict demand control technique. Moreover, parking charge control is easier to implement than congestion charging from the viewpoint of public resistance on the policy. However, it was revealed by the Opinion Survey that employers provide higher income people, such as managers and executives parking lots or parking charges as an allowance. Thus, an increase in parking charges will not affect the travel behaviour of these wealthy people; rather it will impose additional costs on the relatively lower income groups and visitors. The policy would benefit the special group of the society who can use a parking lot without any "out-of-pocket" cost. From the standpoint of equity the parking charge control policy is not recommended.

Table 9.1.4 Parking Demand Control Technique

Techniques	Area Suitability		Impacts on Travel to/in CPA			
	CPA	Outside CPA	SOV reduction	Peak Car Trip Reduction	Veh-km reduction	Transit Impact
On-street parking restriction	○	○	×	×	×	△
Parking supply control strategies supporting traffic restraint in CBD or CPA	○	×	○	◎	◎	◎
Parking Pricing - differential parking charge - parking taxes - remove parking allowance, etc.	○	×	○	○	○	◎
Park & Ride	×	○	×	△	△	○

d. Public Transport Improvement Technique

Public transport improvement technique can be categorised into one of "Pull-type" TDM technique. There are three bus operators: Intrakota, Park May and Metro and three railway companies: KTM, STAR, and PUTRA. These public transport operators have been making good efforts to attract passengers through various measures. However, these exercises have been done independently by each operator. Several techniques require the joint-effort between the operators and between the government and operators. These include the "Bus priority scheme", "Route integration", and "Allowance for public transport use". The allowance for public transport use by the employer must be one of the most effective areas for a joint-effort by the government and the operators. According to the Opinion Survey, most of the car users are provided with an allowance in the form of a parking space or a monthly parking allowance, while the public mode users are not. This is inevitably encouraging people to use cars. Thus, a fair condition should be created among the different modes of transport to improve the people's awareness regarding the public modes of transport.

Table 9.1.5 Public Transport Improvement Technique

Techniques	Responsibility		Impacts on Travel to/in CPA			
	Operator / Private sector	Public Sector	SOV reduction	Peak Car Trip Reduction	Veh-km reduction	Transit Impact
Information Service	○		△	△	△	○
Smart Card - combination ticket (feeder bus & rail) - common ticket (different operators)	○		△	△	△	○
Route integration, Frequency increase (including feeder buses)	○		△	△	△	○
Transit fare reform - discount of ticket	○		△	○	△	◎
Bus Priority Scheme - Exclusive bus lanes - Preferential treatment of buses, etc.	○	○	×	○	△	◎
Employer sponsored / subsidized	○	○	○	◎	△	◎

e. Traffic Restraint Technique

Preferential HOV lanes have a medium impact in the reduction of single-occupancy vehicles, however, they cannot be expected to increase passenger demand for public transport drastically. According to the responses in the Opinion Survey, some 60 percent of the people would call two more persons if the "Low Occupancy Restriction Policy" were employed. Merely 20 percent of respondents would switch to public transport. Although the "Preferential HOV Lane" and the "Low Occupancy Vehicle Restriction" policies are not exactly the same, the results imply that HOV Lane scheme would be more effective in reducing single occupancy vehicles to some extent but less effective in promoting public transport.

Congestion charging is appealing due to its strong impact in reducing peak trips. Since the peak period is short in Kuala Lumpur, congestion charging is effective in smoothening off the peak and in reducing traffic congestion. According to the Opinion Survey people are not sensitive to increases in travel time but are sensitive to increases in travel cost. It is expected that congestion charging would have strong effect in reducing traffic demand in the peak period. Therefore it is proposed that congestion charging be employed in the CBD during the peak period. However, congestion charging also has the same drawback as the parking charge control. Relatively heavier burden would be imposed on car users of the lower income groups. If the collected charges could be used not only for road facilities but for all urban transportation systems including public transport, better public transport services could be achieved. Lower income groups could also enjoy the benefits from the policy.

Among the three TDM techniques discussed above, congestion charging seems to be the most appropriate traffic demand management technique in the context of urban transportation in the Kuala Lumpur metropolitan area.

Table 9.1.6 Public Transport Improvement Technique

Techniques	Area / Roads	Impacts on Travel to/in CPA			
		SOV reduction	Peak Car Trip Reduction	Veh-km reduction	Transit Impact
HOV lanes during peak hours	Arterial roads and Expressways plunging into CPA	○	○	△	×
Cordon Toll Gates - for all vehicle - preferential charge during peak hours	Arterial roads and Expressways plunging into CPA	○	◎	○	△
LOV restriction roads during morning peak hours	Part of Radial Roads inside CPA	◎	◎	○	△
Area Pricing during morning peak hours - Common Sticker - SOV ticket / sticker	Arterial roads in CPA	○	◎	○	△

Summary of TDM for KL

1. Peak-period Dispersion Technique
   - Staggered working hours should be maintained/enhanced.
2. Ride-sharing Technique
   - Car-pooling should be promoted by public information to raise the public's awareness of traffic congestion.
3. Parking Demand Control Technique
   - On street parking restriction policy should be maintained for smooth traffic flow (especially for buses).
   - Parking supply control should not be applied because it is necessary to remove on-street parking.
   - Parking Pricing Policy can be one of the components of pricing policy. However, visitors and short-time parking should not be affected. Car use during the off-peak period should be supported by providing parking spaces at low cost.
4. Public Transport Improvement Technique
   - All the efforts by the operators should be maintained/enhanced.
   - The government should support them by public information to raise the public's awareness of public transport.
   - Joint-efforts by the government and operators should be carried out in the following field:
     - Route integration among different operators.
     - Installation of enhanced bus lanes and operation of trunk buses.
     - Introduction of smart card among different operators (F/S is necessary).

   (Combination ticket (ex. PUTRA feeder buses & PUTRA LRT) can be done by each operator independently.).
   - Transport allowance (subsidy) for public mode users (employees) should be promoted by providing a preferential taxation scheme for the employers.
5. Traffic Restraint Technique
   - After the completion of the proposed rail system (Year 2000), introduction of traffic restraint via the pricing technique is necessary in order to remove the excessive vehicular demand and to improve public transport

9.1.2 Area Pricing

(1) Introduction

Many studies on KL's urban transportation have suggested the necessity of TDM in KL. However, actual implementation has been limited to the partial bus & taxi priority lanes and staggered working hours for government staffs. Restraint type measures such as high occupancy vehicle (HOV) lanes and area pricing scheme have not been introduced yet because effective alternative modes of transportation means have not been provided at present. Another reason is that maximum utilisation of the existing transport facilities has not been achieved yet. However, the transport environment has recently been changing from that of the past.

In the next few years many more vehicular trips will be attracted to the CPA due to several large-scale urban development projects such as KLCC, Plaza Rakyat, Star City, Vision City and so forth. Furthermore, many radial urban expressway/ highway projects plunging into the central area of KL are under construction or under planning. These road projects will provide better access for residents in the suburban areas, consequently attracting more vehicular trips from those areas to the city centre. The traffic congestion will get worse and worse if additional road spaces are not provided. It, however, seems very difficult to increase the current road network capacity drastically in the CBD due to the little possibility of new surface arterial road construction and / or widening of the existing roads. Thus, from the supply side policy alone, the road traffic congestion problem cannot be resolved. On the other hand, new public transport systems such as the LRT System (I) and (II) have been in service. These new public transport systems together with the improved bus services will provide a much more effective alternative transport means.

As discussed above, the question is how to improve the present transport environment by controlling the usage of private vehicles and promoting the usage of public transport modes. In this context, "Area Pricing Policy", which is one of the important components of a series of traffic demand management measures, is discussed in this section. In order to comprehend the effects of the area pricing policy in a numerical manner, the discrete choice models are applied.

(2) Justification for Introducing Area Pricing Policy

1) Vehicular Traffic Congestion

Figure 9.1.2 shows the structure of arterial road system of the Central Planning Area (CPA). There are two ring roads in KL at present: Inner Ring Road (IRR) and Middle Ring Road I (MRR I). Currently the Middle Ring Road II, running along the boundary of the city, is under construction.

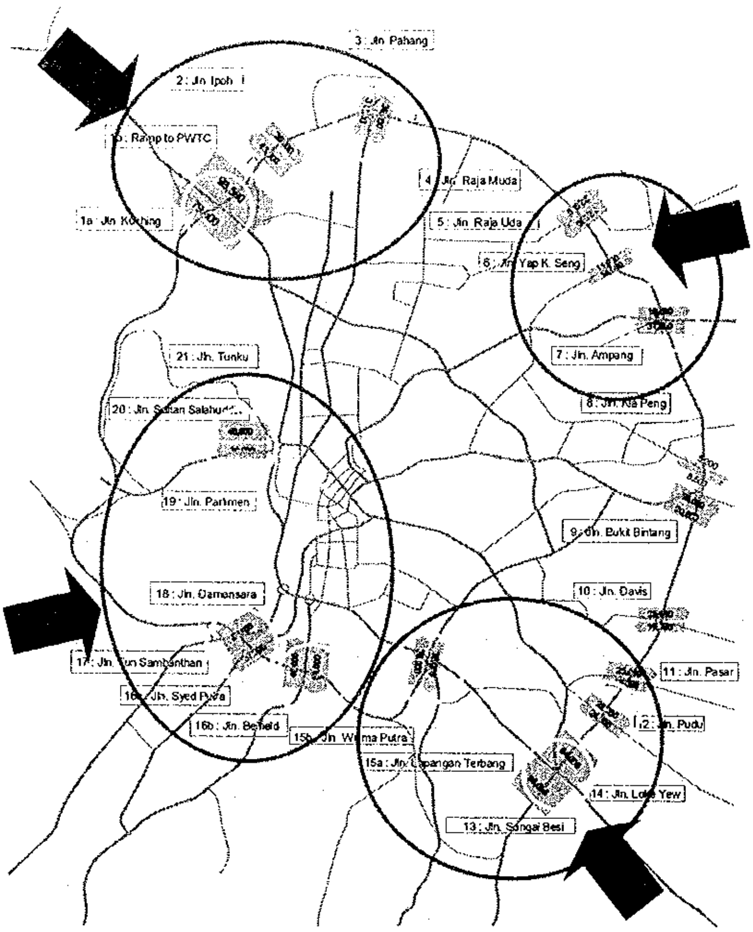


Figure 9.1.2 Arterial Roads of CPA

Over the past few years, the corridor along IRR has been densely developed for office and commercial purposes. As a result, its function as a ring road, that is, dispersing through-traffic, has been weakened. It can be said that there is only one ring road system in KL at present. However, like IRR, land use along the MRR I has also been changed into more dense use in recent years.

Across this ring system, ten major highways plunge into the CPA. Figure 9.1.3 shows the hourly traffic volume of Jalan Kuching. The horizontal axis is time of day and the vertical axis is hourly traffic volume in terms of passenger car unit (pcu). The dotted line is the maximum inbound road capacity of Jalan Kuching in terms of "LOS condition is C". It is around 5,000 pcu / hour. Between 7:00 am and 9:00 am, about 1,000 pcu / hour traffic exceeds the capacity, which means that the current LOS of Jalan Kuching is LOS D or E condition during the morning peak period. The conventional approach in improving this situation is additional lanes, however, this is almost impossible due to the land use along the corridor.

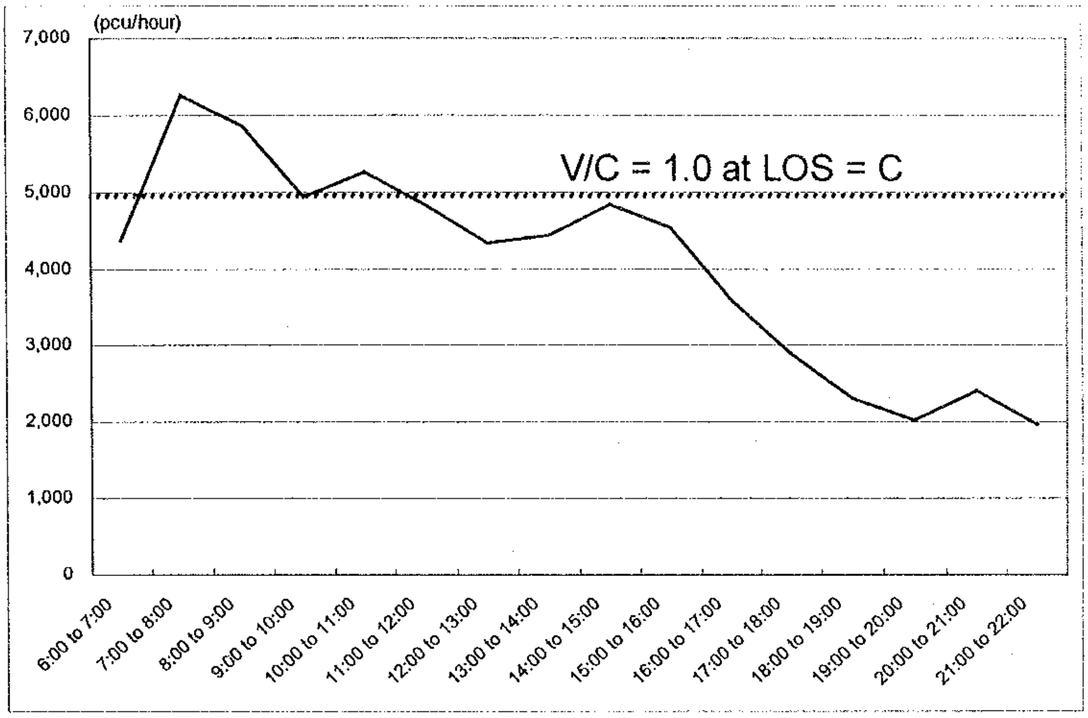


Figure 9.1.3 Inbound Traffic Volume (Jalan Kuching)

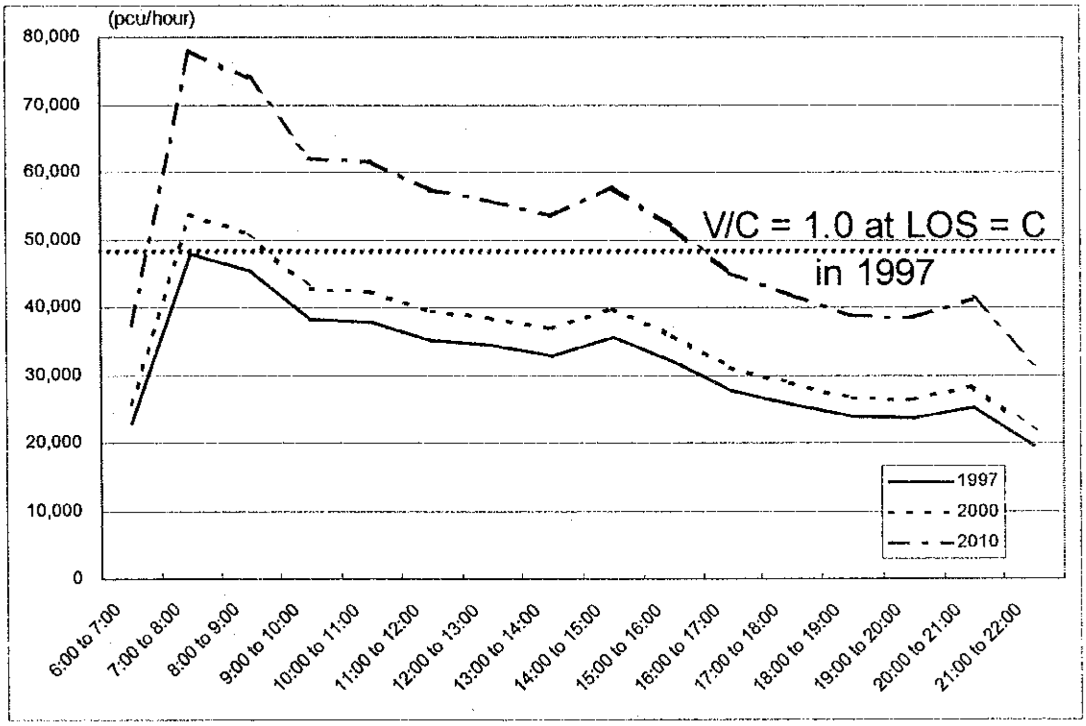


Figure 9.1.4 Total Inbound Traffic Volume Crossing the CPA Boundary

In the same manner, Figure 9.1.4 shows the total hourly inbound traffic volume crossing the CPA boundary, that is, the sum of the ten major highways. In terms of the total traffic volume, the current level is still under the capacity. Furthermore, there is still enough room during off-peak periods. However, the predicted traffic volume exceeds LOS=C condition by 10 to 15% in the year 2000. This amount of traffic can be managed by some policy instruments and through an advanced traffic control system such as ATC. However, in the year 2020 some additional infrastructure will be required to accommodate the huge demand as described in Figure 9.1.4.

Figure 9.1.5 shows the average travel speeds of cars during morning peak periods. Within the shaded area, cars can run under 10km/hour during these periods. As seen in the figure, almost all the areas inside the CPA is shaded, while the area outside the CPA is not. This implies that cars can run along the radial highways at rather high speeds from outside the CPA up to the boundary of the CPA, then suddenly they face a chaotic situation on and within the boundary.

Figure 9.1.5 Area of Low Speeds in Morning Peak Hour

2) Urban Structure

In Kuala Lumpur, business and commercial functions centre on the CPA, while most parts outside the CPA are residential areas. There are a few business and commercial areas outside the CPA, but their scales are not very big. Thus, KL is characterised as a city of one polar system. Under this system, a huge amount of commuting trips is inevitably made between the centre and the outside.

3) Future Urban Development and Traffic Generation

Figure 9.1.6 shows the future urban projects in KL. The current floor area for offices in the CPA is about 400ha. The total floor area of new urban development in the CPA (under construction) is 284 ha. Among them, 94 ha will be used for office use. Thus, primacy of the CPA will be further strengthened.

Due to the projects, it is estimated that around 100,000 car trips will be generated within the CPA. Assuming a 10 % peak hour factor, in a given morning peak hour, around 10,000 cars will be added to the arterial system in the CPA if there is no demand control.

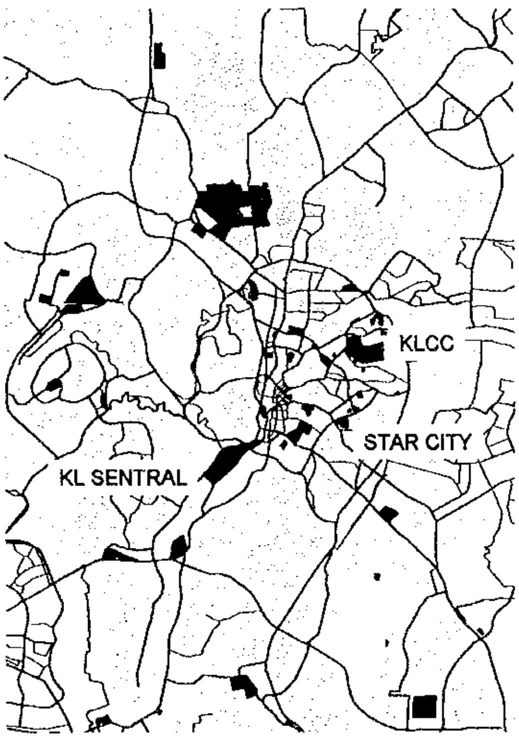


Figure 9.1.6 Future Large Scale Urban Projects in KL

Table 9.1.7 Future Large Scale Urban Projects and Generated Traffic

(unit: sqm)

Status	Office	Hotel	Residential	Others	CPA	CPA/KL	KL Total
Under Construction (by the year 2000)	939,245	192,308	191,428	921,970	2,843,046	54.3%	5,232,216
Development Order	310,952	419,182	58,634	190,001	676,976	13.6%	4,993,170
Approval	79,156	116,598	96,343	121,693	413,791	8.1%	5,123,025
CPA	1,329,352	728,088	346,405	1,233,664	3,933,813	25.6%	15,348,411

Source: City Hall of Kuala Lumpur, Master Plan Unit

Car Trip Generation / Attraction by the Projects in CPA (unit: veh. trips)

Status	Office	Hotel	Residential	Others	CPA
Under Construction (by the year 2000)	46,962	5,769	7,179	36,879	96,789
Development Order	15,548	12,575	2,199	7,600	37,922
Approval	3,958	3,498	3,613	4,868	15,936
CPA	66,468	21,843	12,990	49,347	150,647

Source : SMURT-KL Estimate

4) CPA Workers' Characteristics

The people's preference in their modal choice provides an important suggestion to transport planning activity. The following diagrams were obtained from the SMURT-KL Opinion Survey.

Figure 9.1.7 shows the sample CPA workers' personal income distribution by representative (primary) mode of transport in their commuting. Obviously there is a huge difference between car users and others in income level. This is simply implying that the higher the income level is, the more people tend to use cars for commuting purposes.

Figure 9.1.8 shows the stated preference of car users for using public modes of transport in accordance with time savings. Even though a 20 % time savings is realised by using public modes of transport, only 5 % of the samples stated that they would use public transport. Thus, this diagram implies that it is very difficult to convert car users into public mode users by just providing the time saving incentive to them.

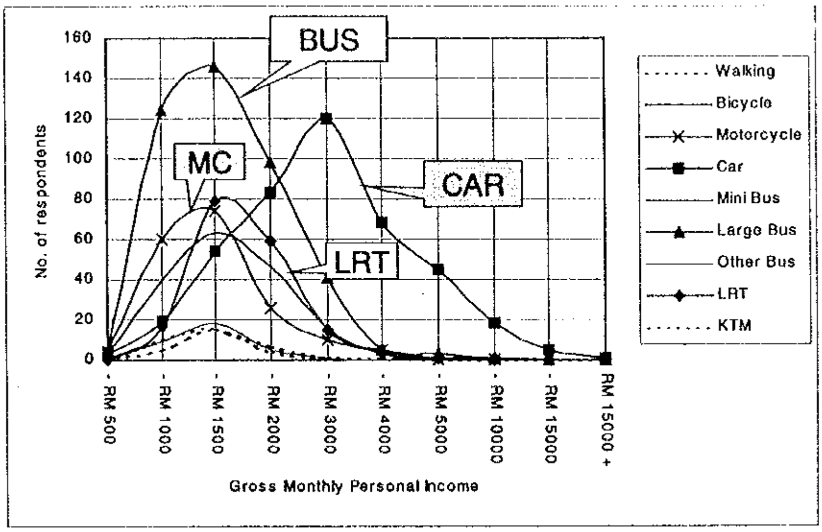


Figure 9.1.7 Income Distribution by Type of Commuter

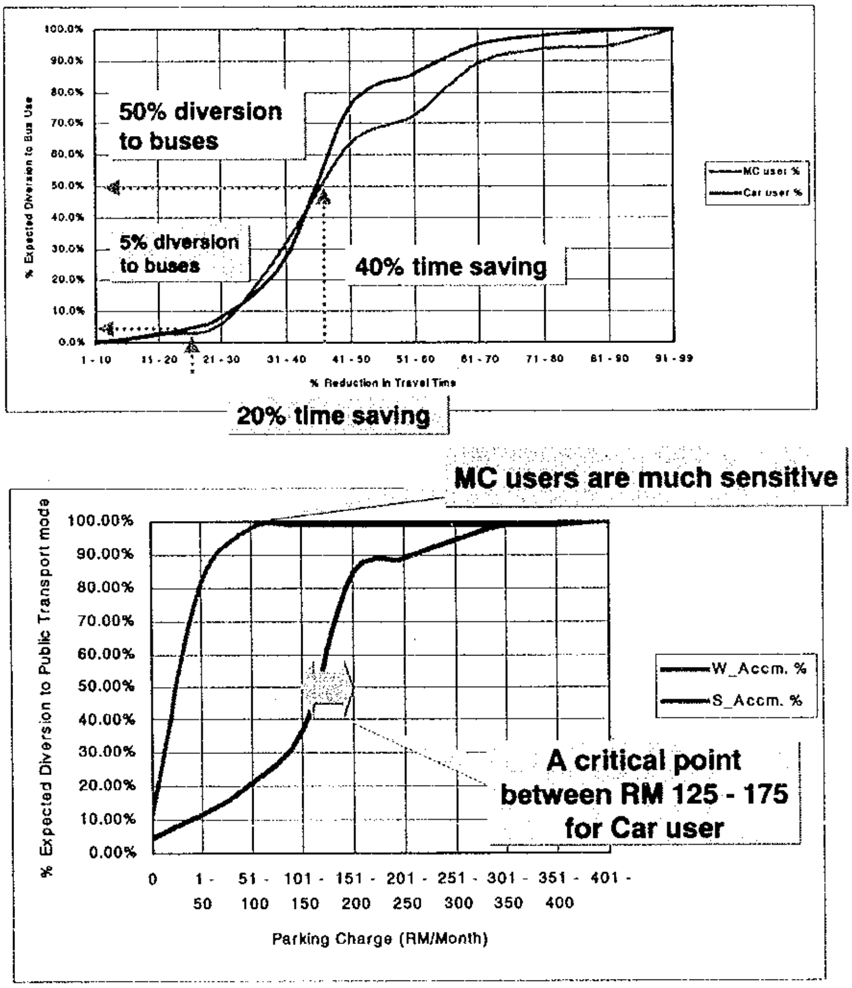


Figure 9.1.8 Car Users' Preference for Using Public Transport Modes

Contrary to their responses toward time saving, people are much more sensitive to price signal. Figure 9.1.8 shows the car users' stated preference for using public modes in accordance with increase of cost. In this case, an increase in transport cost is expressed by a "Parking Charge". As seen in the figure, there is a critical point for the car users, between an increase of RM125 to RM175 per month.

Through the above discussion, the nature of traffic congestion in the CPA and the necessity to introduce of TDM measures are summarised as follows:

Congestion

- Congestion phenomenon will be observed only in the morning / evening peak-hours within the next five years.

- There will be enough road space during the off-peak period.

Urban Structure

- Commercial / Business functions are concentrated in the CPA, while residential areas surrounding the CPA.

- More radial roads will plunge into CPA.

Demand Side

- People prefer to use private modes of transport.

  (Coverage of effective public transport system is limited.)

Supply Side

- Limited road space inside the CPA. (More road policy is difficult to apply)

CPA workers' characteristics

- Car Users: Rich people in comparison to other transport mode users.

- Time saving is not a major factor in their modal choice;

- Cost increase is one of the influential factors (RM125 - 175 is critical for car users).

- Level of service(LOS) attractive enough for private mode users is high.

- Public Mode Users: Likely to use private modes once they are available.

Thus, to mitigate the traffic congestion problem effectively, commuting trips made by private modes of transport in peak hours should be focused on at first. Among the measures of TDM, a type of sending signal with physical constraint should be the most effective technique.

(3) Preliminary Assessment on Alternatives for Pricing Scheme

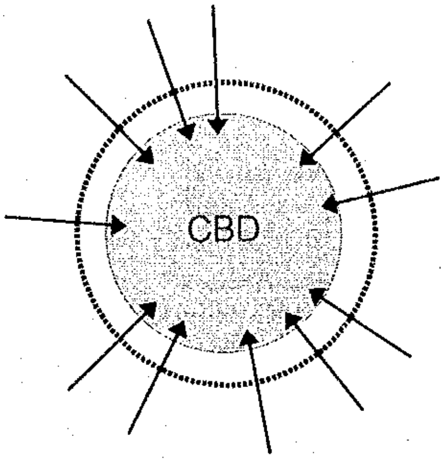
Three alternative pricing techniques have been prepared to make a preliminary assessment on their impact: "Overall Area Pricing in CBD", "Preferential HOV + Cordon Toll Gate", and "Simple Cordon Toll Gate"

Table 9.1.8 summarises the issues of each pricing scheme. Among them, the issue of equity between residents inside the CPA and those outside the CPA is critical in ALT 2 and ALT 3. In both cases, residents inside the CPA are given preferential treatment, that is, they need not pay any money when they go to places inside the CPA from their residence. Accordingly, values of houses inside the CPA may increase. In the case of ALT 2, a negative impact on the bus transport is predicted. Like the situation in Jakarta (the three in one policy), car users may invite bus passengers as their fellow passengers to escape the payment imposed on SOV. Such an impact is totally against the major two objectives set forth in the previous section. ALT 3 has a severe technical problem in collecting the toll fee. Since the amount of traffic bound for the CPA is so huge, a long traffic queue may occur at the gates. A new technology termed Electronic Toll Collection (ETC) might be effective in such cases; however, a certain amount of investment is required. ALT 1 seems to be the severest policy to the public because nobody (no vehicle) has a chance to escape from payment; however, in other words this is the fairest scheme. Furthermore, this technique can designate specific congested roads where the pricing policy is to be applied. In the end, an overall area pricing technique would be preferable.

Table 9.1.8 Nature of Pricing Technique Alternatives

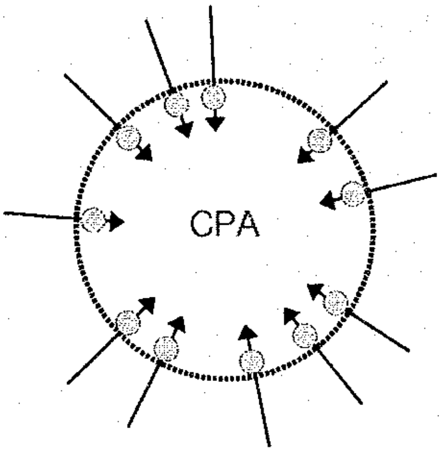
	Strong Point	Weak Point
ALT 1 Overall Area Pricing in CBD	- Reduce SOV (Promote HOV indirectly). - People can share a car (fee) if necessary - People have a chance of solo-drive. - Equity between residents inside the CPA and those ouside the CPA. - Collected money is used for improvement of urban transportation. - Encourage people to use public modes.	- Violation of the rule. - Allocation of policemen (running cost) - Strong oposition by the public (needs to raise public awareness of public transport)
ALT 2 Preferential HOV + Cordon Pricing	- Reduce SOV (Promote HOV directly) - Collected money is used for improvement of urban transportation. - Encourage people to use public modes. (Strong oposition by the public, but, people can escape from payment if they can arrange HOV always)	- Inequity between residents inside the CPA and those outside the CPA (raise land price inside the CPA). - LOV restriction may not contribute to public transport (attract bus passengers to car passengers) - Violation of the rule. - Allocation of policemen (running cost).
ALT 3 Cordon Toll Gate	- Violation is avoided by physical gates. - No policemen allocation needed. - Part of the proposed toll systems can be used as part of the cordon toll gate system. - Collected money is used for improvement of urban transportation. - Encourage people to use public modes.	- Inequity between residents inside the CPA and those outside the CPA. - Additional infrastructure (Gates, ETC) is necessary. - Traffic congestion at the gate without ETC. - Allocation of toll collectors (running cost).

ALT 1: Overall Area Pricing in CBD



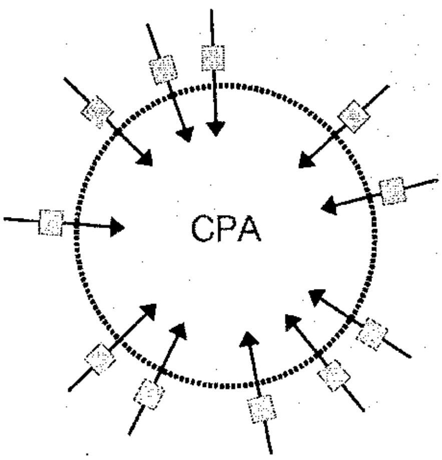
General:
Charges are applied to all cars that are using congested arterial road segments in CBD during peak period.
Exemption:
Buses, emergency vehicles, vehicles with handicapped drivers, government utility vehicles.
Payment & Enforcement:
- Sticker (no gate installed)
- Visual check by policemen on designated road segments.
- ETC in future

ALT 2 Preferential Treatment for HOV



General:
Charges are applied to SOV entering to CPA during peak period.
Exemption:
HOVs (Cars with more than 2 persons), Buses, emergency vehicles, vehicles with handicapped drivers, government utility vehicles.
Payment & Enforcement
- SOV Sticker (no gate)
- Visual check by policemen at the cordon line.

ALT 3: Cordon Toll Gate



General:
Charges are applied to all vehicles entering CPA during peak period.
Exemption:
Buses, emergency vehicles, vehicles with handicapped drivers, government utility vehicles.
Payment & Enforcement:
- At the gate (ETC in future)
In the case of manual toll collection, a preferential treatment can be applied to HOV.

(4) Area Pricing Plan

1) Objective

The objective of area pricing is to use the road space more efficiently in order to alleviate traffic congestion, and thereby reduce travel time and air pollution caused by the exhaust gas of vehicles.

2) Target

The target is to maintain (possibly improve) the present service level of road and to promote use of public transport.

3) Implementation Schedule

Area pricing shall be employed after all the on-going rail-based systems begin operations and supplemental bus transport services are provided for the areas left out by the rail-based transport services.

- LRT System (1) STAR (existing)
- LRT System (2) PUTRA
- PRT (Monorail)
- KTM Komuter (existing)

4) Restricted Area (Areas where Area Pricing are to be Employed)

Area pricing is employed on the congested streets in the CPA as shown in Figure 9.1.9.

5) Operation Period

a. Monday to Friday

Morning Peak Period - 7:00 to 9:00

Afternoon Peak Period - 16:30 to 18:30

b. Saturday

Morning Peak Period - 7:00 to 9:00

Afternoon peak Period - 12:00 to 14:00

6) Charge Level

Charges are to be differentiated by vehicle type according to the road space occupied by the vehicles. Charge rates should be determined to maintain the target service level of road condition in the area. For instance, the projected traffic demand in the

CPA will increase by 15 percent in the year 2000, thus the charge for a car should be around RM 150 per month in order to reduce the traffic demand by 15 percent, based on the analysis of the Opinion Survey data.

7) Vehicles to be Exempted from Charges

The following categories of vehicles should be exempted from the area pricing charges.

- Fixed Route Bus
- School Bus
- Emergency Vehicles (Ambulance, Fire engine, Police Patrol Car)
- Vehicles with Disabled Drivers
- Government Utility Vehicles (Garbage Lorry, Road Maintenance Vehicle and so forth)

If the main objective is to reduce traffic congestion, motorcycles should be included. However, they consume less space than cars, so a much lower rate of one fourth or one third of the rate for cars should be charged.

Taxis could be exempted because their role as public transport. At present some people use taxis for their commuting purposes in Kuala Lumpur because of the cheaper taxi fare and shorter travel time due to bus and taxi priority lanes. If the introduction of an area pricing scheme brings about a shift to taxis and taxis cause traffic congestion in the CBD, taxi should be included in the vehicles to be charged.

8) Payment & Enforcement

Vehicle drivers passing streets within the restricted area must buy a sticker in advance at stores that have a contract with the agency concerned. In the initial stage no gate is prepared for control purposes but violations of the rule will be checked by control officers.

9) Monitoring and Modification of Area Pricing Scheme

It is of great importance for the relevant agency to monitor the change in traffic condition and to modify the restricted area, charge level, vehicles to be charged, and so on according to the change in the traffic condition.

10) Agency in Charge of "Area Pricing Scheme"

It is recommended that a new Kuala Lumpur Metropolitan Transport Authority should deal with the implementation of the area pricing scheme. (Issues on Kuala Lumpur Transportation authority will be discussed in detail in Chapter 14) The agency will collect the area pricing charge from the vehicles passing through the restricted streets. The revenue may amount to around RM 1.3 million at a charge level of RM 150 per month in 2000. This revenue will be allocated for the operation costs for area pricing scheme, and the remainder will be utilised for the improvement of urban transportation facilities.

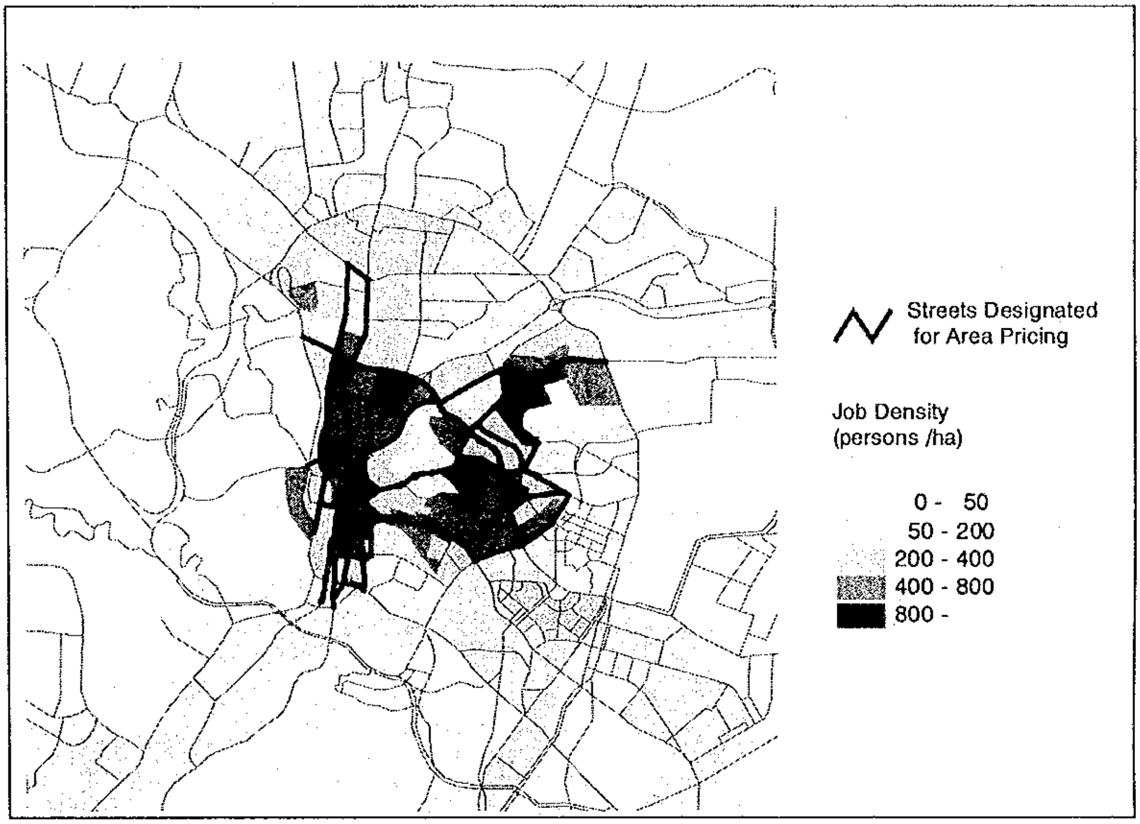


Figure 9.1.9 Proposed Area Pricing Zone (Roads)

(5) Effect of the Area Pricing: Policy Tests

As discussed in Chapter 4, discrete choice models were developed to test the proposed area pricing scheme numerically. Four cases were prepared to examine the degrees of effectiveness of the policy.

1) Influential Area of the Pricing Scheme

The zones to be affected by the area pricing scheme are shown in Figure 9.1.10. Zone numbers in the figure follow the D zone system used in the transport models for SMURT-KL.

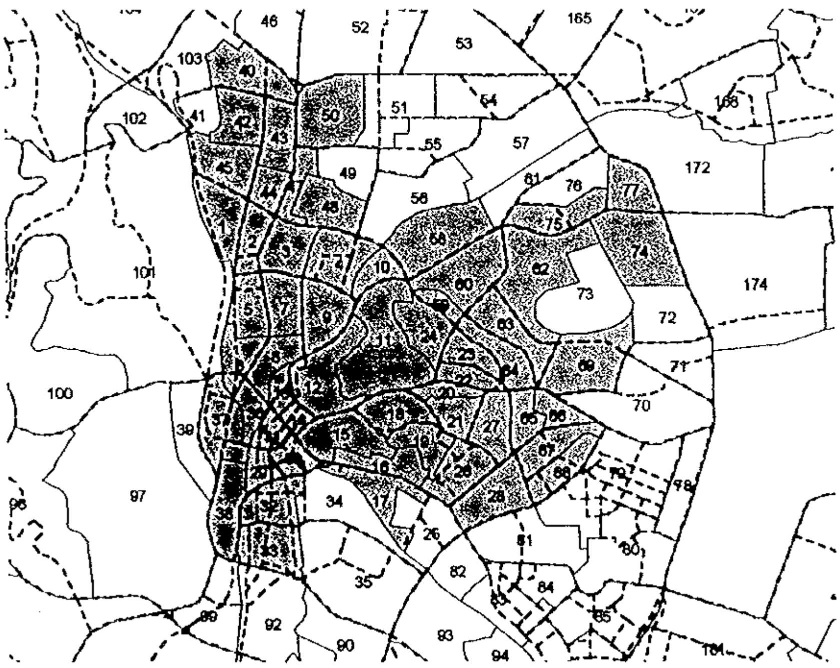


Figure 9.1.10 Traffic Zones (D zones) under Influence of Area Pricing

2) Workers Affected by the Policy

In 1997, it was estimated that there were about 320,000 job opportunities in the CPA. Due to the many large-scale urban development projects in KL, this figure will increase to around 360,000 even though many government staffs will move to Putra Jaya.

Workers that are affected by the area pricing scheme is about 70% of the total of the CPA in 1997, that is, 22,300. In the year 2000, this figure (22,300) will increase slightly to 25,800.

Table 9.1.9 Job Opportunity Influenced by the Pricing Scheme

		Total Job Opportunity				Influenced Job Opportunity			
D_SYSTEM	AREA(ha)	ALLJOB97	ALLJOB00	ALLJOB10	ALLJOB20	ALLJOB97	ALLJOB00	ALLJOB10	ALLJOB20
1	85.60	52,633	57,109	64,592	73,646	52,633	57,109	64,592	73,646
2	55.27	14,117	15,148	18,856	20,192	14,117	15,148	18,856	20,192
3	59.71	26,145	27,966	34,857	37,362	26,145	27,966	34,857	37,362
4	21.51	14,204	14,337	17,678	19,707	14,204	14,337	17,678	19,707
5	46.54	23,061	23,321	24,005	24,038	20,356	20,578	21,041	21,083
6	13.90	13,605	13,842	14,231	14,298	13,605	13,842	14,231	14,298
7	21.80	8,919	9,125	9,410	9,483	8,919	9,125	9,410	9,483
8	52.80	4,247	4,455	4,744	4,818	0	0	0	0
9	42.20	16,288	17,818	16,500	17,450	8,688	9,515	9,043	9,529
10	57.24	12,327	12,691	13,902	13,951	9,602	9,890	10,920	10,950
11	23.28	7,009	7,305	10,228	12,758	0	0	0	0
12	62.95	11,836	14,849	25,812	30,570	6,988	9,914	20,453	25,245
13	46.61	10,932	12,406	9,144	10,179	0	0	0	0
14	28.64	1,560	1,650	13,690	22,923	0	0	0	0
15	82.74	4,045	4,197	5,159	5,125	0	0	0	0
16	51.61	9,454	10,606	19,755	25,131	7,908	8,106	13,621	17,330
17	133.53	26,394	46,908	84,439	87,543	24,931	45,414	80,219	81,693
18	58.59	11,413	11,661	12,122	12,182	8,419	8,586	8,603	8,677
19	30.90	9,660	10,641	14,322	15,760	7,234	8,166	11,630	13,084
20	99.07	3,816	5,303	11,336	13,577	0	0	0	0
21	64.95	13,913	14,206	14,971	15,000	0	0	0	0
22	100.84	2,511	2,687	3,197	3,222	0	0	0	0
23	55.28	4,928	5,157	5,455	9,561	0	0	0	0
24	67.34	7,362	7,690	8,170	8,255	0	0	0	0
25	170.54	4,057	4,485	4,385	4,593	0	0	0	0
26	228.19	5,249	5,896	5,268	5,636	0	0	0	0
	1,761.63	319,685	361,459	466,228	516,960	223,749	257,696	335,154	362,279

Zones that are greatly influenced by the area pricing scheme are Zones 1, 3, and 17. The total attracted Home-Based-Work (HBW) trips of these three zones reach around 46 % of the whole influenced trips.

3) Predicted Changes in Modal Share

The tested three cases are as follows:

Case 1: Impose RM100/Month on car users with HBW purpose;

Case 2: Impose RM150/Month on car users with HBW purpose;

Case 3: Impose RM200/Month on car users with HBW purpose; and

Case 4: Full Transport Allowance to Public Mode Users with HBW purpose.

A summary of the simulations is presented below:

Table 9.1.10 Modal Share of Workers in the Influential Area

	MC	CAR	BUS	RAIL
No Policy	29.0 %	41.4 %	17.2 %	12.5 %
Case 1	29.9 %	38.2 %	18.5 %	13.4 %
Case 2	30.3 %	36.6 %	19.2 %	14.0 %
Case 3	30.7 %	35.0 %	19.9 %	14.5 %
Case 4	21.5 %	33.1 %	1.3 %	44.1 %

Table 9.1.11 Increase of Trips from No Policy Case (unit : person trips)

	MC	CAR	*CAR (veh)*	BUS	RAIL
Case 1: RM100	2,327	- 7,992	*- 6,324*	3,285	2,381
Case 2: RM150	3,312	- 11,958	*- 9,490*	5,016	3,630
Case 3: RM200	4,197	-15,883	*- 12,605*	6,783	4,903
Case 4	- 18,328	- 20,489	*- 16,261*	-39,141	77,959

As shown in Table 9.1.11, if one desires to remove around 10,000 cars in the year 2000, charge amount of around RM150/Month would be effective. Among the test cases, ALT 4 had the strongest impact.

Table 9.1.12 Results of Test Policy Cases

Non Policy Cases in 1997 and 2000

HBW Person Trips attracted to Area Pricing Zones

1997 REVEALED DATA

DEST	PRIVATE	PUBLIC	MC	CAR	BUS	RAIL	TOTAL
1	34,315	10,520	12,004	22,311	9,169	1,351	44,835
2	9,355	3,004	2,886	6,469	2,566	438	12,359
3	16,976	4,853	5,688	11,288	4,374	479	21,829
4	9,908	2,293	2,816	7,092	2,177	116	12,201
5	15,243	4,080	4,278	10,965	3,640	440	19,323
6	8,243	3,334	2,109	6,134	2,977	357	11,577
7	5,729	2,140	1,757	3,972	1,915	225	7,869
9	11,476	2,201	5,132	6,344	1,722	479	13,677
10	7,319	2,194	2,348	4,971	1,844	350	9,513
12	6,467	2,429	2,779	3,688	2,269	160	8,896
16	6,511	1,294	2,247	4,264	1,255	39	7,805
17	17,396	4,225	5,328	12,068	3,968	257	21,621
18	7,733	2,065	2,447	5,286	1,996	69	9,798
19	6,698	1,843	1,904	4,794	1,667	176	8,541
TOTAL	163,369	46,475	53,723	109,646	41,539	4,936	209,844

MODAL SHARE BY DESTINATION ZONE

DEST	PRIVATE	PUBLIC	MC	CAR	BUS	RAIL	TOTAL
1	76.5%	23.5%	26.8%	49.8%	20.5%	3.0%	100.0%
2	75.7%	24.3%	23.4%	52.3%	20.8%	3.5%	100.0%
3	77.8%	22.2%	26.1%	51.7%	20.0%	2.2%	100.0%
4	81.2%	18.8%	23.1%	58.1%	17.8%	1.0%	100.0%
5	78.9%	21.1%	22.1%	56.7%	18.8%	2.3%	100.0%
6	71.2%	28.8%	18.2%	53.0%	25.7%	3.1%	100.0%
7	72.8%	27.2%	22.3%	50.5%	24.3%	2.9%	100.0%
9	83.9%	16.1%	37.5%	46.4%	12.6%	3.5%	100.0%
10	76.9%	23.1%	24.7%	52.3%	19.4%	3.7%	100.0%
12	72.7%	27.3%	31.2%	41.5%	25.5%	1.8%	100.0%
16	83.4%	16.6%	28.8%	54.6%	16.1%	0.5%	100.0%
17	80.5%	19.5%	24.6%	55.8%	18.4%	1.2%	100.0%
18	78.9%	21.1%	25.0%	53.9%	20.4%	0.7%	100.0%
19	78.4%	21.6%	22.3%	56.1%	19.5%	2.1%	100.0%
TOTAL	77.9%	22.1%	25.6%	52.3%	19.8%	2.4%	100.0%

2000 NON POLICY CASE

DEST	PRIVATE	PUBLIC	MC	CAR	BUS	RAIL	TOTAL
1	33,899	15,254	13,947	19,952	8,820	6,434	49,153
2	9,360	3,824	3,848	5,512	2,235	1,589	13,184
3	17,169	7,148	7,069	10,100	4,169	2,979	24,317
4	8,612	3,887	3,544	5,068	2,238	1,649	12,499
5	14,257	5,526	5,862	8,395	3,181	2,345	19,783
6	8,224	3,814	3,390	4,834	2,184	1,630	12,038
7	5,457	2,395	2,245	3,212	1,375	1,020	7,852
9	10,780	4,777	4,438	6,342	2,749	2,028	15,557
10	7,598	3,242	3,122	4,476	1,878	1,384	10,840
12	9,047	3,532	3,711	5,336	2,068	1,464	12,579
16	6,321	2,851	2,600	3,721	1,636	1,215	9,172
17	28,730	11,578	11,829	16,901	6,712	4,866	40,308
18	7,437	2,663	3,073	4,364	1,561	1,102	10,100
19	6,673	2,602	2,757	3,916	1,502	1,100	9,275
TOTAL	173,564	73,093	71,435	102,129	42,306	30,785	246,657

MODAL SHARE BY DESTINATION ZONE

DEST	PRIVATE	PUBLIC	MC	CAR	BUS	RAIL	TOTAL
1	69.0%	31.0%	28.4%	40.6%	17.9%	13.1%	100.0%
2	71.0%	29.0%	29.2%	41.8%	17.0%	12.1%	100.0%
3	70.6%	29.4%	29.1%	41.5%	17.1%	12.3%	100.0%
4	68.9%	31.1%	28.4%	40.5%	17.9%	13.2%	100.0%
5	72.1%	27.9%	29.6%	42.4%	16.1%	11.9%	100.0%
6	68.3%	31.7%	28.2%	40.2%	18.1%	13.5%	100.0%
7	69.5%	30.5%	28.6%	40.9%	17.5%	13.0%	100.0%
9	69.3%	30.7%	28.5%	40.8%	17.7%	13.0%	100.0%
10	70.1%	29.9%	28.8%	41.3%	17.3%	12.6%	100.0%
12	71.9%	28.1%	29.5%	42.4%	16.4%	11.6%	100.0%
16	68.9%	31.1%	28.3%	40.6%	17.8%	13.2%	100.0%
17	71.3%	28.7%	29.3%	41.9%	16.7%	12.1%	100.0%
18	73.6%	26.4%	30.4%	43.2%	15.5%	10.9%	100.0%
19	71.9%	28.1%	29.7%	42.2%	16.2%	11.9%	100.0%
TOTAL	70.4%	29.6%	29.0%	41.4%	17.2%	12.5%	100.0%

Case 1: RM100/Month on Car in 2000

POLICY: 100 RM/MONTH on CAR

2000 MODEL OUTPUT

DEST	PRIVATE	PUBLIC	MC	CAR	BUS	RAIL	TOTAL
1	32,715	17,406	14,385	18,330	9,504	6,933	49,153
2	9,056	4,398	3,976	5,081	2,412	1,715	13,184
3	16,607	8,209	7,302	9,305	4,496	3,214	24,317
4	8,315	4,429	3,650	4,665	2,410	1,775	12,499
5	13,821	6,381	6,071	7,750	3,433	2,529	19,783
6	7,934	4,335	3,489	4,445	2,350	1,754	12,038
7	5,273	2,735	2,315	2,958	1,481	1,098	7,852
9	10,416	5,444	4,577	5,839	2,959	2,182	15,557
10	7,350	3,708	3,225	4,125	2,023	1,467	10,840
12	8,766	4,076	3,839	4,928	2,233	1,579	12,579
16	6,105	3,246	2,680	3,425	1,760	1,307	9,172
17	27,822	13,326	12,235	15,587	7,240	5,246	40,308
18	7,219	3,102	3,185	4,034	1,689	1,192	10,100
19	6,498	2,997	2,833	3,664	1,603	1,174	9,275
TOTAL	167,899	83,792	73,762	94,137	45,593	33,166	246,657

DEST	PRIVATE	PUBLIC	MC	CAR	BUS	RAIL	TOTAL
1	65.3%	34.7%	29.3%	37.3%	19.3%	14.1%	100.0%
2	67.3%	32.7%	30.2%	38.5%	18.3%	13.0%	100.0%
3	66.9%	33.1%	30.0%	38.3%	18.5%	13.2%	100.0%
4	65.2%	34.8%	29.2%	37.3%	19.3%	14.2%	100.0%
5	68.4%	31.6%	30.7%	39.2%	17.4%	12.8%	100.0%
6	64.7%	35.3%	29.0%	36.9%	19.5%	14.6%	100.0%
7	65.8%	34.2%	29.5%	37.7%	18.9%	14.0%	100.0%
9	65.7%	34.3%	29.4%	37.5%	19.0%	14.0%	100.0%
10	66.5%	33.5%	29.8%	38.1%	18.7%	13.5%	100.0%
12	68.3%	31.7%	30.5%	39.2%	17.7%	12.6%	100.0%
16	65.3%	34.7%	29.2%	37.3%	19.2%	14.2%	100.0%
17	67.6%	32.4%	30.4%	38.7%	18.0%	13.0%	100.0%
18	69.9%	30.1%	31.5%	39.9%	16.7%	11.8%	100.0%
19	68.4%	31.6%	30.5%	39.5%	17.3%	12.7%	100.0%
TOTAL	66.7%	33.3%	29.9%	38.2%	18.5%	13.4%	100.0%

INCREASE FROM NON POLICY

DEST	PRIVATE	PUBLIC	MC	CAR	BUS	RAIL	TOTAL
1	-1184	2152	438	-1622	684	499	0
2	-304	574	128	-431	177	126	0
3	-562	1061	233	-795	327	235	0
4	-297	542	106	-403	172	126	0
5	-436	855	209	-645	252	184	0
6	-290	521	99	-389	166	124	0
7	-184	340	70	-254	106	78	0
9	-364	667	139	-503	210	154	0
10	-248	466	103	-351	145	103	0
12	-279	544	128	-408	165	115	0
16	-216	395	80	-296	124	92	0
17	-908	1748	406	-1314	528	380	0
18	-218	439	112	-330	128	90	0
19	-175	395	76	-252	101	74	0
TOTAL	-5665	10699	2327	-7992	3285	2381	0

%INCREASE FROM NON POLICY

DEST	PRIVATE	PUBLIC	MC	CAR	BUS	RAIL	TOTAL
1	-3.5%	14.1%	3.1%	-8.1%	7.8%	7.8%	0.0%
2	-3.2%	15.0%	3.3%	-7.8%	7.9%	7.9%	0.0%
3	-3.3%	14.8%	3.3%	-7.9%	7.9%	7.9%	0.0%
4	-3.5%	13.9%	3.0%	-8.0%	7.7%	7.6%	0.0%
5	-3.1%	15.5%	3.6%	-7.7%	7.9%	7.8%	0.0%
6	-3.5%	13.7%	2.9%	-8.1%	7.6%	7.6%	0.0%
7	-3.4%	14.2%	3.1%	-7.9%	7.7%	7.6%	0.0%
9	-3.4%	14.0%	3.1%	-7.9%	7.6%	7.6%	0.0%
10	-3.3%	14.4%	3.3%	-7.8%	7.7%	7.6%	0.0%
12	-3.1%	15.4%	3.5%	-7.6%	8.0%	7.8%	0.0%
16	-3.4%	13.9%	3.1%	-8.0%	7.6%	7.6%	0.0%
17	-3.2%	15.1%	3.4%	-7.8%	7.9%	7.8%	0.0%
18	-2.9%	16.5%	3.6%	-7.6%	8.2%	8.2%	0.0%
19	-2.6%	15.2%	2.8%	-6.4%	6.7%	6.8%	0.0%
TOTAL	-3.3%	14.6%	3.3%	-7.8%	7.8%	7.7%	0.0%

Case 2: RM150/Month on Car in 2000

POLICY: 150 RM/MONTH on CAR

2000 MODEL OUTPUT

DEST	PRIVATE	PUBLIC	MC	CAR	BUS	RAIL	TOTAL
1	32,096	18,470	14,569	17,528	9,863	7,194	49,153
2	8,896	4,683	4,030	4,866	2,506	1,782	13,184
3	16,310	8,734	7,400	8,910	4,669	3,339	24,317
4	8,159	4,698	3,694	4,465	2,499	1,841	12,499
5	13,590	6,804	6,160	7,431	3,568	2,625	19,783
6	7,784	4,592	3,531	4,252	2,436	1,818	12,038
7	5,177	2,903	2,345	2,832	1,536	1,139	7,852
9	10,225	5,774	4,636	5,590	3,068	2,263	15,557
10	7,220	3,939	3,270	3,950	2,099	1,521	10,840
12	8,619	4,346	3,894	4,726	2,320	1,639	12,579
16	5,991	3,442	2,713	3,278	1,826	1,355	9,172
17	27,342	14,192	12,407	14,935	7,519	5,447	40,308
18	7,103	3,319	3,232	3,870	1,758	1,240	10,100
19	6,405	3,191	2,866	3,540	1,656	1,214	9,275
TOTAL	164,918	89,068	74,747	90,171	47,324	34,415	246,657

DEST	PRIVATE	PUBLIC	MC	CAR	BUS	RAIL	TOTAL
1	63.5%	36.5%	29.6%	35.7%	20.1%	14.6%	100.0%
2	65.5%	34.5%	30.6%	36.9%	19.0%	13.5%	100.0%
3	65.1%	34.9%	30.4%	36.6%	19.2%	13.7%	100.0%
4	63.5%	36.5%	29.6%	35.7%	20.0%	14.7%	100.0%
5	66.6%	33.4%	31.1%	37.6%	18.0%	13.3%	100.0%
6	62.9%	37.1%	29.3%	35.3%	20.2%	15.1%	100.0%
7	64.1%	35.9%	29.9%	36.1%	19.6%	14.5%	100.0%
9	63.9%	36.1%	29.8%	35.9%	19.7%	14.5%	100.0%
10	64.7%	35.3%	30.2%	36.4%	19.4%	14.0%	100.0%
12	66.5%	33.5%	31.0%	37.6%	18.4%	13.0%	100.0%
16	63.5%	36.5%	29.6%	35.7%	19.9%	14.8%	100.0%
17	65.8%	34.2%	30.8%	37.1%	18.7%	13.5%	100.0%
18	68.1%	31.9%	32.0%	38.3%	17.4%	12.3%	100.0%
19	66.7%	33.3%	30.9%	39.2%	17.9%	13.1%	100.0%
TOTAL	64.9%	35.1%	30.3%	36.6%	19.2%	14.0%	100.0%

INCREASE FROM NON POLICY

DEST	PRIVATE	PUBLIC	MC	CAR	BUS	RAIL	TOTAL
1	-1803	3216	622	-2424	1043	760	0
2	-464	859	182	-646	271	193	0
3	-859	1586	331	-1190	500	359	0
4	-453	811	150	-603	261	192	0
5	-667	1278	298	-964	387	280	0
6	-440	778	141	-582	252	188	0
7	-280	508	100	-380	161	119	0
9	-555	997	198	-752	319	235	0
10	-378	697	148	-526	221	157	0
12	-428	814	183	-610	252	175	0
16	-330	591	113	-443	190	140	0
17	-1388	2614	578	-1966	807	581	0
18	-334	656	159	-494	197	138	0
19	-268	589	109	-376	154	114	0
TOTAL	-8646	15995	3312	-11956	5016	3630	0

%INCREASE FROM NON POLICY

DEST	PRIVATE	PUBLIC	MC	CAR	BUS	RAIL	TOTAL
1	-5.3%	21.1%	4.5%	-12.2%	11.8%	11.8%	0.0%
2	-5.0%	22.5%	4.7%	-11.7%	12.1%	12.1%	0.0%
3	-5.0%	22.2%	4.7%	-11.8%	12.0%	12.0%	0.0%
4	-5.3%	20.9%	4.2%	-11.9%	11.7%	11.6%	0.0%
5	-4.7%	23.1%	5.1%	-11.5%	12.2%	11.9%	0.0%
6	-5.4%	20.4%	4.2%	-12.0%	11.6%	11.5%	0.0%
7	-5.1%	21.2%	4.5%	-11.6%	11.7%	11.6%	0.0%
9	-5.1%	20.9%	4.5%	-11.9%	11.6%	11.6%	0.0%
10	-5.0%	21.5%	4.7%	-11.7%	11.8%	11.5%	0.0%
12	-4.7%	23.0%	4.9%	-11.4%	12.2%	12.0%	0.0%
16	-5.2%	20.7%	4.4%	-11.9%	11.6%	11.5%	0.0%
17	-4.8%	22.6%	4.9%	-11.6%	12.0%	11.9%	0.0%
18	-4.5%	24.6%	5.2%	-11.3%	12.6%	12.5%	0.0%
19	-4.0%	22.6%	3.9%	-9.6%	10.3%	10.3%	0.0%
TOTAL	-5.0%	21.9%	4.6%	-11.7%	11.9%	11.8%	0.0%

Case 3: RM200/Month on Car in 2000

POLICY: 200 RM/MONTH on CAR

2000 MODEL OUTPUT

DEST	PRIVATE	PUBLIC	MC	CAR	BUS	RAIL	TOTAL
1	31,467	19,520	14,733	16,734	10,226	7,459	49,153
2	8,732	4,964	4,078	4,654	2,602	1,850	13,184
3	16,006	9,254	7,487	8,519	4,846	3,465	24,317
4	8,000	4,963	3,734	4,266	2,591	1,906	12,499
5	13,354	7,222	6,240	7,114	3,706	2,723	19,783
6	7,631	4,845	3,570	4,062	2,524	1,883	12,038
7	5,079	3,070	2,372	2,707	1,593	1,160	7,852
9	10,031	6,100	4,688	5,343	3,180	2,345	15,557
10	7,088	4,167	3,310	3,778	2,177	1,576	10,840
12	8,468	4,613	3,943	4,525	2,411	1,700	12,579
16	5,876	3,636	2,744	3,132	1,892	1,404	9,172
17	26,851	15,050	12,563	14,268	7,806	5,651	40,306
18	6,962	3,535	3,275	3,707	1,828	1,289	10,100
19	6,311	3,383	2,895	3,416	1,711	1,253	9,275
TOTAL	161,878	94,322	75,632	86,246	49,091	35,688	246,657

DEST	PRIVATE	PUBLIC	MC	CAR	BUS	RAIL	TOTAL
1	61.7%	38.3%	30.0%	34.0%	20.8%	15.2%	100.0%
2	63.8%	36.2%	30.9%	35.3%	19.7%	14.0%	100.0%
3	63.4%	36.6%	30.8%	35.0%	19.9%	14.3%	100.0%
4	61.7%	38.3%	29.9%	34.1%	20.7%	15.3%	100.0%
5	64.9%	35.1%	31.5%	36.0%	18.7%	13.8%	100.0%
6	61.2%	38.8%	29.7%	33.7%	21.0%	15.6%	100.0%
7	62.3%	37.7%	30.2%	34.5%	20.3%	15.0%	100.0%
9	62.2%	37.8%	30.1%	34.3%	20.4%	15.1%	100.0%
10	63.0%	37.0%	30.5%	34.9%	20.1%	14.5%	100.0%
12	64.7%	35.3%	31.3%	36.0%	19.2%	13.5%	100.0%
16	61.8%	38.2%	29.9%	34.1%	20.6%	15.3%	100.0%
17	64.1%	35.9%	31.2%	35.4%	19.4%	14.0%	100.0%
18	66.4%	33.6%	32.4%	36.7%	18.1%	12.8%	100.0%
19	65.1%	34.9%	31.2%	36.8%	18.4%	13.5%	100.0%
TOTAL	63.2%	36.8%	30.7%	35.0%	19.9%	14.5%	100.0%

INCREASE FROM NON POLICY

DEST	PRIVATE	PUBLIC	MC	CAR	BUS	RAIL	TOTAL
1	-2432	4266	786	-3218	1406	1025	0
2	-628	1140	230	-858	367	261	0
3	-1163	2106	418	-1581	677	486	0
4	-612	1076	190	-802	353	259	0
5	-903	1696	378	-1281	525	378	0
6	-593	1031	180	-772	340	253	0
7	-378	675	127	-505	218	160	0
9	-749	1323	250	-999	431	317	0
10	-510	925	188	-698	299	212	0
12	-579	1061	232	-811	343	236	0
16	-445	785	144	-589	256	189	0
17	-1879	3472	734	-2613	1094	785	0
18	-455	872	202	-657	267	187	0
19	-362	781	138	-500	209	153	0
TOTAL	-11686	21229	4197	-15883	6783	4903	0

%INCREASE FROM NON POLICY

DEST	PRIVATE	PUBLIC	MC	CAR	BUS	RAIL	TOTAL
1	-7.2%	26.0%	5.6%	-16.1%	15.9%	15.9%	0.0%
2	-6.7%	29.8%	6.0%	-15.6%	16.4%	16.4%	0.0%
3	-6.8%	29.5%	5.9%	-15.7%	16.2%	16.3%	0.0%
4	-7.1%	27.7%	5.4%	-15.8%	15.8%	15.7%	0.0%
5	-6.3%	30.7%	6.4%	-15.3%	16.5%	16.1%	0.0%
6	-7.2%	27.0%	5.3%	-16.0%	15.6%	15.5%	0.0%
7	-6.9%	28.2%	5.7%	-15.7%	15.8%	15.7%	0.0%
9	-6.9%	27.7%	5.6%	-15.8%	15.7%	15.7%	0.0%
10	-6.7%	28.5%	6.0%	-15.6%	15.9%	15.5%	0.0%
12	-6.4%	30.6%	6.2%	-15.2%	16.6%	16.2%	0.0%
16	-7.0%	27.5%	5.5%	-15.8%	15.6%	15.5%	0.0%
17	-6.5%	30.0%	6.2%	-15.5%	16.3%	16.1%	0.0%
18	-6.1%	32.7%	6.6%	-15.0%	17.1%	17.0%	0.0%
19	-5.4%	30.0%	5.0%	-12.8%	13.9%	13.9%	0.0%
TOTAL	-6.7%	29.0%	5.9%	-15.6%	16.0%	15.9%	0.0%

9.2 Short-term CPA Packaged Action Plan

9.2.1 General

(1) Objectives

As pointed out previously in the analysis of the current situation (refer to Chapter 2 of the Interim Report), the existing traffic congestion problem is caused by the inadequate road capacity including the lack of well-developed traffic management. Short-term countermeasure objectives for promoting the quality of the urban environment are, therefore, listed as follows, and measures to improve the bus priority system, traffic control system and road/traffic management facilities are proposed below.

- Improvement of bus services,
- Smooth traffic flow,
- Alleviation of traffic congestion, and
- Reduction of traffic accidents.

An appropriate, systematic traffic management plan is essential for the safe, smooth flow of increasing motor traffic on the roads. Traffic management is particularly important in making the most of the existing road facilities, and improving the current road capacities. Since the traffic management plan involves relatively low cost, except for those measures which improve facilities of a large size, and since it is possible to carry out a trial-error method while observing the effects on the traffic flow and other factors, it is necessary to introduce improvement measures that respond to the changing requirements of different times.

With a view to achieving smooth traffic flow in important areas as the CBD and inter-modal points, the objective of the short-term plan is to mitigate traffic congestion at bottlenecks.

Thus, it is necessary to increase road traffic capacity through the improvement of traffic management facilities. Measures to achieve this are listed in Table 9.2.1.

(2) Study Area

CPA is defined as a 17.6 km^2 circular area, surrounded by the seven arterial roads, Jalan Tun Razak, Jalan Yew, Jalan Sungai Besi, Jalan Lapangan Terbang, Jalan Istana, Jalan Damansara, and Lebuhraya Mahameru (see Figure 9.2.1). CPA is the most important part of the Kuala Lumpur city from the standpoint of economic and transportation activity; it encompasses the CBD, governmental building areas and main transportation gateways toward the north, south, east and west.

Figure 9.2.1 Study Area of CPA Development Plan

Table 9.2.1 Current Problems and Countermeasures

Current Problems	Countermeasures
1. Traffic congestion at signalised intersections	Improvement of traffic signal control system 1) Traffic response system on over-saturated condition 2) Co-ordination system of traffic signals 3) Improvement of signal phasing system
2. Traffic congestion at no-signalised roundabout	Improvement of roundabout 1) Traffic signalised roundabout 2) Improved channelisation system
3. Traffic spill-back associated with bottlenecks (lack of capacity)	Improvement of road traffic capacity 1) Reversible flow lane system
4. Traffic congestion of buses	Improvement of level of services of buses 1) Bus priority lane system
5. High rate of traffic accidents involving pedestrians and no pedestrian friendliness of crossing / sidewalk	Improvement of pedestrian facilities 1) Signalised pedestrian crossing 2) Pedestrian crossing bridge 3) Scramble pedestrian crossing 4) Pedestrian-friendly sidewalk

Source: SMURT-KL

9.2.2 Plan Details

(1) Improvement of Traffic Signal Control System

The current problems and issues relating to the existing traffic signal control system are as follows;

- For traffic congestion caused by spill-back due to over-saturation, technical improvement of the signal control system to manage the traffic volume should be considered.
- For serious traffic congestion on major radial roads during peak hours, it is recommended that a co-ordinated traffic signal system be introduced.
- For reduced traffic capacity caused by multi-phase type systems which set only one direction green in each phase, the improvement of traffic signal phase system should be considered.

Based on the foregoing consideration, the three plans listed below were proposed for mitigating traffic congestion.

1) Traffic response system in an over-saturated condition

2) Co-ordination system of traffic signal lights

3) Improvement of signal phase system

1) Traffic Response System in an Over-saturated Condition

In order to alleviate traffic congestion in an over-saturated condition, it is recommended that a traffic response system be introduced. It is applicable for all traffic conditions, from under-saturation to over-saturation. As part of the advanced traffic control system of the Tokyo Metropolitan Police Department, this new signal control system* has been developed.

*Source: Advanced traffic control system of Tokyo Metropolitan Police Department.

This section discusses the concept of control, system configuration, and the result of application.

a. Concept of Real-time Control System

The concept of control is explained below.

i When traffic demand is under-saturated, the system aims not only to reduce delays and stops but also to make the traffic flow safe by moderating the speed of the vehicles. It therefore uses a tool to set up an offset which corresponds to the cycle length, and uses a pattern selection method for real-time offset control.

ii When traffic demand is nearly saturated, this system curbs congestion by improving the efficiency of the green time at critical intersections and maximising the traffic capacity. A critical intersection control method (congestion alleviation control) is used to achieve this. The congestion alleviation control directly calculates the split and cycle length every 2.5 minutes based on the queue and traffic volume calculated from the vehicle detector information. This system also incorporates right turn vehicle actuation which is run every second by a signal controller at each critical intersection.

iii When traffic demand is over-saturated, this system runs priority control for competing traffic flows at critical intersections. If congestion has exceeded a certain limit within a specific area such as the city centre, this system controls inflow into that area. Priority control is made possible by the congestion alleviation control function and inflow control is provided by the Intentional Priority Control.

b. System Configuration and Summary of Functions

As shown in Figure 9.2.2, this system consists of several Area Computers, a Traffic Information Processing Computer, and Signal Control Supervisor Computer.

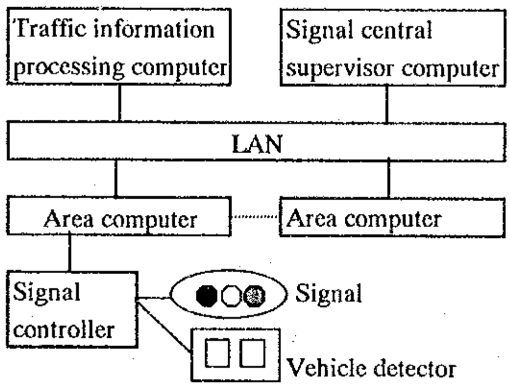


Figure 9.2.2 System Configuration

c. Result of Application

The introduction of Congestion Alleviation Control, which is the main function of this system at 308 critical intersections within Tokyo, showed that total travel time during the daytime (7 a.m. to 7 p.m.) fell by 9%, total delay fell by 23% and congestion length-time fell by 28%.*

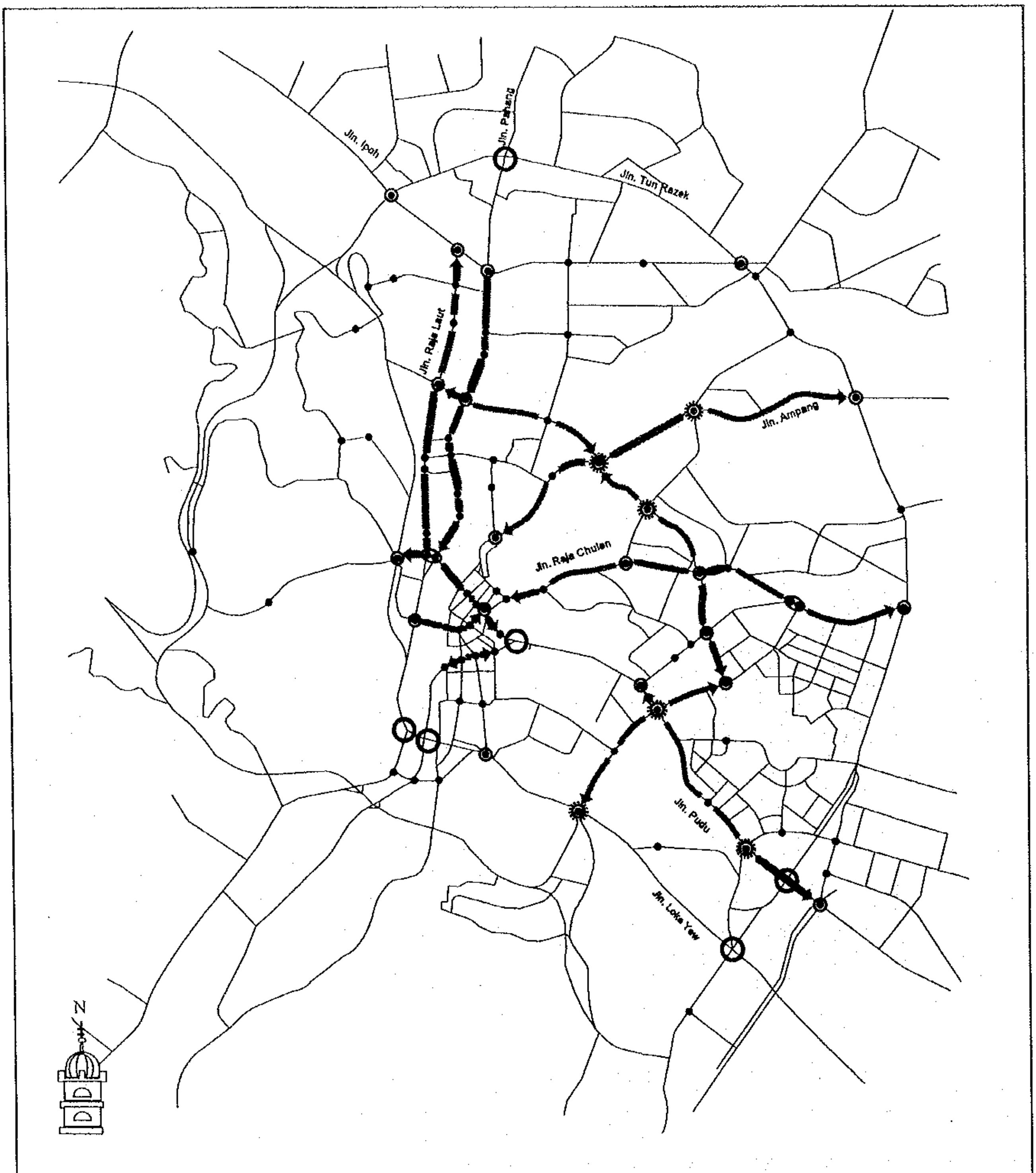
*Source: Advanced traffic control system of Tokyo Metropolitan Police Department.

d. Locations of Traffic Response System on Over-saturated Condition

As shown in Figure 9.2.3, this plan will deal with the signalised intersections, which have been pinpointed as key bottlenecks with an over-saturated condition through the analysis of the current situation.

2) Co-ordination System of Traffic Signal Lights

Currently, during peak hours, most major signalised intersections are manually controlled by traffic policemen; however, this manual control is not enough to control the co-ordination of the signals. In order to achieve a smooth traffic flow in major directions on seriously congested roads, it is highly recommended to strengthen the computerised co-ordination system of signals during peak hours. The aim of this is also to assist the increase in traffic capacity in the case of reversible flow lanes and bus priority lane systems. Figure 9.2.3 shows the planned locations of the co-ordination system, which cover the major routes for reversible flow lane and bus priority lane systems.



LEGEND

- Existing Singnalised Intersection
- Traffic Response System in an Over-Saturated Condition
- Co-ordination System of Traffic Signal Light
- Signal Phase Improvement (highly effective intersections)
- Traffic Signalised Roundabout and Channelization

Figure 9.2.3
Improvement of Traffic Signal Control System and Non-Signalised Roundabouts

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IN
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3) Improvement of Signal Phase System

The multi-phase type system which sets only one direction green in each phase should be improved with a phase type system, because the existing multi-phase type leads to a long cycle length as a total and a decrease in traffic capacity. This section will discuss and compare the traffic capacity under the existing system and the improved system.

a. Proposed Signal Phase System

Figure 9.2.4 illustrates an example of the proposed signal phase system at a typical four-leg intersection. In principal, the proposed system is composed of two (2) main phases and two (2) additional green splits for right turns.

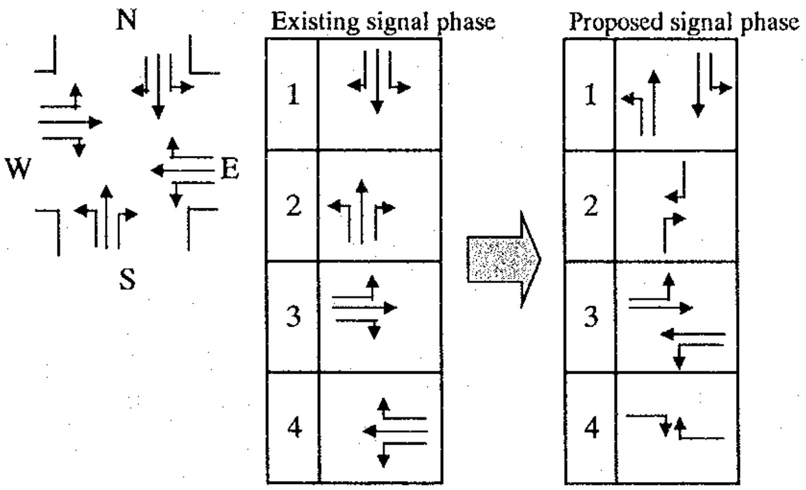


Figure 9.2.4 Proposed Signal Phase

b. Proposed Signal Step Diagram

Based on the proposed signal phase system, the signal step diagram is shown in Figure 9.2.5. The cycle length of the proposed signal phase system is established as about 100 seconds with the green time of each main phase set as 40 seconds; the current cycle length is about 170 seconds.

If the cycle length is too long, waiting pedestrians and/or drivers will get irritated, and vehicle queues may also become too long. Therefore, the absolute maximum cycle length is normally assumed to be 180 seconds (about 3 minutes). The minimum cycle length is determined as 40 seconds under the constraint of the minimum green time, even if the intersection is too small. In consequence, a cycle length should vary within a range of between 40 and 180 seconds.

Existing signal step. (cycle length=172sec)

Phase No.	Time (sec) 50 / 100 / 150 / 172					
1	G(40)	Y	R(129)			
2	R(43)	G(40)	Y	R(86)		
3	R(86)	G(40)	Y	R(43)		
4	R(129)	G(40)	Y			

Note: G: green, R: red, Y: yellow (3sec)

Proposed signal step. (cycle length=106sec)

Phase No.	Time (sec) 50 / 106			
1	G(40)	Y	R(60)	
2	R(43)	GA	R(53)	
3	R(53)	G(40)	Y	R(10)
4	R(96)	GA		

Note: G: green, R: red, GA: green arrow (10sec),
Y: yellow (3sec)

Figure 9.2.5 Proposed Signal Step Diagram

c. Comparison of Traffic Capacity and Results of Implementation

The traffic capacity was roughly compared among these signal phase systems. Table 9.2.2 shows the results of the total traffic capacity at a signalised intersection. The results show that the proposed signal phase system will increase the traffic capacity by approximately 20%. When right turns are prohibited, the results indicate that the traffic capacity will increase by approximately 40%. Therefore, these results show that the proposed signal phase system is obviously more effective in increasing the traffic capacity at a signalised intersection.

Table 9.2.2 Comparison of Traffic Capacity at an Intersection

Unit: PCU/green time hour

Phase / Prohibition	Existing Phase	Proposed Phase	Rate of increase
Right-turn traffic	5,400	6,700	+ 19%
No right-turn traffic	3,700	6,000	+ 38%

Note: Traffic capacity is total of 4 approaches

Basically, the proposed signal phase system should be adopted at all signalised intersections inside the CPA in order to avoid confusion among drivers and to be systematically consistent with other improvement measures such as the co-ordination system for traffic signal lights. However, the following intersections are especially recommended, in that they will see a drastic change from the current condition and generate a remarkable effect. (See Figure 9.2.3.)

- Jalan Ampang - Jalan Yap Kwan Seng – Jalan P. Ramlee
- Jalan Sultan Ismail - Jalan Ampang
- Jalan Sultan Ismail - Jalan P. Ramlee
- Jalan Pudu – Jalan Imbi – Jalan Hang Tuah
- Jalan Maharajalela - Jalan Loke Yew – Jalan Hang Tuah – Jalan Lapangan Terbang
- Jalan Pudu - Jalan Pasar – Jalan Sungai Besi

(2) Improvement of Non-signalised Roundabouts

The plan for roundabout improvement, including channelisation will cover the non-signalised roundabouts which, based on the analysis of the current situation, are considered to be traffic bottlenecks. Major objectives of the improvement are the following two (2) items;

- To increase traffic capacity on at-grade roundabouts, and
- To avoid blockage of vehicles on an at-grade segment due to congestion on grade-separated roundabouts.

1) Signalised Intersection

The signalised intersection plan aims at installing new signals at roundabouts, in order to control both motor vehicles and pedestrian traffic. As this plan is just an introduction, the overall plan should be carried out after a more detailed survey. The proposed locations are as follows (see Figure 9.2.3).

- Jalan Pahang - Jalan Tun Razak
- Jalan Pudu - Jalan Yew
- Jalan Syed Putra
- Jalan Sultan Hishamuddin - Jalan Kinabalu
- Jalan Pudu - Jalan Tun Perak*

* This plan is shown in the immediate action plan of Model Area.

2) Channelisation System

Based on the installation of traffic signal lights at the roundabouts mentioned above, the traffic channelisation plan will mainly be executed according to the following:

a. Introduction of channelling islands,
b. Improvement of the size of channelling islands,
c. Landscaping of channelling islands,
d. Available width for channels,

e. Channelisation by pavement markings,
f. Directional pavement markings,
g. Protection of pedestrians,
h. Improvement of corner cut-offs,
i. Minimisation of the intersection area, and
j. Moving the flow of traffic as close as possible to a right angle.

(3) Improvement of Road Traffic Capacity

Since there is no space in the built-up area of the CPA, for the short-term, it is very difficult to widen the existing roads or to construct new roads. Accordingly, based on the current problem of traffic spill-back caused by lack of traffic capacity, it is necessary to increase the road traffic capacity through the maximum utilisation of the existing road facilities. The countermeasure should take into account the need to decrease the delay time and long queue of vehicles during peak hours. It is therefore necessary that a reversible flow lane system be selected for mitigating traffic congestion.

1) Reversible Flow Lane System

The reversible flow lane system is one of the ways to make the most of the existing road facilities. The reversible flow lane system is the most effective, as it allots lanes as required by demand during the peak hours. It is a cost-effective method. At present, reversible flow lane roads are located on major radial roads with high traffic volume such as Jalan Loke Yew, Jalan Sentul, and Jalan Kampung Pandan. The currently implemented reversible flow lanes have performed effectively in handling the present tidal traffic demand in KL. This section discusses the installation of reversible flow lane system on major roads with serious congestion inside the CPA. At the same time, the operating method and required traffic facilities are described.

a. Plan Locations

This plan will cover the segments on major roads in the CPA which, based on the analysis of the current situation, are congested with a low travel speed of under 10 km/h (see Figure 9.2.6). These locations are shown in Table 9.2.3.

Table 9.2.3 Locations of Congested Road Segments

Road	Direction	Congested segments (Average travel speed < 10km/h)			
		Morning peak hour		Evening peak hour	
		From	To	From	To
1. Jln. Ipoh	(1) Inbound	-	-	-	-
	(2) Outbound	Jln. T. Abdul Rahman	Jln. Tun Razak	-	-
2. Jln. Pahang	(1) Inbound	Jln. Tun Razak	Jln. Ipoh	Jln. Tun Razak	Jln. Ipoh
	(2) Outbound	Jln. Ipoh	Jln. Tun Razak	Jln. Ipoh	Jln. Tun Razak
3. Jln. T.Abdul Rahman	(1) Inbound	Jln. Ipoh	Jln. Tun Perak	Jln. Ipoh	Jln. Dang Wangi
4. Jln. Ampang	(1) Inbound	Jln. Tun Perak	Jln. Sultan Ismail	Jln. P.Ramlee	Jln. Sultan Ismail
	(2) Outbound	Jln. P.Ramlee	Jln. Tun Razak	Jln. P.Ramlee	Jln. Tun Razak
5. Jln. Raja Chulan	(1) Inbound	Jln. Tun Perak	Jln. Sultan Ismail	Jln. Pesoaran	Jln. Sultan Ismail
	(2) Outbound	-	-	Jln. Bukit Bintang	Jln. Sultan Ismail
6. Jln. Bukit Bintang	(1) Inbound	Jln. Tun Razak	Jln. Imbi	Jln. Tun Razak	Jln. Imbi
	(2) Outbound	Jln. Imbi	Jln. Tun Razak	Jln. Imbi	Jln. Tun Razak
7. Jln. Pudu	(1) Inbound	Jln. Yew	Jln. Imbi	Jln. Bukit Bintang	Jln. Tun Perak
	(2) Outbound	Jln. Bukit Bintang	Jln. Imbi	Jln. Tun Perak	Jln. Imbi
8. Tun Pearak	(1) Inbound	Jln. Raja Laut	Jln. Raja Chulan	Jln. Raja Laut	Jln. Pudu
	(2) Outbound	Jln. Raja Chulan	Jln. Kuching	Jln. Raja Chulan	Jln. T.Abdul Rahman
9. Jln. Syed Ptura	(1) Inbound	Jln. Damansara	Jln. Kinabalu	Jln. Damansara	Jln. Kinabalu
	(2) Outbound	Jln. Kinabalu	Jln. Sultan Sulaiman	Jln. Kinabalu	Jln. Sultan Sulaiman
10. Jln. Nirwana	(1) Inbound	Jln. Sultan Sulaiman	Jln. Pudu	-	-
- Cheng Lock	(2) Outbound	-	-	-	-
11. Jln. Kinabalu	(1) Inbound	-	-	Jln. Stn Hishamuddin	Jln. Sutan Sulaiman
	(2) Outbound	Jln. Stn Hishamuddin	Jln. Parlimen	-	-
12. Jln. Hishamuddin	(1) Inbound	Jln. Kinabalu	Jln. Raja Laut	Lebh. Pasar Besar	Jln. Raja Laut
	(2) Outbound	-	-	-	-
13. Jln. Raja Laut	(2) Outbound	Jln. Tun Perak	Jln. Dang Wangi	Jln. Dang Wangi	Jln. Ipoh
14. Jln. Sultan Ismail	(1) Clockwise	Jln. Kuching	Jln. Imbi	Jln. Ampang	Jln. Pudu
	(2) Countercl	Jln. Loke Yew	Jln. Raja Abdullah	Jln. Loke Yew	Jln. T.Abdul Rahman
15. Jln. Tun Razak	(1) Clockwise	Jln. Pahang	Jln. Ampang	Jln. Raja Muda	Jln. U.Thant
	(2) Countercl	Jln. Pahang	Jln. Ipoh	Jln. Pahang	Jln. Ipoh
		Jln. U Thant	Jln. Tja Muda	-	-
		Jln. Kampung Pandon	Jln. Inai	-	-

Source: SMURT-KL, 1997, Travel time survey

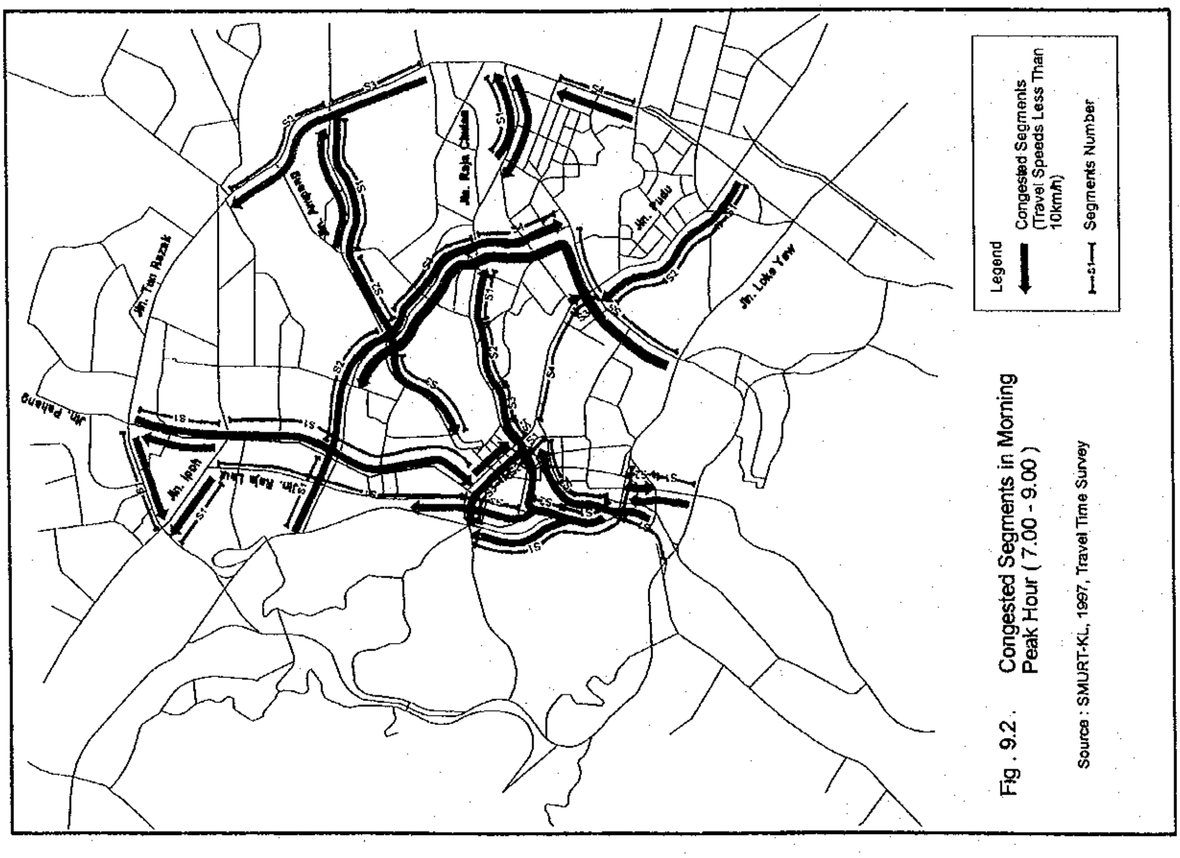


Fig. 9.2. Congested Segments in Morning Peak Hour (7.00 - 9.00)

Source : SMURT-KL, 1997, Travel Time Survey

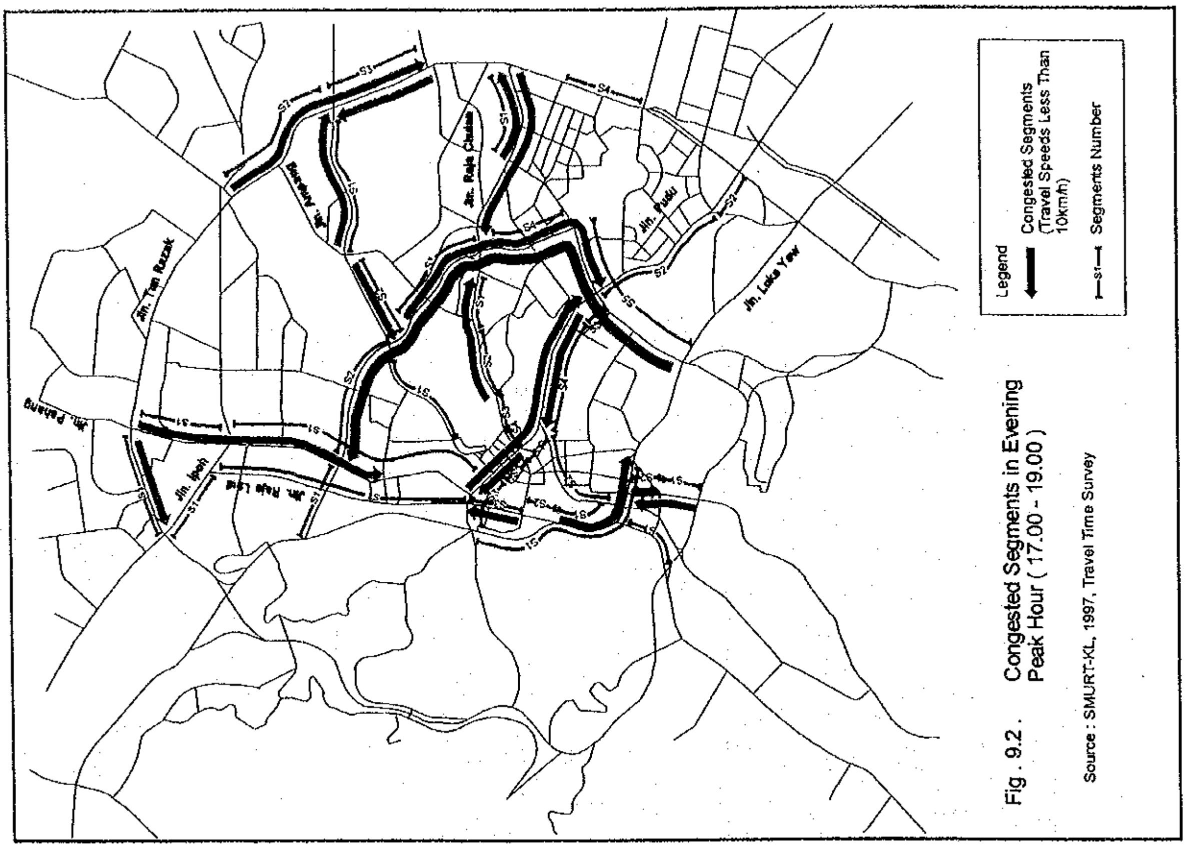


Fig. 9.2. Congested Segments in Evening Peak Hour (17.00 - 19.00)

Source : SMURT-KL, 1997, Travel Time Survey

b. Fluctuation of Traffic Volume

Based on the quarter-hourly fluctuations in traffic volume on congested segments of major roads, six (6) types of fluctuation patterns were observed as shown in Table. 9.2.4 and Figure 9.2.7.

c. Balance of Directional Traffic Volume

Figure 9.2 8 and Table 9.2.5 show the ratio of main directional traffic volume by congested segments in the peak hours. In order to select effective locations for the reversible flow lane system, the ratio of current directional traffic demand in the peak hour was calculated. The ratio of main directional traffic demand was classified into four (4) ranks; above 80%, 70-80%, 60-70%, and 50-60%.

During the morning peak hour, of the fifteen (15) roads, Jalan Pahang, Jalan Ampang, Jalan Raja Chulan, Jalan Pudu, Jalan Sultan Ismail and Jalan Nirwana – Jalan Cheng Lock have high directional ratios of more than 70%, which means that it is possible to allot an additional lane in the inbound direction as the demand requires. On the other hand, during the evening peak hour, Jalan Raja Chulan, Jalan Syed Putra, and Jalan Sultan Ismail have main directional ratios of more than 70%, and Jalan Pahang, Jalan Ampang, and Jalan Kinabalu show a ratio of more than 60%.

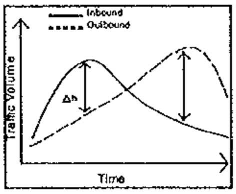
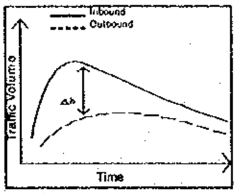
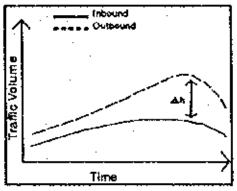
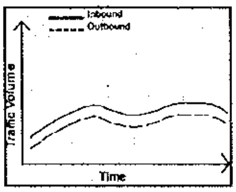
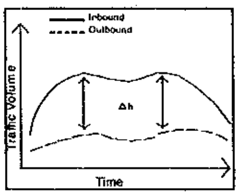
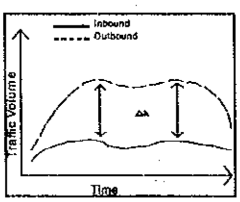
d. Segments for the Reversible Flow Lane System

As the figure for fluctuation patterns indicates, the directional traffic volume in patterns A, B, or C varies greatly depending on the peak periods. A highly effective way of controlling traffic flow on roads with such fluctuating volume would be the reversible flow lane system in which lanes are allotted according to the changing demand during the morning and evening peak hours. In the case of patterns E and F, there is a significant difference in traffic volume between the inbound and outbound directions all day. An unbalanced lane system or one-way system may be suitable at these areas.

Based on the foregoing consideration, the reversible flow lane system should be introduced on segments of the major roads listed below (see Figure 9.2.9, Figure 9.2.10, and Table 9.2.6). In determining the locations, the following criteria were used:

- Current congested segments indicating travel speed of under 10km/h,
- Roads with traffic fluctuation patterns of A, B, or C,
- Major roads with a main directional rate of over 70% during peak hours,
- Roads classified as arterial roads (radial roads) in CPA, and
- Planned locations for the bus priority lane system.

Table 9.2.4 Type of Fluctuation Patterns of Traffic Volume

Type of Pattern		Description
No.	Figure	
A		- There are two (2) large fluctuations. - The large traffic volume in the inbound direction generally occur only during morning peak hour. - The large traffic volume in the inbound direction generally occur only during evening peak hour. - Between the inbound and the outbound directions in each peak hour, there are so much difference in traffic volume.
B		- There is one (1) large fluctuation. - The large traffic volume in the inbound direction generally occur only during morning peak hour. - Between the inbound and the outbound directions in morning peak hour, there are so much difference in traffic volume.
C		- There is one (1) large fluctuation. - The large traffic volume in the outbound direction generally occur only during evening peak hour. - Between the inbound and the outbound directions in evening peak hour, there are so much difference in traffic volume.
D		- There are two (2) large fluctuations. - The large traffic volume in the both directions generally occur during morning and evening peak hours. - Between the inbound and the outbound directions, there are not so much difference in traffic volume.
E		- There are two (2) large fluctuations. - Only the large traffic volume in the inbound direction generally occur during morning and evening peak hours. - Between the inbound and the outbound directions in all day, there are so much difference in traffic volume.
F		- There are two (2) large fluctuations. - Only the large traffic volume in the outbound direction generally occur during morning and evening peak hours. - Between the inbound and the outbound directions in all day, there are so much difference in traffic volume.

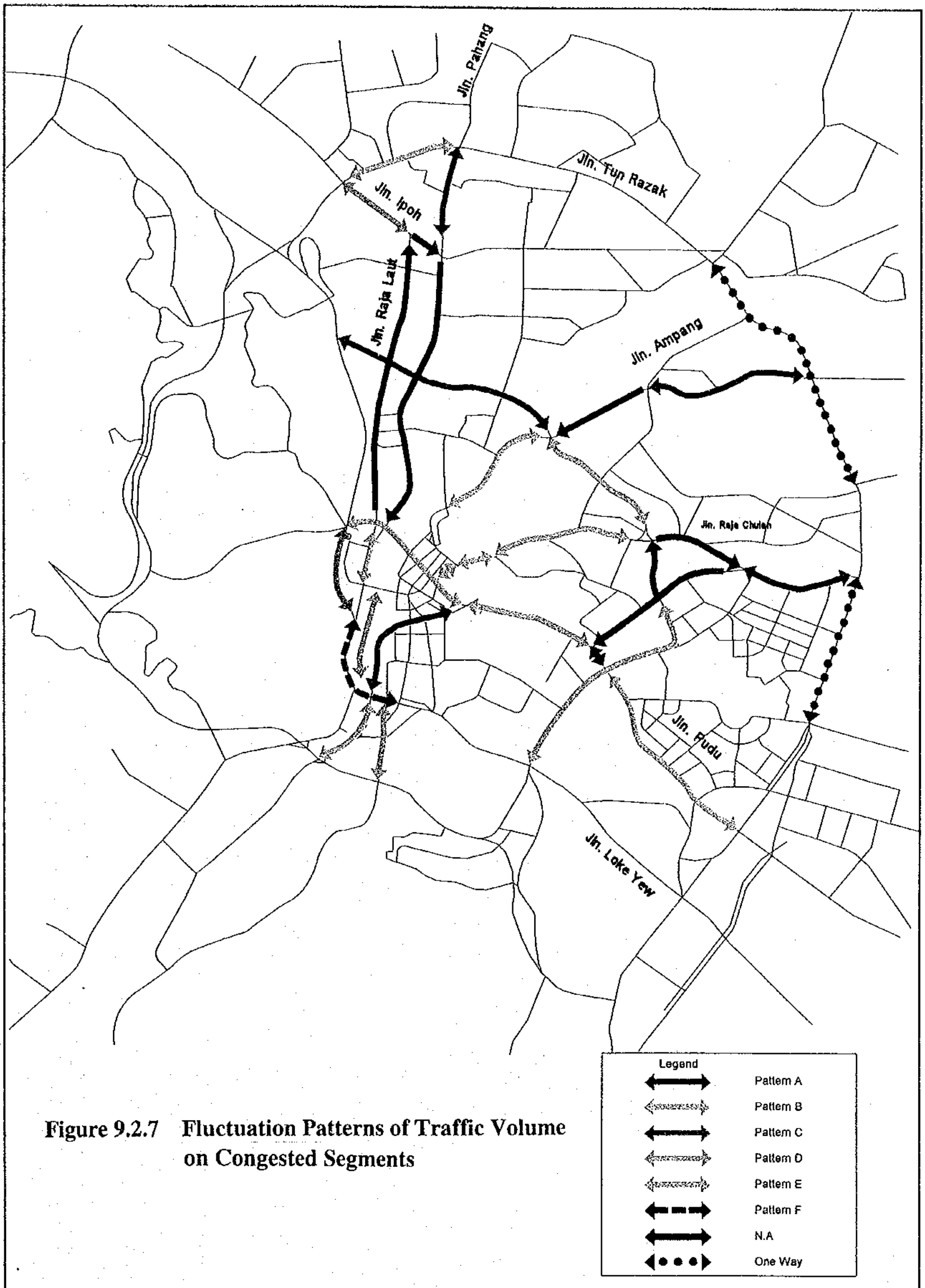
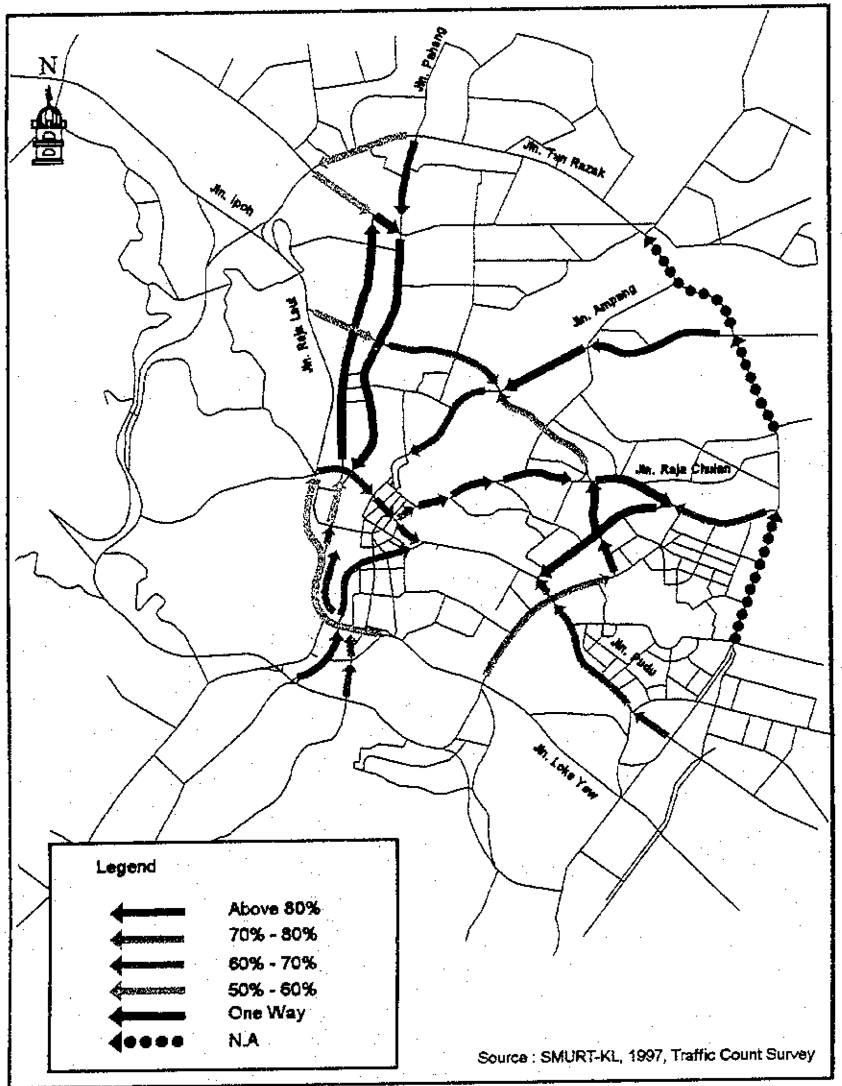
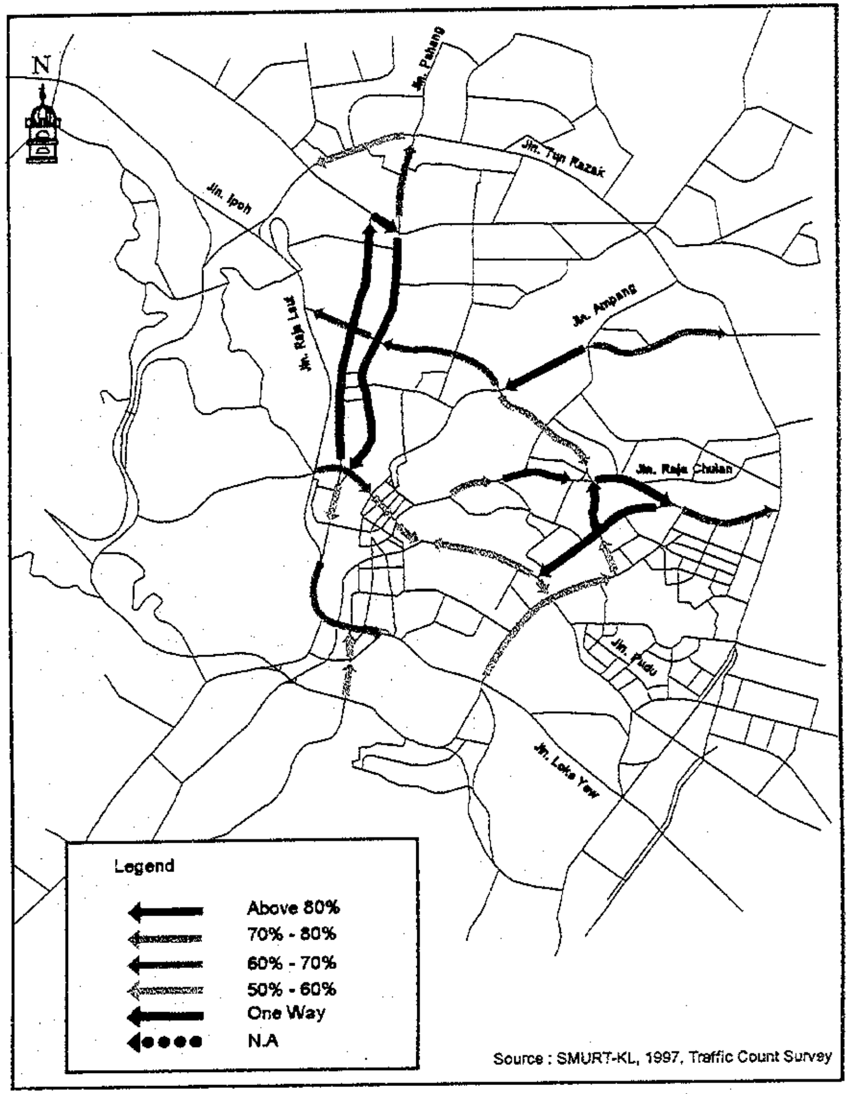


Figure 9.2.7 Fluctuation Patterns of Traffic Volume on Congested Segments



Ratio of Main Directional Traffic Volume on Congested Segments in Morning Peak Hour



Ratio of Main Directional Traffic Volume on Congested Segments in Evening Peak Hour

Figure 9.2.8 Ratio of Main Directional Traffic Volume on Congested Segments in Peak Hours

Table 9.2.5 Ratio of Main Directional Traffic Volume by Congested Segments during Peak Hours

(Morning Peak Hour: 7:30-8:30)

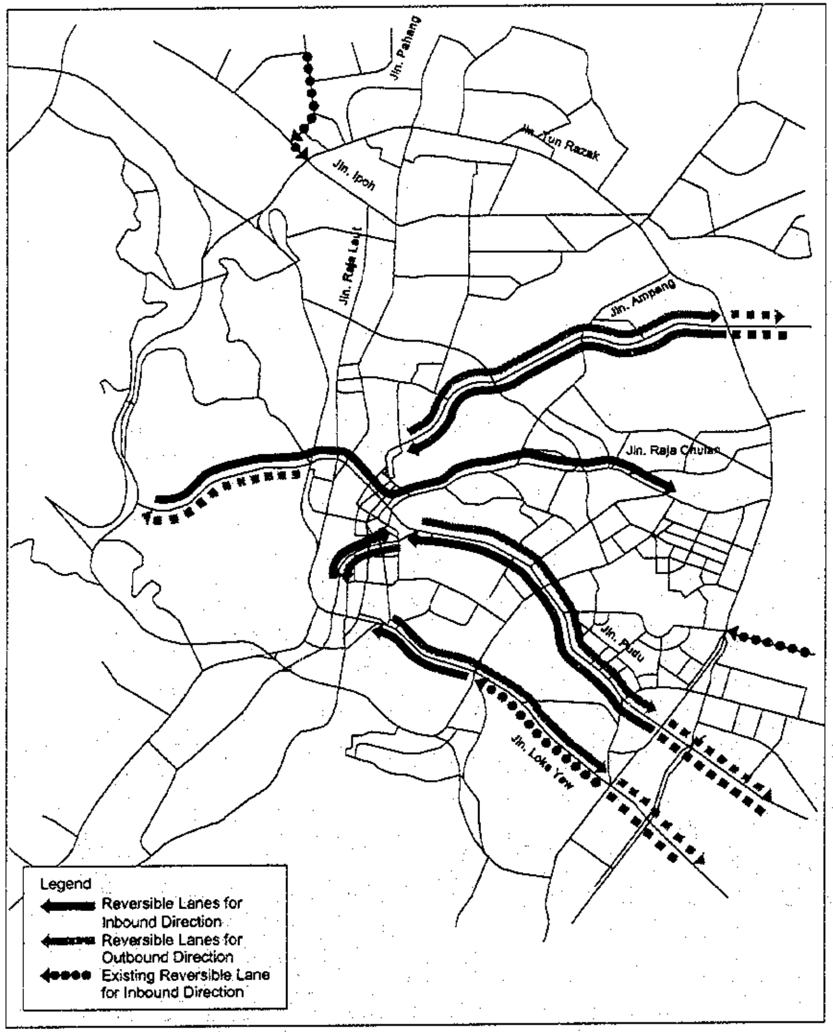
Road	Direction	Congested segments (Average travel speed<10km/h)		Ratio of congested traffic volume by 15 min. by section (%)									
				Section 1		Section 2		Section 3		Section 4		Section 5	
		From	To	Range	Total	Range	Total	Range	Total	Range	Total	Range	Total
1. Jln. Ipoh	(1) Inbound	-	-	-	-	-	-	-	-	-	-	-	-
	(2) Outbound	Jln. T. Abdul R	Jln. Tun Razak	45-58	49	-	-	-	-	-	-	-	-
2. Jln. Pahang	(1) Inbound	Jln. Tun Razak	Jln. Ipoh	79-88	83	-	-	-	-	-	-	-	-
	(2) Outbound	Jln. Ipoh	Jln. Tun Razak	12-21	17	-	-	-	-	-	-	-	-
3. Jln. T.Abdul	(1) Inbound	Jln. Ipoh	Jln. Tun Perak	100	100*	-	-	-	-	-	-	-	-
4. Jln. Ampang	(1) Inbound	Jln. Tun Perak	Jln. Sultan Ism	72-88	81	40-75	51	58-63	60	-	-	-	-
	(2) Outbound	Jln. P.Ramlee	Jln. Tun Razak	12-28	19	-	-	-	-	-	-	-	-
5. Jln. Raja Ch	(1) Inbound	Jln. Tun Perak	Jln. Sultan Ism	95-98	96	91-94	93	59-71	67	72-82	76	-	-
	(2) Outbound	-	-	-	-	-	-	-	-	-	-	-	-
6. Jln. Bukit B	(1) Inbound	Jln. Tun Razak	Jln. Imbi	56-67	61	-	-	-	-	-	-	-	-
	(2) Outbound	Jln. Imbi	Jln. Tun Razak	33-44	39	-	-	-	-	-	-	-	-
7. Jln. Pudu	(1) Inbound	Jln. Yew	Jln. Imbi	66-74	71	67-74	71	54-66	61	-	-	-	-
	(2) Outbound	Jln. Bukit Bint	Jln. Imbi	-	-	-	-	34-46	39	-	-	-	-
8. Tun Pearak	(1) Inbound	Jln. Raja Laut	Jln. Raja Chula	64-74	69	57-67	63	57-85	69	-	-	-	-
	(2) Outbound	Jln. Raja Chula	Jln. Kuching	26-36	31	33-43	37	15-43	31	-	-	-	-
9. Jln. Syed Ptu	(1) Inbound	Jln. Damansara	Jln. Kinabalu	56-68	60	69-78	73	-	-	-	-	-	-
	(2) Outbound	Jln. Kinabalu	Jln. Sultan Sula	-	-	22-31	27	-	-	-	-	-	-
10. Jln. Nirwar	(1) Inbound	Jln. Sultan Sula	Jln. Pudu	100	100**	56-65	61	-	-	-	-	-	-
- Cheng Loc	(2) Outbound	-	-	-	-	-	-	-	-	-	-	-	-
11. Jln. Kinaba	(1) Inbound	-	-	-	-	-	-	-	-	-	-	-	-
	(2) Outbound	Jln. Stn Hisham	Jln. Parlimen	48-68	55	-	-	-	-	-	-	-	-
12. Jln. Hisham	(1) Inbound	Jln. Kinabalu	Jln. Raja Laut	55-68	64	64-94	74	53-58	56			-	-
	(2) Outbound	-	-	-	-	-	-	-	-	-	-	-	
13. Jln. Raja L	(2) Outbound	Jln. Tun Perak	Jln. Dang Wan	100	100*	-	-	-	-	-	-	-	-
14. Jln. Sultan	(1) Clockwise	Jln. Kuching	Jln. Imbi	49-63	54	47-69	60	22-29	25***	14-19	15	-	-
	(2) Countercloc	Jln. Loke Yew	Jln. Raja Abdu	-	-	31-53	40	71-78	75***	81-86	85	69-81	77
15. Jln. Tun Ra	(1) Clockwise	Jln. Pahang	Jln. Ampang	N.A									
	(2) Countercloc	Jln. Pahang	Jln. Ipoh	47-58	54	-	-	-	-	-	-	-	-
		Jln. U Thant	Jln. Tja Muda	N.A									
		Jln. Kampung	Jln. Inai	N.A									

Notes: * One-way. ** Outbound was closed by police. *** Counterclockwise between Ramlee and Raja Chulan was closed by One-way.

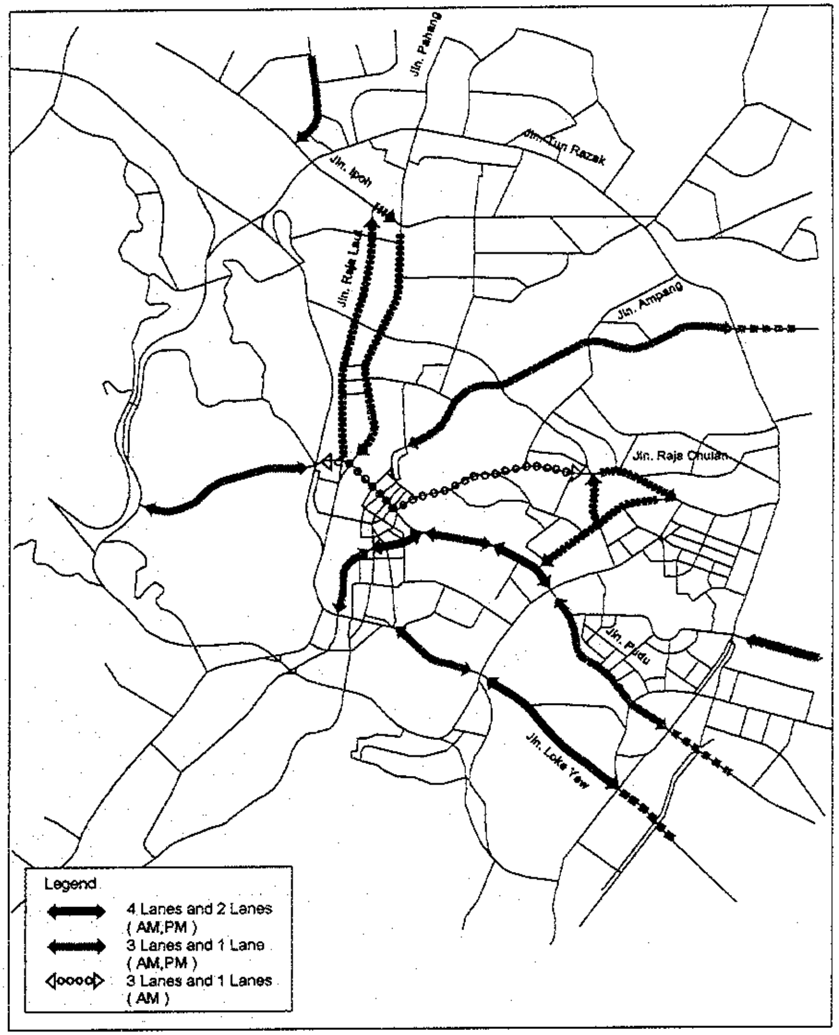
(Evening Peak Hour: 17:00-18:00)

Road	Direction	Congested segments (Average travel speed<10km/h)		Ratio of congested traffic volume by 15 min. by section (%)									
				Section 1		Section 2		Section 3		Section 4		Section 5	
		From	To	Range	Total	Range	Total	Range	Total	Range	Total	Range	Total
1. Jln. Pahang	(1) Inbound	Jln. Tun Razak	Jln. Ipoh	22-50	36	-	-	-	-	-	-	-	-
	(2) Outbound	Jln. Ipoh	Jln. Tun Razak	50-78	64	-	-	-	-	-	-	-	-
2. Jln. T.Abdul	(1) Inbound	Jln. Ipoh	Jln. Dang Wan	100	100*	-	-	-	-	-	-	-	-
3. Jln. Ampang	(1) Inbound	Jln. P.Ramlee	Jln. Sultan Ism	-	-	42-65	55	-	-	-	-	-	-
	(2) Outbound	Jln. P.Ramlee	Jln. Tun Razak	54-74	64	-	-	-	-	-	-	-	-
4. Jln. Raja Ch	(1) Inbound	Jln. Pesiaran	Jln. Sultan Ism	96-99	97	72-85	80	-	-	-	-	-	-
	(2) Outbound	Jln. Bukit Bint	Jln. Sultan Ism	-	-	-	-	N.A**			-	-	-
5. Jln. Bukit Bi	(1) Inbound	Jln. Tun Razak	Jln. Imbi	34-44	38	-	-	-	-	-	-	-	-
	(2) Outbound	Jln. Imbi	Jln. Tun Razak	56-66	62	-	-	-	-	-	-	-	-
6. Jln. Pudu	(1) Inbound	Jln. Bukit Bint	Jln. Tun Perak	-	-	-	-	-	-	47-61	52	-	-
	(2) Outbound	Jln. Tun Perak	Jln. Imbi	-	-	-	-	52-73	59	39-53	48	-	-
7. Tun Pearak	(1) Inbound	Jln. Raja Laut	Jln. Pudu	44-69	59	40-68	51	58-79	66	-	-	-	-
	(2) Outbound	Jln. Raja Chula	Jln. T. Abdul R	31-56	41	32-60	49	21-42	34	-	-	-	-
8. Jln. Syed Ptu	(1) Inbound	Jln. Damansara	Jln. Kinabalu	67-74	71	52-59	56	-	-	-	-	-	-
	(2) Outbound	Jln. Kinabalu	Jln. Sultan Sula	-	-	41-48	44	-	-	-	-	-	-
9. Jln. Kinabalu	(1) Inbound	Jln. Stn Hisham	Jln. Sultan Sula	64-79	70	-	-	-	-	-	-	-	-
	(2) Outbound	-	-	-	-	-	-	-	-	-	-	-	-
10. Jln. Hisham	(1) Inbound	Lebh. Pasar Be	Jln. Raja Laut	-	-	-	-	45-50	47			-	-
	(2) Outbound	-	-	-	-	-	-	-	-	-	-	-	
11. Jln. Raja L	(2) Outbound	Jln. Dang Wan	Jln. Ipoh	100	100*	-	-	-	-	-	-	-	-
12. Jln. Sultan	(1) Clockwise	Jln. Ampang	Jln. Pudu	-	-	-	-	63-79	73***	28-53	42	36-47	40
	(2) Countercloc	Jln. Loke Yew	Jln. T. Abdul R	65-69	67	58-75	65	21-37	36***	47-72	58	53-64	60
13. Jln. Tun Ra	(1) Clockwise	Jln. Raja Muda	Jln. U. Thant	N.A									
	(2) Countercloc	Jln. Pahang	Jln. Ipoh	47-63	53	-	-	-	-	-	-	-	-

Notes: * One-way. ** Outbound between S. Ismail and B. Bintang was closed by one-way. *** Counterclockwise between Ramlee and Raja Chulan was closed by one-way.



Effective Reversible Flow Lane Roads



Number of Lanes on Reversible Lanes Roads

Figure 9.2.9 Reversible Flow Lanes and Number of Lanes

At ring roads which function as distributors of radial road traffic in the CBD, the fluctuation patterns are complicated during peak hours and the traffic varies widely depending on the day of the week. Therefore, Jalan Tun Razak and Jalan Sultan Ismail have been excluded from the introduction of the reversible flow lane system.

In principal, a 4-lane dual-way road will be changed to a reversible flow lane road consisting of 3 lanes and 1 lane, while a 6-lane dual-way road will be changed to a reversible flow lane road of 4 lanes and 2 lanes. The selection of the road segments for the reversible flow lane system will be finalised after traffic analyses using Dynamic Simulation.

Table 9.2.6 Locations of Reversible Flow Lane System

Road	Segments	Distance (km)	Direction	No. of Lanes M.P	No. of Lanes E.P
1. Jln. Pahang	Jln. Tun Razak - Jln. Ipoh	0.80	Inbound	3	1
			Outbound	1	3
2. Jln. Ampang	Jln. Tun Razak - Jln. Munshi Abdullh	2.85	Inbound	3	1
			Outbound	1	3
3. Jln. Raja Chulan	Jln. Tun Perak - Jln. Bukit Bintang	2.15	Inbound	3	-
			Outbound	1	-
4. Jln. Tun Perak	Jln. T.Abdul Rahman - Jln. Raja Chulan	0.50	Inbound	3	-
			Outbound	1	-
5. Jln. Parlimen	Lebuh. Mahameru - Jln. T.Abdul Rahman	1.50	Inbound	3	1
			Outbound	1	3
6. Jln. Pudu	Jln. Yew - Jln. Cheng Lock	2.45	Inbound	3	1
			Outbound	1	3
7. Jln. Loke Yew	Jln. Sungai Besi - Jln. Sultan Sulaiman	2.20	Inbound	4	2
			Outbound	2	4
8. Jln. Cheng Lock	Jln. Nirwana - Jln. Tun Perak	0.60	Inbound	4	2
			Outbound	2	4

e. Operating Method

i. Time Periods for Reversible Flow Lane System

As a general rule, time periods for the reversible flow lane system are determined so that priority may be given to inbound traffic during the morning peak hours and to outbound traffic during the evening peak hours. Accordingly, priority is given to inbound traffic between 7:00 and 9:00 a.m., and priority is given to outbound traffic between 4:30 and 6:30 p.m. These time periods were established after considering the time periods currently applied to the existing reversible flow lanes in KL, as well as the survey results of traffic counting (See Appendix Figure, quarter-hourly fluctuations of traffic volume).

ii. Traffic Operation System

The reversible flow lane system will be implemented in the presence of the traffic police. The introduction of the system will be notified to the drivers by overhead lane direction signals and signs (i.e., gantries and pedestrian bridges), variations in lane line colour, lane-use designators (the temporary signs). As a general rule, overhead lane direction signals will be provided at the main gantries, between which overhead lane direction signs will be attached to the existing pedestrian bridges. Use of pedestrian bridges will reduce the cost of overhead lane direction signals. At the intersection, reversible lane usage will be notified by variations in lane line colour and lane-use designators. In areas outside the reversible flow lane system, guide signs would be installed 150-200 metres upstream from the starting point in order to warn drivers.

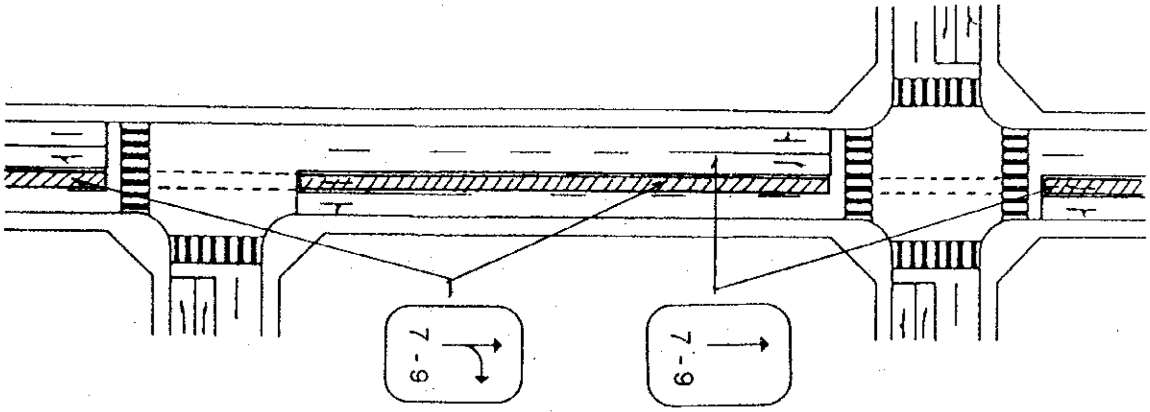
In reversible lane sections, parking, and diverging and right-turning movements onto side roads will be restricted. Right-turning movement at non-signalised intersections will also be restricted.

The standard traffic operation methods for the reversible flow lane system are shown in Figure 9.2.10.

iii. Traffic Facilities Plan

The standard designs of traffic facilities required for reversible flow lane operation are shown in Figure 9.2.11.

a. At section and signalised intersection without right-turn lane



b. At signalised intersection with right-turn lane

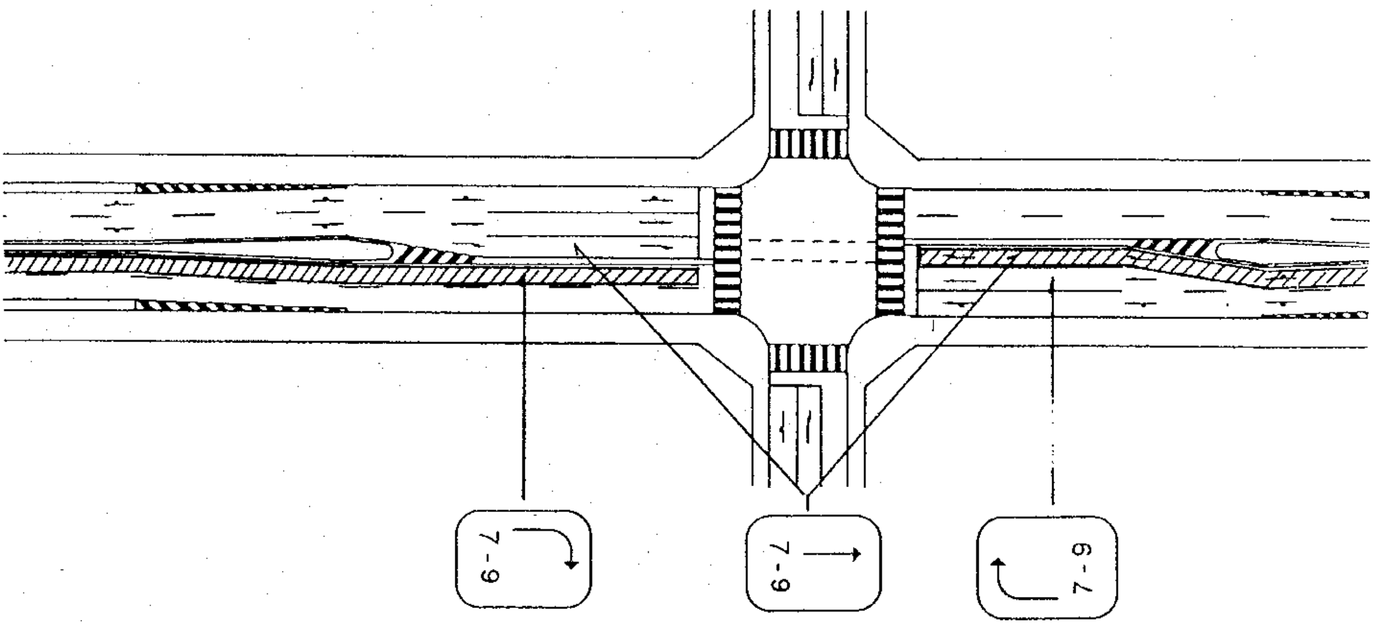
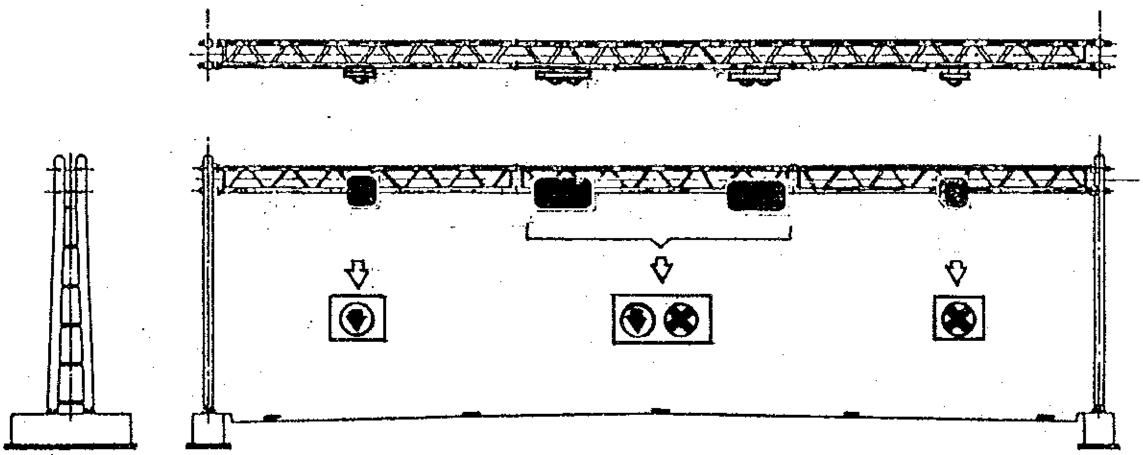
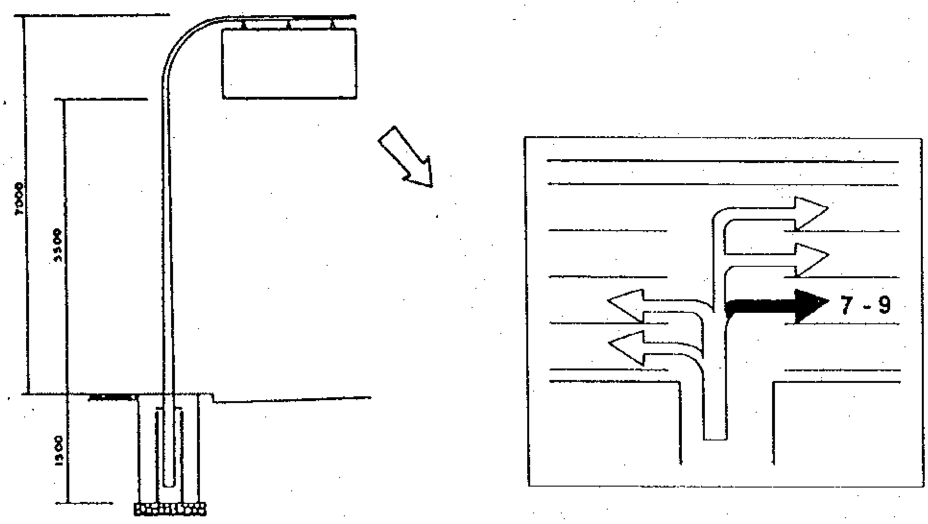


Figure 9.2.10 Standard Traffic Operation Method

Overhead Lane Direction Signals on Gantry



Guide Sign at Signalised Intersection in Area Outside the Section of Reversible Flow Lane System



Overhead Lane Direction Signs on Pedestrian Bridge

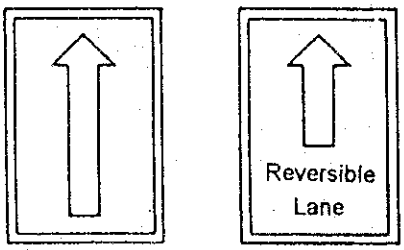


Figure 9.2.11 Standard Designs for Traffic Facilities