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URBAN TRANSPORT PROBLEMS AND ISSUES RELEVANT TO ITIS IN KLANG VALLEY

5.0 URBAN TRANSPORT PROBLEMS AND ISSUES RELEVANT TO ITIS IN KLANG VALLEY

5.1 Existing Transport Problems And Issues

5.1.1 SMURT – KL Study's Findings : Problems and Causes

The relationship between traffic congestion and its causes has been explored by the earlier SMURT-KL study. Its findings are summarised below:

i) Car-driven society

Two major factors have been identified which have induced a car-driven society and created a lifestyle strongly dependent on private cars. These two factors are:

- High car ownership, and
- Dispersed landuse pattern

ii) Heavy traffic crossing in and out of CPA

Very high volumes of traffic have been recorded to enter the CPA daily. A total daily volume of close to 1.15Million vehicles per day have been observed to cross the CPA cordon:

• Total In-Bound	=	593,000pcu/day
• Total Out-Bound	=	556,000pcu/day
Total (2-Way)	=	1,149,000pcu/day

iii) High peaking factor or phenomenon during the commuter peak hours (in particular the morning peak)

Sharp peaking phenomenon for most CPA-bound corridor traffic has been observed. Empirical surveys conducted by SMURT-KL Study have shown that traffic plunges into the CPA during a limited morning peak hour, typically between 7a.m. to 8a.m. In the evening peak hour, a more moderate concentration of out-bound traffic has been observed. It suggests that people are more flexibles in selecting their departure time to go back home compared to the morning hour.

These characteristics, the Study concludes, indicate clearly that the traffic problem is brought about by commuting trips to the CPA during a limited morning peak hour.

iv) Excessive urban development

Many large-scale urban development projects have been planned in Kuala Lumpur. Some of these are under construction at present and the remaining ones are expected to be built in the near future. The additional traffic to be generated from these large-scale developments is expected to be huge in volume.

It has been estimated that the additional traffic generated from these new development projects may account for more than 40% of the total vehicle trips within the CPA and may add another 14% to 15% increase to the current traffic congestion at the CPA boundary.

v) Out-migration and sub-urbanisation

Many people have moved away from Kuala Lumpur to the fringe areas (a phenomenon of suburban sprawl) due to the progress of current urban development, which has changed the residential landuse of the central area in Kuala Lumpur to (dense) business and commercial use. This has accelerated the decline in residential population in the central area, inducing more people to reside at the suburb. Hence, more people will have to make longer commuting trips as a result.

vi) Traffic congestion at the CPA boundary

SMURT-KL Study has reported the following congestion levels in the morning peak at the various Arterial Roads leading to the CPA (Table 5.1.1).

Table 5.1.1 Congestion Ratio on Arterial Roads in Morning Peak Hour

No.	Jalan	Daily Vol. (pcu)	Hourly Vol. (pcu)	Peak Ratio	Capacity (pcu)	V/C
1.	Loke Yew	70,749	6,583	0.093	4,200	1.567
2.	Kuching	62,802	6,255	0.100	4,200	1.489
3.	Pahang	29,931	3,711	0.124	2,520	1.473
4.	Ampang	25,348	2,867	0.113	2,520	1.138
5.	Syed Putra	33,819	3,483	0.103	4,200	0.829
6.	Damansara	37,811	3,468	0.092	4,200	0.826
7.	Parlimen	23,859	1,901	0.080	2,520	0.754
8.	Wisma Putra	22,976	1,741	0.076	2,520	0.691
9.	Tun Sambanthan	17,272	1,728	0.100	2,520	0.686
10.	Bukit Bintang	17,200	1,598	0.093	2,520	0.634
11.	Pudu	19,991	1,592	0.080	2,520	0.632
12.	Ipoh	22,055	1,432	0.065	3,780	0.379
Total		**383,813**	**36,359**	**0.095**	**38,220**	**0.951**

Source: SMURT-KL, CPA Screen Line Survey
Note: In-bound traffic only

The arterial roads, which have been recorded to have a congestion or v/c (volume/capacity) ratio of more than 1.0 are (in descending order of severeness):

- Jalan Loke Yew
- Jalan Kuching
- Jalan Pahang, and
- Jalan Ampang

Those with a v/c ratio between 0.75 and 1.0 are (in descending order of severeness):

- Jalan Syed Putra
- Jalan Damansara, and
- Jalan Parlimen

Hence, in terms of congestion information collection, these arterial roads identified above should warrant close monitoring.

5.1.2 Problems And Issues: Corridor Analysis

Though this present study concurs substantially with the findings of the earlier SMURT-KL Study, from the perspective of the ITIS it is preferred to begin our analysis of the transportation problems and issues in the study area by examining the transport corridor. Here, a clearer picture would emerge if travel demands were to be distributed and analysed by corridor catchment. It is more so for Kuala Lumpur, as it has a strong centre with traffic gravitated to it through several major radial arterials.

The likely major problem or challenge confronting a corridor radial arterial is the issue of corridor capacity and efficiency, i.e. can it adequately carry the volume of trips demanded of it by its catchments, and can it deliver this traffic efficiently and speedily to its destination?

Different corridors would involve different demands, depending on the size and characters of the related catchments. *Figure 5.1.1* shows the historical growth in traffic demand for some major radial arterials in the Klang Valley.

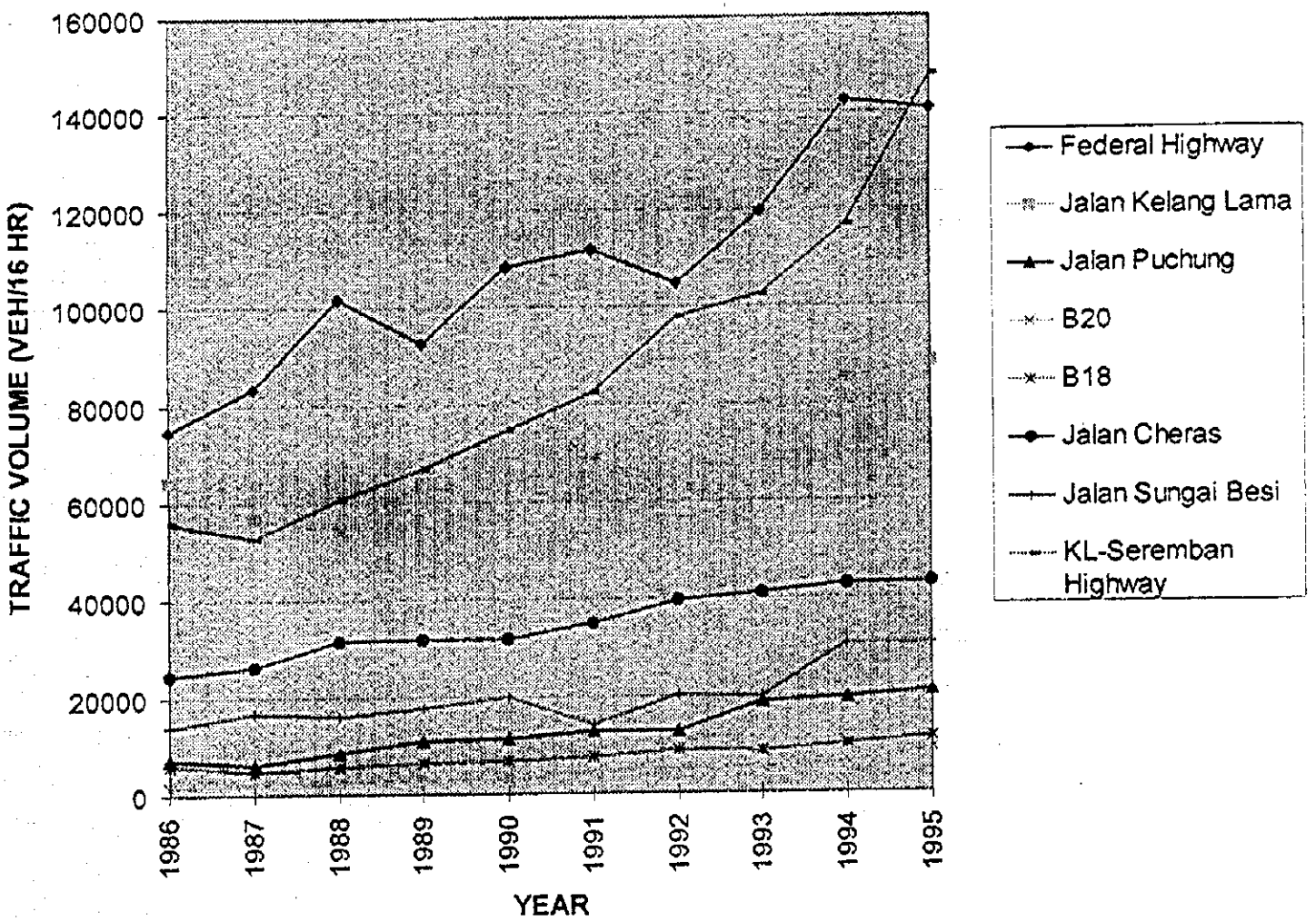

FIGURE 5.1.1 : HISTORICAL GROWTH IN TRAFFIC DEMAND ON SOME ARTERIAL ROADS IN KLANG VALLEY

It is shown that Federal Highway II predominates over the other arterials. Over the 10 years period, its demand has grown from 75,000 vehicles/day (16-hour) in Year 1986 to a high of 140,000 vehicles/day in Year 1995. However, the KL-Seremban Highway has exhibited a more surprising trend. Its growth rate was the highest among the six arterials, and appeared to have overtaken Federal Highway in its daily traffic volume at about 148,000 vehicles/day (16-hour) in Year 1995. In Year 1986, its volume was only about 75% that of the Federal Highway at about 56,000 vehicles/day. Jalan Klang Lama appeared to have experienced a moderate growth and recorded a daily volume of close to 90,000 vehicles/day. The rate of traffic growth at Jalan Cheras was marginally lower than that at Jalan Klang Lama, whilst Jalan Sg. Besi was at the bottom of this league.

Among these major arterial corridors, despite their different flow demands, there appeared some commonalties in their traffic flow problems:

a) Saturated Demands Giving Rise To Unstable Flow

The traffic demands along most of these corridors are so high during peak hours that they have definitely reached their capacities. Assuming a capacity of 1,500 vehicles/lane/hour, a dual-three highway could only accommodate a carrying capacity of 4,500vph per direction. But the situation is that many of these corridor arterials have to carry a peak hour volume of more than 5,000vph in one direction. Under such an unstable flow condition, any minor road incident alone can cause a massive traffic jam on the highway, not to mention a major traffic accident.

Prompt response to road incidents and fast removal of damaged vehicles or disturbances are therefore very important for restoring the function of a highway. Quick dissemination of information on any incident is therefore very essential to prevent any secondary accidents and to notify vehicles upstream about the occurrence of the accident so that they could make a detour to by-pass the accident site.

b) Weaving Problems

Traffic weaving can pose as a problem at locations where insufficient weaving or merging lengths are provided. Serious weaving problems can be observed at certain sections of the Federal Highway II (Subang Jaya/KFC Interchange, Motorola Interchange and Jalan Syed Putra/Klang Lama Interchange), Jalan Sg. Besi (Jalan Istana Interchange), and KL-Seremban Highway (Jalan Kuchai Lama and Jalan Klang Lama/Petaling Jaya Interchange).

c) Capacity of Junctions

Some of the junctions along these arterial corridors are obviously lack capacity. This is because most of these junctions were not designed as full interchanges, but as signal-controlled at-grade intersections or diamond interchanges. Such junctions lack sufficient capacity and when traffic demand is high, massive traffic jams or bottlenecks may occur.

5.2 Traffic Congestion and ITIS Related Issues

To mitigate any massive traffic congestion on a highway, traffic movements on it must constantly be monitored.

When congestion occurs downstream, some of the on-coming traffic from upstream can be diverted if early warning messages are given to them. They could only do so if and only if early warnings are given. Hence the importance of this automatic incident detection capability for a major highway. For this purpose, therefore, automatic congestion or incident detection devices such as vehicle sensors and surveillance cameras should be installed along selected major highways at about, say, 0.5km to 1.0km intervals to monitor traffic speed and to detect any congestion. Such information can be processed and disseminated or displayed via the Internet, roadside variable message signs (VMS) or LED graphic display panels, in-vehicle navigation unit, radio broadcast or other means.

Figure 5.2.1 provides an example of a LED Graphic Display Panel indicating that an accident had occurred at the Jalan Kinabalu/Loke Yew Interchange on the Federal Highway, and that congestion had extended upstream beyond the Jalan Mahameru/Istana Interchange, and motorists were advised to divert and exit through the Brickfields and Sg. Besi/KL-Seremban Interchange.

However, before any of these automatic incident detection and dissemination systems could be installed, appropriate arterial or corridor routes must first be identified. Thus, a demand and congestion analysis should first be carried out on the major roads and highways to determine if they should be included in this ITIS road network system. Once selected, their associated alternative routes should also be identified and be included for surveillance.

Hence, the selection of an appropriate road network for inclusion in this ITIS road system represents an important step in the development of ITIS for Klang Valley and the MSC.

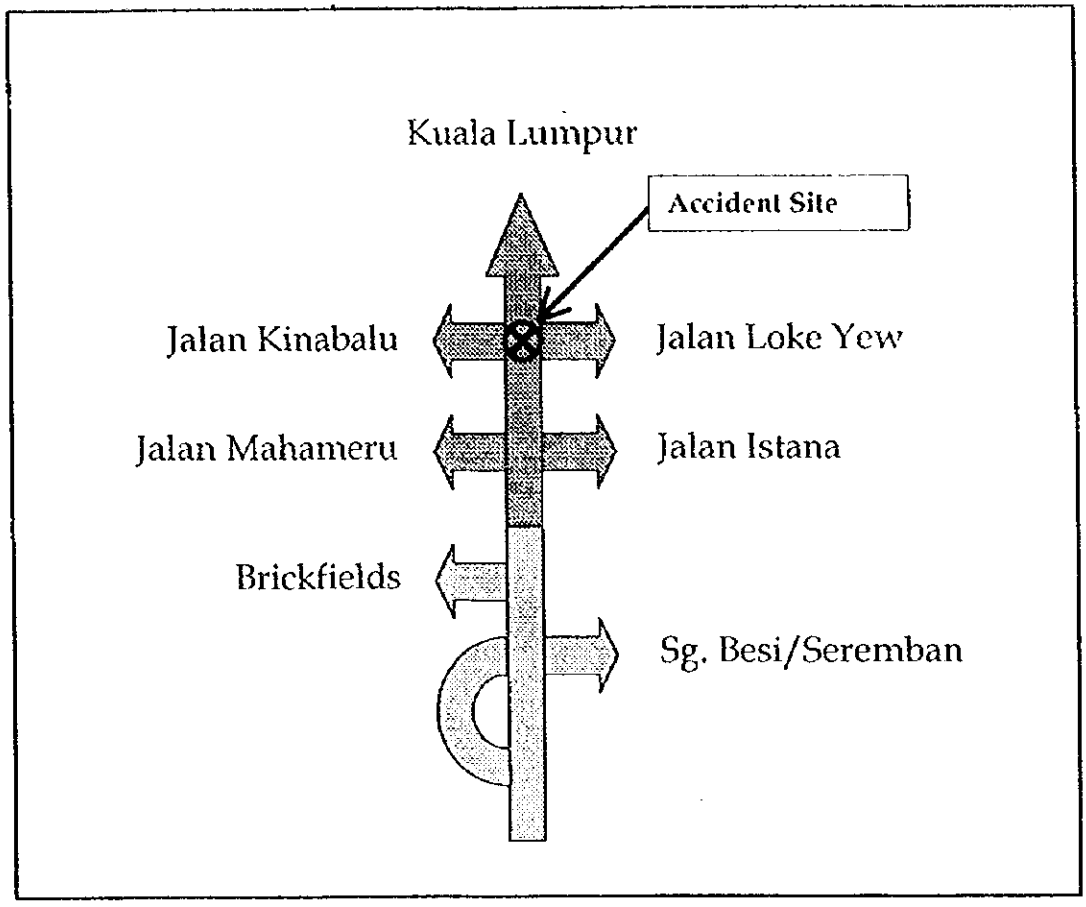

Figure 5.2.1 AN EXAMPLE OF A LED GRAPHIC DISPLAY PANEL

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INTELLIGENT TRANSPORT SYSTEM (ITS) DEVELOPMENT AND DEPLOYMENT IN THE REGION AND MALAYSIA

6.0 INTELLIGENT TRANSPORT SYSTEM (ITS) DEVELOPMENT AND DEPLOYMENT IN THE REGION AND MALAYSIA

6.1 Necessity Of ITIS

Transport problems and issues are identified and discussed in the preceding chapter. Among the various measures to tackle these problems, Integrated Transport Information System (ITIS) is expected to play an important role for a number of reasons.

One of the main reasons that ITIS is recommended to the study area is that a large amount of benefits both direct and indirect can be expected with its introduction. Although it is difficult to quantify these benefits especially those indirect benefits in support of the assertion above, there are reports in other countries that show the large benefits estimated with the deployment of ITIS. The VICS car navigation system was introduced in Japan in Year 1996 to provide real-time traffic information to drivers through in-vehicle units. This system, for example, is found to be capable of producing benefits amounting to 7.7Trillion Yen (US$63Billion) for a period of 20 years against a total investment of 1.2Trillion Yen (US$9.7Billion) for the same period.

Current traffic situation in the Study Area suggests great potential for the deployment of ITIS to optimise the utilisation of existing road transport infrastructure. The SMURT-KL Study conducted by JICA in Year 1998 reports that the current daily in-bound and out-bound traffic volume across the Kuala Lumpur Central Planning Area (CPA) screenline has reached more than 1Million vehicles per day. Outside the central planning area, Federal Highway (II) and KL-Seremban Highway carry more than 200,000pcu/day. These figures indicate that the roads are already saturated with vehicles. The report further states that the average travel speed on the major arterial roads in Kuala Lumpur and surrounding area declined significantly by 4km to 18km per hour over the ten-year period from Year 1986 to Year 1997. Jalan Gombak, Jalan Pahang, Jalan Ampang, Jalan Cheras, Jalan Pudu and Jalan Pantai are heavily congested and average travel speed is below 15km/hr.

When level of service of a road is like what is described above, its traffic is very susceptible to any disturbance. A small disruption to traffic flow would easily lead to a severe congestion. Currently no variable message sign is installed along any of the congested roads mentioned above. Thus, no real time traffic information is given to drivers except the brief traffic reports aired from FM broadcasting station in the morning and evening which are very limited in scope, coverage area and frequency. Very often drivers would 'learn' of the incident only after they are stranded in the congestion. If drivers are promptly and properly informed of the incident in advance, they could have taken detour route resulting in a very large amount of saving in travel time. Or in the absence of a detour route, drivers could decide to delay their journey and engage in more productive activities meanwhile.

According to the opinion survey conducted in this Study, more than 60% of the drivers interviewed regard various traffic information as important to them. Among the information, 'severity of congestion', 'route guidance' and 'cause of congestion' ranked highest and the percentage of respondents who consider these kinds of information very important or important, are 96%, 89% and 83% respectively. On the other hands, more than half of the respondents said they are not satisfied with the current methods of providing traffic-related information to the public.

Even when there is no serious incident, it is doubtful that road network such as that in the study area is utilised efficiently by the large and dynamic travel demand. At present, most drivers select their travel routes based on their limited experiences in the past. According to the same opinion survey, an overwhelming 94% of drivers responded that they would take alternative routes if such information were provided to them.

If no real-time information on the traffic condition is available for route selection, drivers have to make sufficient allowance in estimating travel time to the destination to avoid late arrival at meeting or appointment. If they arrive early without experiencing congestion then they have to waste away the extra time until the scheduled meeting. Although time wasted may be small for each person, the total loss of all drivers could be very substantial and productivity is thus seriously affected by traffic problem in this way.

Greenhouse effect due to excessive emission of CO_2 is becoming a serious global environment issue. One of the sources of CO_2 emission is vehicle engine that runs on either gasoline or diesel fuel. The amount of CO_2 emission increases rapidly as running speed decreases. Thus, elimination of congestion is an effective way to reduce CO_2 emission. A recent study by a Japanese organisation estimated that a 2.7% reduction in CO_2 emission by vehicles could be achieved with the introduction of a traffic information system to Kuala Lumpur. In this way, ITIS can contribute significantly in mitigating such global environmental issue.

As described earlier, the existing traffic reports on Kuala Lumpur from FM radio broadcasting station rely chiefly on observations of traffic condition through TV camera installed at ten locations in the city. Not only drivers but also road administrator would not know any traffic congestion at locations or roads without such TV camera. The coverage area is thus limited and no quantitative data such as queue length or travel time are mentioned in the program. Expansion of this system, upgrading of system functions and wider use of the system are urgently required.

Some toll road operators have installed vehicle detector, TV camera, and variable message sign on their highways for traffic management purposes. But the existing system is not well designed to provide real-time congestion information. There seems to be no efficient operating procedure established to utilise the system fully and effectively. It has been observed that the existing variable message sign shows pre-defined messages most of the time.

The growth of traffic volume has slowed down recently due to the economic downturn. But once the economy recovers, the growth will be substantial like what happened in the past. The number of registered vehicles including motorcycle increased remarkably in the country with an annual average of 6.19% during the ten-year period of 1988 and 1997. SMURT-KL Study forecasts the annual trip production growth of 2.73% for all types of trip purpose in their study area through the Year 2020, and annual average growth of 4.99% for non-home based business trip. Such a rapid growth imposes heavy burden on the road network and its efficient use will become a crucial issue in the near future. Mid-term Review of The Seventh Malaysia Plan 1996-2000 encourages a wider use of Intelligent Transport Systems (ITS) to enhance the transportation efficiency, safety, comfort and environmental standards.

The current effort on traffic management is piecemeal and very little co-ordination seems to exist among the toll road operators, DBKL, JKR and other agencies. No organisation collectively handles all traffic information. An integrated and systematic approach is required to manage more efficiently the road network in the study area as a whole. Introduction and operation of an Integrated Transport Information System provides a good opportunity to establish such an organisation and to implement network-wide approach to better manage the traffic in the study area.

6.2 Current ITS Development and Deployment in the Region

In Malaysia, the Road Engineering Association of Malaysia (REAM) is taking an initiative of formulating an ITS Malaysia Masterplan or ITS Strategic Plan. The plan is intended to guide the development and deployment of the ITS applications in Malaysia. For this purpose, a Technical Committee on ITS was established by experts in traffic, transportation, electronic and other field relevant to ITS within REAM. They have conducted a questionnaire survey on ITS in August 1998 among the professionals, operators, and potential users to gather information on their understanding, perception, and assessment of user services. A draft ITS Strategic Plan is being formulated based on the survey results, consultation with concerned organisations and parties, and discussions among the committee members. Although, the plan is expected to be completed soon, it is still premature to discuss on the plan in this study.

6.3 Present ITS Services in Klang Valley

A number of ITS user services are in fact already in operation in the study area. The installation of a computerised traffic signal control system in the City of Kuala Lumpur in the mid-1970s was one such application where the use of computer technology was involved. Presently, out of a total of 287 traffic control signals in Kuala Lumpur, some 89 (or 31%) of them are actually inter-connected or co-ordinated with the use of an Australian software system called the Sydney Co-ordinated Adaptive Traffic System (SCATS). Another 40 of these traffic signals are now being inter-connected using a Spanish system called the ITACA system; and they are expected to be fully operational in the second half of 1999. The Kuala Lumpur City Hall (DBKL) is the only municipal council currently in the Study Area that operates a centrally computerised traffic control system.

DBKL has also deployed 28 colour CCTV cameras at 10 locations in Kuala Lumpur for traffic surveillance. Most of these cameras are located on the top of tall buildings at the corner of major intersections. They can become useful information collection device within the ITS framework.

There are several toll road operators who operate the toll roads in the Klang Valley and MSC region. They have adopted different approach to traffic surveillance and information dissemination within their respective toll highways. Some of them have virtually no traffic management facilities on the toll road, while others have installed vehicle detectors, TV cameras and variable message signs. The table below summarises the traffic management facilities by some major toll road operators.

Table 6.3.1 Existing Traffic Management Facilities on Toll Roads

Facility/Equipment	Type	No. of Facilities by Operator				
		Elite	Kesas	LDP	Karak	Besraya
Infrared vehicle detector	-	-	-	78	-	-
Video vehicle detector	-	14	21	-	-	-
CCTV camera	PTZ	6	8	8	4	1
	Fixed	-	-	-	16	19
Variable message sign	-	12	4	4	-	-

Source : toll road concessionaires
PTZ = Pan, Tilt and Zoom

Although there are a total of 20 variable message signs, they are only found on three toll highways. Their deployment criteria also obviously differ among these toll highways. From the displays and information gathered from the operators, there is little or no operating procedure to use such signs for providing real-time traffic or incident information to the users. They are used for providing warning and advisory messages most of the time.

6.4 Selection of ITIS Services for Klang Valley and MSC

6.4.1 User Services And Information

Application of ITS takes the form of various user services. User services selected for development and eventual application in any specific region should reflect the public needs, technology level, social framework and role of road transport in that country or region. Thus user service lists for different countries may vary in terms of their contents and priorities among the various user services.

Some user services are closely related with traffic and transport information, while others are not. After a careful review of the user services being considered in Malaysia, USA, Europe and Japan, seven (7) user services are identified as having close relation with ITIS, while another three (3) user services are regarded as having loose relation with ITIS as shown below.

User services closely related with ITIS:

- Pre-trip traveller information system
- En-route driver information system
- Traveller service information system
- Route guidance system
- Parking guidance system
- Pubic transport information system
- Public transport operation system

User service loosely related with ITIS:

- Environmental monitoring system
- Commercial fleet management system
- Emergency vehicle management system

Each of these user services makes use of different information. The information used by these services is summarised in the table attached. (Table 6.4.1). As shown in the table, most of the listed information are commonly used by a number of different user services. In other words, user services often have overlapping functions and distinction between user services is sometimes not strictly clear. Brief explanations of these services are given below.

a) Pre-trip traveller information system

Pre-trip traveller information refers to all types of information related to travel and destination. It consists of both static and real-time information. Static information includes road network, traffic regulation, transit schedule, fare, etc. Real-time information covers traffic condition, incident, travel time, accident, temporary traffic regulation, parking availability, bus and transit operating condition, weather condition etc. The information is meant to help travellers select his travel mode, route and departure time before making a trip.

Two types of information dissemination are commonly used for this system, namely broadcasting type and interactive type. Broadcasting type announces the traffic information covering a wide area through radio stations or TV stations. Such media may include not only conventional TV system but also broadcasting satellite or communication satellite. No exclusive device is required to receive such information.

In interactive type, potential user can inquire about road and traffic condition to a traffic information centre or similar organisation either through telephone, fax or the Internet. Replies will be given either manually by operators or automatically by answering machines. For example, the primitive type of telephone inquiry system uses the manual method in handling inquiries and uses pre-recorded messages to reply. More advanced system is automated with voice synthesiser and auto-answering telephone system.

The Internet has increasingly become a popular medium in providing real-time traffic information with the proliferation of Internet users. Users can easily access to such service and select areas for which they want to get the information. A typical Internet traffic information service my provide a road network map showing the travel speed for each road section and the location of incidents, which are updated at every 5 minutes for example, or other short intervals.

Table 6.4.1 User Service and Traffic Related Information

		⇐ Real-time information												Static information ⇒			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	User Service	Video image	Vehicle location	Volume/ congestion	Incident	Parking availability	Travel time	Bus travel time	Road condition	Environmental condition	Weather	Destination information	Public transport schedule	Public transport route	Traffic Regulation	Parking location	Digital road map
1	Pre-trip traveller information system	O		O	O	O	O		O	O	O	O	O	O	O	O	O
2	En-route driver information system			O	O	O	O		O		O	O	O	O	O	O	O
3	Traveller services information system					O				O	O	O	O	O		O	O
4	Route guidance system		O	O	O	O	O		O			O			O	O	O
5	Parking guidance system					O						O				O	O
6	Environmental monitoring system			O						O	O						
7	Commercial fleet management system		O	O	O		O		O						O	O	
8	Emergency vehicle management system		O	O	O		O		O	O	O				O	O	
9	Public transport information systems		O					O					O	O			
10	Public transport operation systems		O		O			O					O	O			

b) En-route driver information system

En-route driver information system differs from pre-trip information system in that it provides drivers already on the road with real-time information about congestion, accident, temporary regulation, construction work and other incidents that are useful for drivers in selecting their route. The system may provide estimated travel time at a specific location if equipped with such function. The information is given through devices installed at roadside such as variable message sign, graphic display panel, highway advisory radio, variable regulatory sign, travel time display board, etc.

c) Traveller services information system

Traveller services information system assists travellers to plan and make trips. It provides travel-related information such as location and operating hours of restaurant, hotel, bank, hospital, tourism office, etc. Most of the information is static or semi-static. The information can be accessed in an interactive way through telephone, fax, computer, or information terminal placed at public locations.

d) Route guidance system

Route guidance system uses an in-vehicle unit, which accommodates a digital road map in the form of CD-ROM or DVD. In response to the inquiry input, the device shows the route to the destination usually based on the shortest distance. It detects present position of the vehicle based on the signals sent from Global Positioning System Satellites and indicates it on the monitor screen superimposed on the road map. If additional data were stored in the database, the device would show such information as the location of parking or other landmarks. The device is not capable of receiving real-time information and all operations depend on the static data stored in the device except the present position of the vehicle.

Route guidance system becomes car navigation system with the addition of real-time information receiving unit. Real-time information is sent from FM station over sub-carrier of ordinary FM program on area wide traffic information, or through beacon installed at roadside for local condition in the neighbourhood. For this system to work effectively, a traffic information centre must be established. It would collects detector data at each link in the network and would calculate its travel time. This information is then sent to the in-vehicle car navigation device. The device shows the best route to the destination based on both static and the real-time information. For road network with frequent congestion, car navigation system therefore offers more advantage over the static route guidance system.

e) Parking guidance system

Parking availability is one of the destination-related information. Parking guidance system is a variation of roadside traffic information system. But it uses display board exclusively designed for the system. Instead of giving real time traffic information, the signs display real time parking availability of parking facilities in a specific area, building or floor. The system uses graphic display with an arrow showing the direction to get to the locations of parking with available parking space. The display is often updated at adequate time intervals.

f) Environmental monitoring system

Environmental monitoring system consists of two sub-systems. Air quality monitoring system continuously monitors air quality by measuring the concentration of pollutants such as CO2, NOx and SPM. If the level of pollutant exceeds the pre-set threshold, warning signal is issued or certain restrictive measures are implemented to prevent further worsening of the pollution level. Drivers may be notified or warned of the air quality through roadside signboard.

Emission control system measures the amount of pollutants emitted by vehicle at designated service workshop or at roadside. If a vehicle is found to be non-compliant with the set standards, instruction is given to the vehicle owner to adjust the engine. This system is used to help reduce the pollutants from vehicles.

g) Commercial fleet management system

Commercial fleet management system improves the efficiency and safety of commercial vehicle operation. It is a variation of route guidance system in which real-time location of each vehicle is identified at the control centre and drivers are given instruction as to the best route to take. They are also informed of incident, road condition, weather condition and other information that is helpful for safe driving. For the fleet operator, the system will bring about savings in operational cost.

h) Emergency vehicle management system

Emergency vehicle management system is also an application of navigation technology. It provides public safety agency such as police, fire station and ambulance with the fleet management capability. Location of each emergency vehicle is shown on the monitor at a command centre and instruction is given to the emergency vehicle as to the best route to the destination or tasks to be performed. Exclusive wireless communication system is usually used for two-way communication between the command centre and the emergency vehicles. Pre-emption function of signal for emergency vehicle may be introduced as part of such system.

i) Public transport information system

Public transportation information systems offer better services to riders. It uses vehicle location technology and shows the location of the next bus on a display panel installed at bus stop. Waiting passengers would be able to judge the approximate time to wait for the next bus. The information is of much help for passengers compared with the situation in which they have to wait without knowing when the next bus will arrive. Other information such as bus route, time schedule, fare, and transfer points may also be provided.

j) Public transport operation systems

Public transportation operation system is similar to commercial feet operation system. Location of public transport vehicle in service is shown on the monitor at the control centre on a real-time basis. It keeps records of bus operation and provides the management with useful information. If normal bus operation is disturbed for any reason, countermeasures can be taken promptly to keep the punctuality of service. Advanced type of bus location system is capable of counting the number of passengers on the bus at any one time and equipped with communication system between the bus operation centre and bus drivers.

Table 6.4.2 below summarises the function or purpose, dissemination device, benefit, and beneficiary of candidate user services described above.

Table 6.4.2 Benefits of ITIS related User Services

	User Service	Function/Purpose	Dissemination Device	Benefit	Beneficiary
1	Pre-trip traveller information system	Provides static and real-time information such as road, traffic, and destination-related information in general or in response to inquiry basically to pre-trip drivers.	Auto-answering telephone. Fax service. Internet. CATV.	Reductions in travel time, fuel consumption and air pollution. Efficient use of road network	Potential road user for all types of vehicle.
2	En-route driver information system	Provide road and traffic information at downstream section to drivers. May include travel time information.	Graphic display panel. Variable message sign. Travel time display Highway advisory radio.	- ditto - Enhanced safety	All types of vehicle.
3	Traveller service information system	Provides travel-related information such as hotel, foods, bank, hospital, police, etc.	Same as pre-trip information	Better service to traveller	Traveller (before and during trip)
4	Route guidance system	Guide vehicles to their destination based on both static and real-time information.	In-vehicle navigator with FM multiplex receiver and beacon transceiver.	Reductions in travel time, fuel consumption and air pollution. Efficient use of road network. Enhanced safety	All types of vehicle.
5	Parking guidance system	Provide parking location and availability information.	Roadside signboard. Pre-trip information device Route guidance device	Time saving spent on finding parking space. Reduction of unnecessary traffic.	Mainly for private vehicles.
6	Environmental monitoring system	Monitoring and warning of air quality.	Roadside signboard. Broadcasting.	Prevention of air pollution.	General public.
7	Commercial fleet management system	Monitor movement of fleet and improve the efficiency	Dedicated communication system.	Savings in fleet operation costs.	Fleet operator.
8	Emergency vehicle management system	Guide emergency vehicles to their destination based on the real-time information.	Dedicated vehicle management system.	Efficient operation of emergency vehicle.	General public who received emergency service.
9	Public transport information system	Improve level of service to users by informing users of location of next bus.	Bus location display at bus stop.	Better service to bus passenger.	Bus passenger.
10	Public transport operation system	Provide bus location information to bus operator to improve operational efficiency of bus service.	Central monitor at bus operator's office.	Savings in fleet operation cost.	Bus operator.

6.4.2 Candidate User Services

In the preceding section, ten (10) user services that have relation with integrated transport information system are scrutinised and information used by each user service is identified. In this section, some of these user services are first selected based on their extent of benefits accrued to the public. The selected services are then further examined for setting priorities in introduction of these services to the study area.

It should be pointed out, however, that discussions on some of the user services in the preceding section are conceptual, covering broad idea of providing information through various media. In addition, different grouping criteria may be applied to define user services. For example, pre-trip traveller information and en-route driver information refer to situations in which information is provided, while traveller services information and parking availability information refer to the specific 'type' of information that each service handles. In terms of system configuration, pre-trip information and traveller services information systems are of the same type in providing different information to different user groups. Likewise, route guidance can be considered as an advanced form of en-route driver information.

Commercial fleet management and bus operations management are excluded from the list of user service for further study. The reason is that these services are to be managed by the private sector who will be the main beneficiary. As a result, the following eight (8) user services are to be further examined for introduction to the study area.

- Pre-trip traveller information system
- En-route driver information system
- Traveller services information system
- Route guidance system
- Parking availability information system
- Environmental monitoring system
- Emergency vehicle management system
- Public transportation information system

6.4.3 Prioritisation Criteria

The factors below are considered in prioritising user services. It should be noted that cost is not considered at this moment as it varies depending on the design and size of the service. It should also be mentioned that evaluation of user services by these criteria is relative to each other and a simple scoring system has been devised to provide more objective ranking of priority.

Criteria:

- Need for user service
- Beneficiary and potential amount of benefits
- Information availability
- Technology used
- Ease of implementation

a) Need for user service

No user service is meaningful if there is no need or demand for it in a society. One way to know the social need is through opinion survey, which was conducted in this study. Respondents were asked questions regarding the present situation on traffic information and the type of user services that they want to have. The results of the survey provide valuable inputs to determine the priority of the user services.

Opinion survey does not necessarily reveal the true need of a society, especially in the case of technically very advanced system like ITIS. This is because most of the user services are new to Malaysia and respondents are not in a position to draw past experiences to correctly image and evaluate them. Analytical method based on the current transportation problem is also needed to understand the latent need for these user service. Need for a user service is rated as large, medium or small.

b) Beneficiary and potential amount of benefits

Benefits that an ITIS user service brings about include reduction in congestion, reduction in travel time, reduction in fuel consumption, improvement of environment (air pollution, noise and vibration) and traffic safety. Psychological effect of relieving drivers of frustration is also significant. User service that generates more benefits is thus rated as having higher priority than user service with less benefit.

Each user service provides service or benefit to a specific group of road users. If a large number of road users receive benefits, the service is considered more desirable and of higher priority. The overall size of benefit is the amount of benefit each user receives multiplied by the number of beneficiaries. Benefit of a user service is rated as large, medium or small.

c) Information availability

Each user service needs one kind of information or another as shown in the table in the preceding section. If reliable information is easily available, the user service has more chance of success. On the other hand, if necessary and accurate information is hard or costly to get, or a service requires large amount of different kinds of information, establishment of the user service becomes difficult. Information source and availability are rated as simple, moderate or complex.

d) Technology used

Technology is a key factor of the user services. Advancement of technology has made ITS a reality. Application such as car navigation was conceived long time ago. But it only became commercially available recently thanks to the development of technology in computer and communications. Advanced technology may give a positive impact to the local industry and society. ITIS technology, in particular, will assist Malaysia to enter into the information technology society.

Technology evolves day by day. New technology is emerging and conventional technology may become obsolete. It is important, therefore, to understand the technology used in each user service and its significance. We consider user service that uses advanced technology in accordance with current technical trend and global standardisation as having more priority in application. Technology used in a user service is rated as advanced, moderate or conventional.

e) Ease of implementation

Successful introduction of a user service depends not only on the technologies it utilises but also on the social framework in which the system operates. The framework includes physical condition of road and road network, characteristics of road traffic, institutional set-up of road administration and toll road operation, social system, legal system such as laws and regulations related to road traffic, and customs and preference of local people. In other words, if there is a favourable social framework for a user service, its implementation would be easier. Implementation of a user service is rated as simple, moderate or complex.

6.4.4 Prioritisation Of User Services

The user services are evaluated from the above-mentioned viewpoints. The following paragraphs explain how each candidate ITIS user service is reviewed. It must be pointed out that if a particular user service is rated as 'difficult', it does not necessary mean that its introduction must be discouraged. It merely means that introducing the user service is a challenging task.

a) Pre-trip traveller information system

The opinion survey has revealed that there is a large demand for traffic information. Road users want to obtain information in particular, on congestion, causes of congestion, travel time, recommended route and parking availability. These kinds of information can be effectively disseminated as pre-trip information through broadcasting, Internet, telephone inquiry and auto-reply fax.

Benefits of pre-trip traveller information system are expectedly large. The reason is that the traffic condition on the some of the toll roads and the arterial streets in the study area is reaching a critical point while useful travel information is not readily available at this moment.

Pre-trip traveller information includes a wide range of information, from traffic to weather conditions. Some of them are already available but efforts are required to co-ordinate between various information sources and to collect them continuously. Installation of additional vehicle detectors, TV cameras and other surveillance equipment is necessary to construct a system with the congestion data collection capability.

Technologies required for design, installation, operation, management and maintenance of pre-trip traveller information system are quite basic and are commonly available. If an interactive system is to be constructed, sufficient knowledge and experience are necessary to design a workable system. Advanced technology is, however, required for some very specific applications like travel time measurement using automatic vehicle identification (AVI) detectors, which can read and recognise a vehicle's license plate. Regardless of the design of the service, system integration is a core technology for successful implementation.

Implementation of pre-trip traveller information is quite simple. No major obstacle is foreseen. But it is of paramount importance to provide continuous, reliable and updated information in a timely manner. Otherwise, the service will loose the users' confidence. Co-ordination among agencies involved in providing information and operating the system is also crucial.

b) En-route driver information system

En-route driver information system is similar to pre-trip traveller information system in terms of system configuration and function. Both handle almost the same information. The main difference is the way information is disseminated. En-route driver information provides drivers already on the road with information useful to them through roadside device or broadcasting. The same evaluation and rating as pre-trip traveller information can be applied for need, benefit, information availability and ease of implementation.

Information is disseminated through roadside devices and broadcasting stations. The former group includes variable message sign, graphic display panel, highway advisory radio, variable speed limit sign and signboard for an exclusive application such as parking information or travel time. Design and manufacturing of these devices are not difficult. However, operation of en-route driver information system requires knowledge and know-how as to the collection, selection, editing, presentation, and updating of information to be delivered to drivers. Like pre-trip traveller information, system integration is a key factor for successful implementation.

c) Traveller service information system

Traveller service information system offers destination-related information to travellers. It is similar to pre-trip traveller information but it concentrates more on the information at the destination such as hotel, restaurant, shopping centre, leisure facility, tourism spots, hospital, police, etc. Therefore, traveller service information can be offered as part of the pre-trip traveller information.

The demand for travel service information in the study area is not as large as that for traffic condition related information judging from the fact that majority of vehicle trips in the Study Area is for commuting and business purposes. These trips do not require the information that traveller service information provides.

Only those travellers who receive traveller service information benefit from the service so that the total size of benefits is estimated as small.

Most of the information to be supplied is easily available. However, it is still quite a major task to gather, compile, edit and update a set of comprehensive information.

There is no technical difficulty in providing the service. Most of the information can be collected and input to the service manually. The same media as that in the pre-trip traveller information is used for information dissemination.

The key factor of implementing this service is the organisation that manages the service. If an organisation, either existing or newly established for the service, can take charge of the service and co-ordinate with the other agencies concerned in an effective manner, the service can be implemented without much difficulty.

d) Route guidance system

Route guidance system guides drivers on the best route to take to their destinations. There are two types of route guidance system. Static route guidance uses static information such as road network data stored in a device and guidance is then given based on the distance or pre-defined average travel time of each link. Dynamic route guidance, on the other hand, receives real-time information and develops the best route to the destination based on not only fixed data but also real-time traffic conditions, travel time and other data.

Demand for route guidance in the Study Area could be high. The opinion survey conducted shows that 89% of the respondents replied that route guidance information is either 'very important' or 'important'. The survey also revealed that over half of the respondents are not satisfied with the current practice of traffic information provision and more than 90% of them are willing to take alternative routes if route guidance suggests it.

Benefits of route guidance system are significant. A report of study conducted in Japan, the only country where real-time route guidance system is in operation on a region-wide scale, estimated the benefits to be 6.4 times larger than the cost of system implementation for a period of 20 years. This estimate may not be applied to Malaysia directly, as the conditions of both countries are not the same. Nonetheless, route guidance system can be a very effective and useful traffic management tool in the Study Area.

The basic information that route guidance system requires is road network data in the form of a digital road map, average travel time on each link and the present position of vehicle in the road network. The last data can be obtained using signals form Global Positioning System (GPS) satellite. To be a user-friendly and useful system, various landmarks and destination information must be included in the digital road map. Vehicle detectors must be installed and maintained at many locations throughout the road network to get the constantly updated travel time data. The accuracy and reliability of the guidance will therefore largely depend on the density and operation of vehicle detectors. Good co-ordination among the agencies that manage or operate various toll roads and arterial streets is also important for data collection.

Route guidance system uses several advanced technologies ranging from global positioning system, digital road map, in-vehicle unit with the capability of speech recognition and 3D graphics, etc. FM sub-carrier is commonly used to send area-wide traffic information to vehicles. Dedicated short range communications (DSRC) used for two-way data transmission between vehicle and roadside beacon is also one of the key technologies required. Global standards are currently being developed by an international organisation regarding the application of these technologies.

There are several preparatory works that need to be done before route guidance service can become operational. A good and accurate digital road map must first be developed. A systematic traffic condition data gathering system must then be constructed. FM sub-carrier transmission or beacons must be installed throughout the network. Reference signal for differential GPS must be available from a FM radio station. Sales and maintenance organisation must be set up for the in-vehicle car navigation units. These works may be hard and complex, but the system will have a favourable impact on the development of technology in the country.

e) Parking guidance system

Parking availability information system is dedicated to the collection and provision of parking information. The opinion survey results show that 69% of the respondent are not satisfied with the parking availability information at present. Thus, there is a large need for this service.

Benefits of providing parking availability information are threefold. Drivers looking for a parking space can find it more quickly resulting in a reduction of traffic circulating in the vicinity of the facility looking for a vacant space. Other vehicles in the vicinity thus also benefited from the service. Although the total size of benefit could not be big, it is very helpful in improving local traffic condition at locations where many vehicles gather such as shopping centre or highrise office building. Finally, the operator of parking facility can receive more revenue as more vehicles are called in through the service.

Information source of the service is the parking operators. Their co-operation is, therefore, necessary to introduce the system. Parking availability information can be gathered either manually at an initial stage or automatically at a later stage.

The service is simple in function and no advanced technology is required to establish the service. However, operational knowledge of the service is necessary to design a workable service.

Implementation of this service is relatively simple once co-ordination among the participants of the service is developed.

f) Environmental monitoring system

Vehicle is one of the major sources of air pollution in cities, particularly where traffic congestion is a daily occurrence. Pollution data over a long period is required in order to formulate a workable policy in managing city air quality. The prime objective of such monitoring system is to measure the pollution at strategic locations and at regular intervals, taking into account of other prevailing factors like wind and temperature fluctuations, and if these levels are found to be worse than the allowable standards, countermeasure will be implemented. The need for environmental monitoring system in the Study Area exists but it is not as pressing as other services.

There is less immediate tangible benefit by such monitoring system when air pollution is not a problem yet. But as pollution worsens in future, its implementation can provide early warning signals for activating various countermeasure in a timely manner. Benefits of such a system are not confined only to drivers on the road network but also to all inhabitants within the area.

Air quality data is obtained through measuring equipment housed in air pollutant monitoring stations to be established at strategic locations. Automatic and continuous monitoring is possible and the data can be sent periodically to a system control centre. Pollutant emission data of vehicle is obtained by measuring the amount of pollutants in the exhaust gas from vehicles with suitable measuring apparatus. Automatic measurement system is now available.

Technology to analyse air quality and measure amount of pollutants is an established technology with standardised procedure. No technical difficulty is foreseen in introducing the system.

Implementation of the system depends on the policy of government agency responsible for environmental management. Once a decision is made, implementation of such a system is relatively simple.

g) Emergency vehicle management system

Emergency vehicle management system is an application of vehicle location technology as used in route guidance. The need for the system depends on the policy of agency operating the emergency vehicle and the structure and operation of the existing emergency vehicle management system.

Direct benefit of such a system is improved efficiency in operation of the emergency vehicles. This leads to operation cost savings by the management and life saving benefits by those who request the emergency services. Although the size of benefits for such service would not be big, but it could be very significant in terms of security, social stability, property and life saving.

The core technology used is a dynamic route guidance system dedicated to emergency vehicle. Descriptions on information availability and technology are similar as those described in the (4) route guidance system above.

The system may be implemented at the same time with route guidance system or as part of it with a separate operation body. Alternatively, installing car navigation device in the emergency vehicle will be an effective way of improving emergency vehicle management. Constructing an isolated service when there is no route guidance system will not be feasible.

h) Public transport information system

Improving attractiveness of public transportation is an urgent issue in Kuala Lumpur and its surrounding area where commuting by private car is a norm. As the residential area sprawls, more private cars will be used for transportation. Public transportation information system is one of the measures to decelerate such trend. The results of the opinion survey conducted in this study reveals that a majority of respondents regard public transport information as either 'very important' or 'important'. At the same time, they are not satisfied with the current condition. More than 2/3 of respondents answered that they are not satisfied with the waiting time information. Thus, there is a large and urgent need for the service.

Providing public transportation information does not shorten the travel time of passengers. But it helps them plan the trip and decide whether to use public transport or not. It improves the service and better service attracts more passengers. For public transport operators, the system is likely to increase their revenue.

The system is a variation of route guidance system. Location of each bus is monitored and displayed at bus terminal and bus stop. Detection of bus and collection of location data may use route guidance system, or dedicated location system. Static data such as route, schedule and fare are easily available from the public transport operator.

The core technology used in this system is the vehicle location positioning system and several technologies are available for such application. System integration also plays an important role for developing an attractive system for both users and operators.

For the implementation of this system, establishment of an organiser is required to co-ordinate among the many public transport operators and to operate the system. Good co-ordination and co-operation are essential for the system to function effectively.

6.4.5 Results of Prioritisation

Based on the review described above, each user service is rated. For each evaluation criterion, score is given as follows: 3 for large, simple or advanced, 2 for medium or moderate, and 1 for small, complex or conventional. Then, the overall priority of a particular service is determined by summing up the score. The priority is finally classified into four groups, A through D, where A being 13 points or more; B for scores of 11 or 12; C for scores of 9 or 10 and D for score of 8 or below. The results are shown in the table attached (Table 6.4.3).

User services classified as A have the existing urgent need and large benefits. Pre-trip traveller information and en-route driver information systems belong to Group A. They are highly needed, produce large benefit and are relatively simple to implement. Their immediate introduction is recommended.

Route guidance system, parking guidance system and public transport information system are rated as Group B. They have high demand and large to medium benefits. Data collection for route guidance system is a complex task because travel time information must be collected from a sizeable number of links for the system to be effective. It must be pointed out, however, that the data collection for the pre-trip traveller information and en-route driver information systems can provide a strong foundation for establishing a route guidance system. For this reason, route guidance system is considered as an expansion of the two systems and can be introduced one or two years after the other two systems.

Data collection of parking guidance system is relatively easy, while that of public transportation is moderate. Implementation of both services depends on the co-ordination and willingness among the participants. These services can be implemented at the same time with the services in Group A.

Environmental monitoring and emergency vehicle management systems are classified into Group C. The need for the former is relatively less urgent and it is moderately simple to implement. Emergency vehicle management system depends partly on the route guidance technology so that its implementation will be at the same time with route guidance. They may be introduced after services classified as A or B have been implemented.

The traveller service information system is rated as Group D. It does not produce much benefit when introduced at this moment. It may be reconsidered in the future when the need arises or road traffic environment changes.

Table 6.4.3 Priority Ranking of User Services

	User Services	Needs	Benefits	Information availability	Technology	Implementation	Overall Priority
1	Pre-trip traveller information system	Large (3)	Large (3)	Moderate (2)	Moderate (2)	Simple (3)	A (13)
2	En-route driver information system	Large (3)	Large (3)	Moderate (2)	Moderate (2)	Simple (3)	A (13)
3	Traveller service information system	Small (1)	Small (1)	Moderate (2)	Moderate (2)	Moderate (2)	D (8)
4	Route guidance system	Large (3)	Large (3)	Complex (1)	Advanced (3)	Complex (1)	B (11)
5	Parking guidance system	Large (3)	Medium (2)	Simple (3)	Conventional (1)	Simple (3)	B (12)
6	Environmental monitoring system	Medium (2)	Small (1)	Simple (3)	Moderate (2)	Moderate (2)	C (10)
7	Emergency vehicle management system	Medium (2)	Small (1)	Moderate (2)	Advanced (3)	Moderate (2)	C (10)
8	Public transportation information system	Large (3)	Medium (2)	Moderate (2)	Advanced (3)	Moderate (2)	B (12)

Note : numbers in ( ) are scores

7

ROAD USERS AWARENESS AND OPINIONS ON ITIS

7.0 ROAD USERS AWARENESS AND OPINIONS ON ITIS

7.1 Opinion Surveys : Survey Sites and Sample Size

The opinion surveys were conducted at a variety of land uses at various locations. The locations selected to conduct these surveys include Kuala Lumpur city centre, Petaling Jaya, Klang, Shah Alam, Subang Jaya and Gombak.

Various types of land uses were also selected to allow the collation of opinions from all road users. The selected land uses for the private vehicle users include housing areas, offices, shopping complexes and colleges. The opinion surveys of public transport users on the other hand were focussed on locations such as housing area, transport terminal and bus stops.

The best returns for the surveys were obtained from the housing areas and car parks while offices provided the lowest return. In total, more than 800 forms were distributed, following which a return of approx. 560 forms was achieved. Table 7.1.1 below tabulates the survey forms obtained from the various land uses.

Table 7.1.1 Locations of Opinion Survey Interviews

Location	No. Of Interviews (private vehicle users)	No. of Interviews (public transport users)
House	293	120
Office	24	-
Shopping Complex	120	-
Car Park	92	-
Transport Terminal	31	80
Total	**560**	**200**

7.2 Private Vehicle Users

7.2.1 Travel Characteristics

a) Trip Purposes

More than half of the private vehicle users interviewed used their vehicles for commuting to office. The distribution of the private vehicle users by trip purpose is tabulated below:

Trip Purpose	No. of Respondents	Percentage (%)
Commuting to Office	318	56.8
Schools & colleges	48	8.6
Leisure & Social	86	15.3
Business	108	19.3
Total	**560**	**100.0**

b) Frequency of Driving

A high proportion of private vehicle drivers used their vehicle everyday.

Frequency of Driving	No. of Respondents	Percentage (%)
Everyday	359	64.1
Weekdays Only	117	20.9
2-3 Weekdays	45	8.0
Every Weekend	39	7.0
Total	**560**	**100.0**

c) Duration Spent in Driving Per Day

The distribution of average driving time in a day is given in the table below:

Driving Time Per Day	Respondents	Percentage (%)
Less than 0.5 hour	80	14.4
0.5 hour to 1. hour	138	24.8
1.0 hour to 1.5 hour	107	19.2
1.5 hour to 2.0 hour	73	13.1
2.0 hour to 3.0 hour	59	10.6
3.0 hour to 5.0 hour	47	8.5
More than 5.0 hour	52	9.4
Total	**556***	**100.0**

** Of the total 560 respondents, 4 entries were invalid*

About 61% of the respondents were recorded to drive more than 1 hour per day and 28% more than 2 hour per day.

d) Varying Driving Route

38% of the respondents preferred to use fixed routes every time, with another 42% used almost fixed routes, all the time.

Driving Route	Respondents	Percentage (%)
Fixed Route	210	37.7
Almost Fixed	232	41.7
Vary Frequently	115	20.6
Total	**557***	**100.0**

** 3 entries were invalid*

7.2.2 Importance of Different Items of Information

Different drivers perceive the importance of a particular item of traffic information differently. Conversely, different items of traffic information may be of different significance to a particular driver.

The table below provides a ranking of relative importance of different items of information to private vehicle users.

Rank	Item of Information	Information as very important or important (%)	Information as Not Important or Average (%)
1	How Congested?	95.8	4.2
2	Route Guidance	88.6	11.4
3	Causes of Congestion	82.6	17.4
4	Estimated Time to Destination	68.1	31.9
5	Availability of Parking	65.9	34.1
6	Parking Location	61.8	38.2

Overwhelming majority of those interviewed considered congestion or route guidance information as very important or important, followed by estimated journey time and parking information. *Figure 7.2.1* illustrates the ranking on the relative importance of the above listed items of traffic information by the respondents.

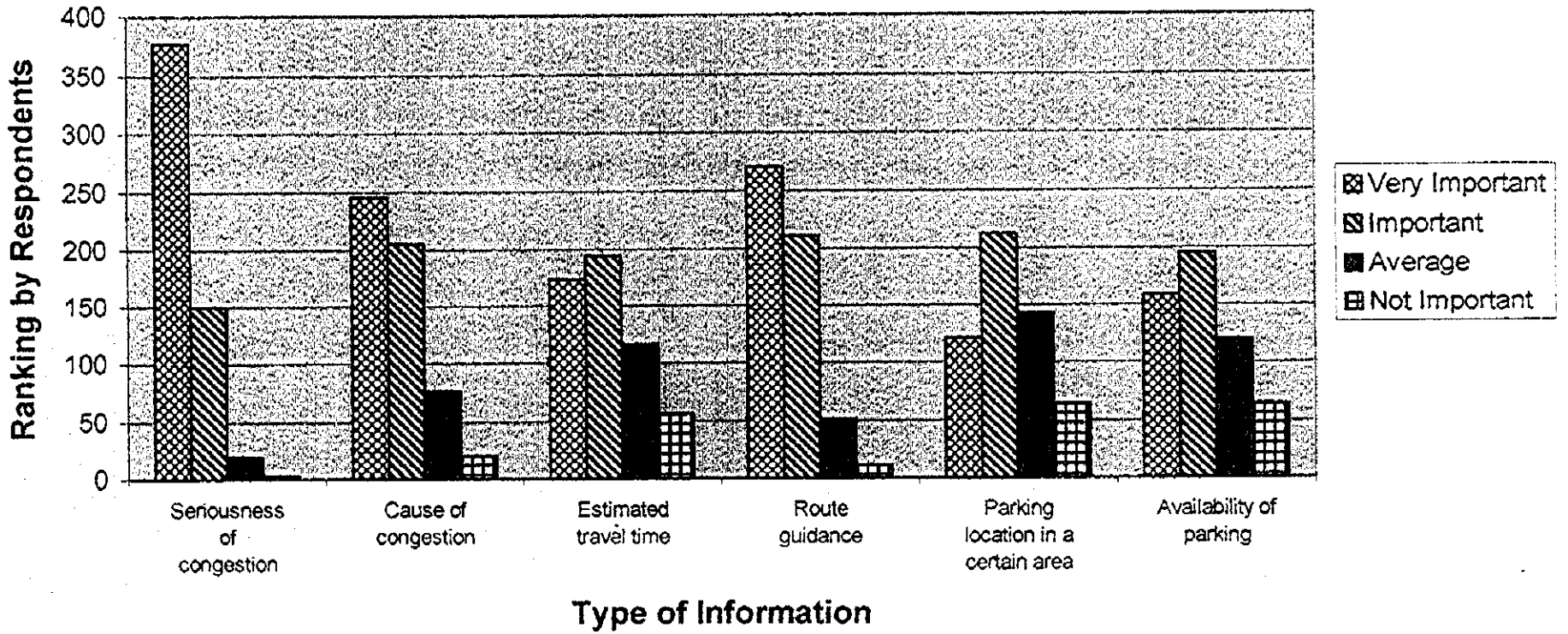


FIGURE 7.2.1 : RANKING ON THE TYPE OF INFORMATION

7.2.3 Importance of Traffic Information by Trip Purpose

The importance of various items of traffic information may be compared against different trip purposes by the use of cross-tabulation. The results are presented in the table below.

Proportion of Respondents who considered a Particular Item of Information as Important by Trip Purpose

Item of Information	Trip Purpose			
	To Office (%)	To School/College (%)	Leisure/Social (%)	Business (%)
Level of Congestion	97.2	95.7	91.5	96.3
Causes of Congestion	84.2	78.8	78.5	82.6
Journey Time	67.8	65.9	61.4	75.9
Route Guidance	87.7	93.6	85.5	91.3
Parking Location	61.8	65.9	55.4	65.7
Parking Availability	67.8	74.4	56.6	63.3

Respondents with trip purpose of commuting to office or on business appeared to have placed marginally greater importance for traffic information than those who were going to school/college or on a leisure/social purpose.

7.2.4 Importance of Traffic Congestion Information By Frequency of Driving

Statistical tests on the importance of congestion information as against the frequency of driving have revealed a significant difference between the perception of frequent drivers and the infrequent drivers.

The cross-tabulation table below shows that for those respondents who drive only 2 to 3 days during weekdays placed less importance on congestion information than those who drive more frequently and every weekend.

Perception on Congestion Information	Frequency of Driving			
	Everyday (%)	Weekdays Only (%)	Every Weekend (%)	2 to 3 Days in Weekdays* (%)
Important	84.4	82.6	83.3	66.7
Not Important	15.6	17.4	16.7	33.3

* *Chi-square test showed that statistically it was significantly different at 3.3% level (i.e. p = 0.033).*

7.2.5 Willingness To Pay for the Traffic Information

Between 30% to 40% of those interviewed are willing to pay for the items of traffic information listed in the previous section. This is considered to be an encouraging response, as many of them have had little or no direct experience on the workings of this Integrated Traffic Information System. Indeed, in Japan for instance the target for the Dynamic Route Guidance System (DRGS) users has been set at 16% (i.e. one in six) of the private vehicle users.

The table below presents the average amount the private vehicle users interviewed were willing to pay for each of the listed items of traffic information.

Item of Information	Average Amount From Those Willing to Pay* (RM)
How congested?	0.35
Causes of Congestion	0.29
Estimated Time to Destination	0.25
Route Guidance	0.28
Parking Location	0.26
Parking Availability	0.26

* *Average amount per item of information*

Consistent with the ranking of importance of information, congestion and route guidance information appeared to fetch the highest amount from those who were willing to pay. The average amount ranged from RM0.35 to RM0.25 per item of information, almost equivalent to 2 or 3 times of a unit of phone call. (Note: currently the charge rate per unit of domestic call by Telekom stands at RM0.13.)

7.2.6 Willingness To Pay for the Traffic Information by Trip Purpose

The willingness to pay and the average amount for the different items of traffic information were cross-tabulated against the different trip purpose and the results were given below:

Proportion for Respondents Who Were Willing To Pay for the Various Items of Traffic Information and the Average Amount by Trip Purpose.

Item of Information	Trip purpose							
	To Office (%)		To School/College (%)		Leisure/Social (%)		Business (%)	
	Willing to pay (%)	Average Amt (RM)	Willing to pay (%)	Average Amt (RM)	Willing to pay (%)	Average Amt (RM)	Willing to pay (%)	Average Amt (RM)
Level of Congestion	40	0.32	33	0.29	42	0.31	28	0.60
Causes of Congestion	37	0.28	25	0.34	41	0.29	26	0.32
Journey Time	35	0.23	27	0.26	39	0.28	22	0.31
Route Guidance	36	0.27	26	0.26	41	0.27	21	0.34
Parking Location	32	0.27	26	0.16	35	0.27	20	0.26
Parking Availability	31	0.28	29	0.13	33	0.28	21	0.26

It has been found that for respondents on business trip purpose, they were significantly (statistically speaking) more willing to pay for congestion information than those who were on other trip purposes. The finding was statistically significant at the 3% level (at $p = 0.031$ and $F = 3.003$ in the Analysis of Variance ANOVA test)).

7.3 Public Transport Users

7.3.1 Travel Characteristics

a) Trip Purpose

- 42% used public transport for social, shopping and leisure purpose
- 39% used it for commuting to office
- 13% used it to go to school or college
- Only 7% used it for business purpose

b) Frequency of Use

- 34% of reported to use public transport everyday (including weekends)
- 17% used public transport everyday for the weekdays
- A high proportion (36%) used it only during weekends

c) Duration in Riding Public Transport

- 50% reported to spend 1 hour or more a day in a public transport vehicle
- About 19% reported to spend 2 hours or more per day in public transport journeys
- On congestion-free days, only 35% said they needed to spend 1 hour or more a day in public transport journeys

d) Choice of Public Transport Mode

- 80% of users take buses regularly
- 10% are regular KTM commuter users
- 7% used taxi regularly
- Only 1% used LRT regularly

e) Ranking on Importance of Items of Information

Rank	Item of Information	Very Important (%)	Important (%)	Sub-Total (%)
1	Route Info at Bus Stops	61	31	93
2	Route Info at Terminals	49	45	93
3	Arrival & Waiting Times Info at Bus Stops	52	37	89
4	Arrival & Waiting Times Info at Terminals	46	41	87

A diagrammatic representation of this ranking of importance of public transport information is shown in *Figure 7.3.1.*

7.4 General Public Perception on ITIS

From the results of the opinion survey, it is clear that the general public in the Klang Valley are very interested in traffic information, in particular in traffic congestion and route choice information for private vehicle users, and in bus route information for public transport users. More than 90% of those surveyed considered the above-mentioned information as important or very important.

In addition, it was also found that more frequent drivers, (for example, those who drive everyday or every weekend or weekday) attached greater importance to this congestion information than those less-frequent drivers (i.e. those who drive 2 to 3 days in weekdays).

Of those interviewed, 30% to 40% had responded positively that they are willing (without compulsion) to pay for the information. Different kinds of information were attached different values by the respondents. For example, congestion information were valued the highest and the respondents were willing to pay an average of RM0.29 to RM0.35 per item of traffic congestion information; an average of RM0.28 for route guidance information and RM0.26 for parking information.

Those who are on business trip purpose were found to be willing to pay more for congestion information than those who are on other trip purposes.

It may be said that the survey has established conclusively the need and importance of this traffic information, i.e. congestion information, route guidance information and parking information (in descending order of importance) to the general public. However, it has also been found that different persons would accord different values to these different items of traffic information. There are a substantial number of people who have accorded enough importance to this traffic information to be willing to pay for this information.

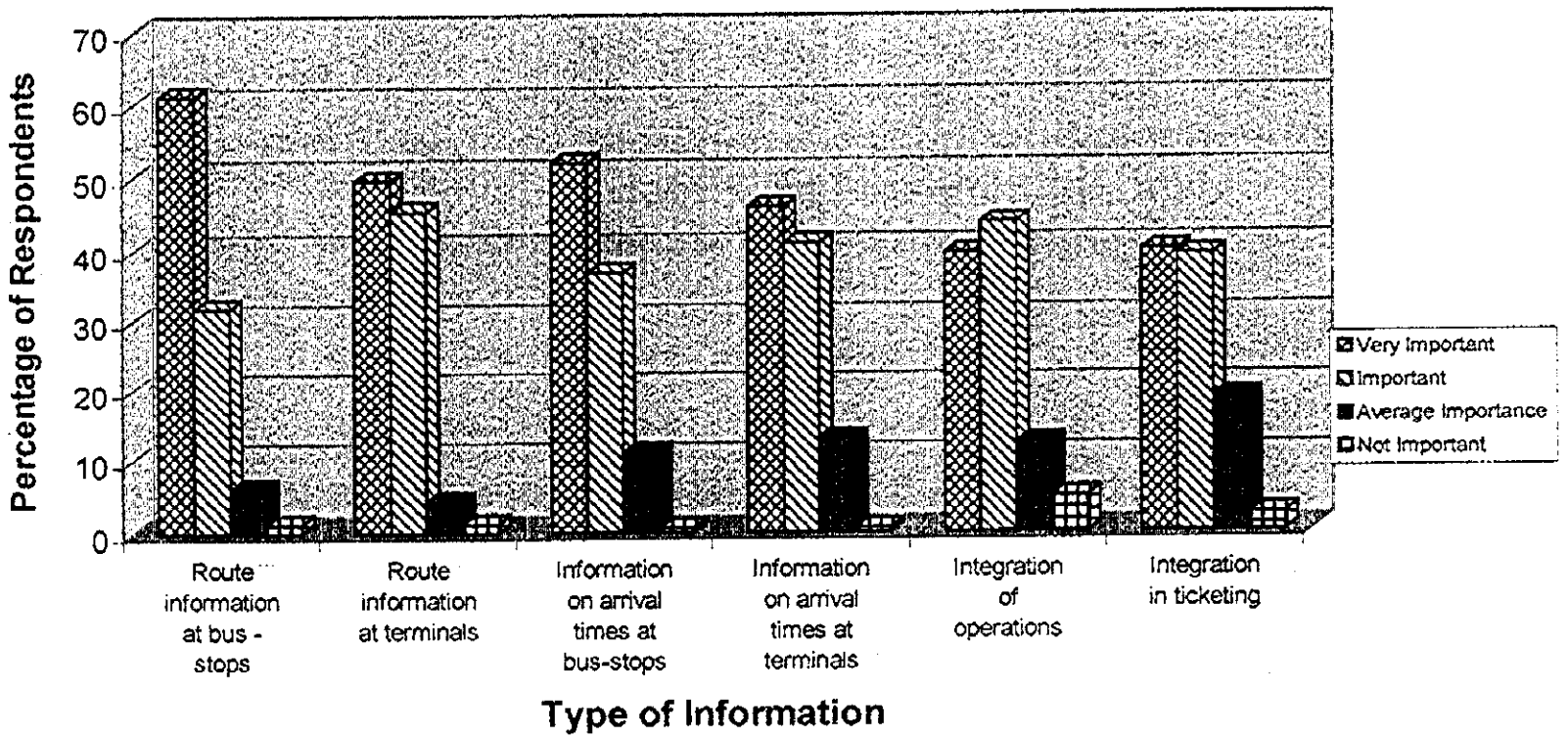


FIGURE 7.3.1 : RANKING OF IMPORTANCE OF PUBLIC TRANSPORT INFORMATION BY USERS

8

CONCEPTUAL PLANNING AND DESIGN OF AN ITIS IN KLANG VALLEY

8.0 CONCEPTUAL PLANNING AND DESIGN OF AN ITIS IN KLANG VALLEY

8.1 Overall Concept Plan for ITIS

In Chapter 6, user services related to traffic and transport information are identified and prioritised for further study. A total of ten user services are found to have relation with traffic-related information. Among the ten user services, commercial fleet management system and public transport operation information system are excluded from the list as these services are to be managed by the private sector for their own management purposes. Finally, four user services, namely pre-trip traveller information system, en-route driver information system, parking guidance system and public transport information system are selected among the remaining eight for the conceptual design. *Figure 8.1.1* illustrates the logical architecture of eight user services and their interrelationship. Four user services shown in solid line are the systems to be developed in this study, while another four user services in broken line are the systems for future and will not be studied in further details in this study.

In terms of system component, all four user services consist of information collection, information processing and information dissemination systems. Table 8.1.1 summarises the system components of the four user services selected for conceptual design.

Pre-trip traveller information and en-route driver information systems have common information and processing functions. They differ however in the media used for information dissemination. In addition, pre-trip traveller information deals with the information of both current and future event, while en-route driver information concentrates on only the current events. For the reason of this commonality, the two systems are dealt with together in the conceptual and basic design.

Table 8.1.1 Configuration of Selected User Services

User Services	Information Collection		Information Processing	Information Dissemination		
				Area-wide		Roadside
	Collection Device	Information	Processing Output	Broadcasting	Interactive	
Pre-trip traveller information system	• Vehicle detector • AVI detector • TV camera • Communication with other systems/agencies • General public	• Traffic volume • Occupancy rate • Speed • Incident • Various traffic related information	• Congestion level • Queue length • Travel time • Incident database	• Radio broadcasting • TV broadcasting • Cable TV	• Telephone answering system • Fax service • Internet	
En-route driver information system	Devices above are common to both pre-trip and en-route information systems.	Same as above	Same as above but limited to current incidents	• Radio broadcasting		• Variable message sign • Graphic display panel • Travel time display • Highway radio
Parking guidance system	• Parking management system	• Number of available spaces	• Display information			• Parking guidance sign
Public transport information system	• On-board bus location sensor	• Bus location in co-ordinates	• Bus location along bus route			• Bus stop display

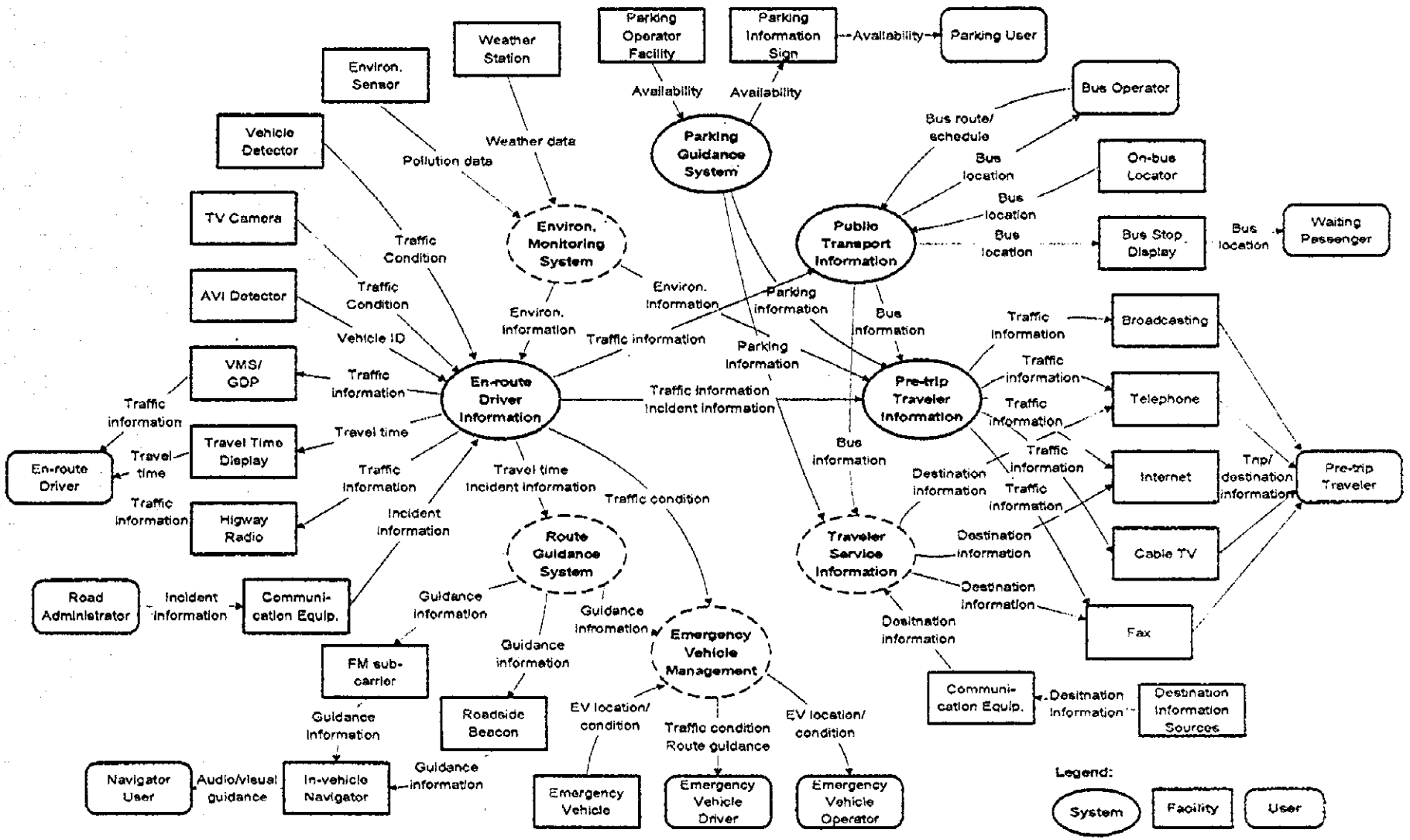


Figure 8.1.1: Logical Architecture of Integrated Transportation Information System

8.2 Pre-trip Traveller and En-route Driver Information Systems

8.2.1 Staged System Construction

The Integrated Traffic Information System, which offers pre-trip traveller information and en-route driver information, will be installed to the study area in two phases, Phase 1 system and Phase 2 system, in terms of system functions and coverage area. This staged construction is deemed desirable from the viewpoints of social needs, infrastructure and urban development including construction of planned road and new development centres; capability of implementing agency and their staff, and project cost. Conceptually, Phase 1 System is a basic traffic information system in which roadside facilities are extensively used for information dissemination, while Phase 2 System is an advanced in-vehicle traffic information system in which real-time information is sent to in-vehicle car navigation units through FM broadcasting.

It is expected that the Phase 1 system becomes operational in Year 2003, while the Phase 2 system in Year 2006. The schedule is derived based on the following calculation: detailed design of the system for 1.0 year, system construction for 1.5 years and the selection of consultant and contractor for 0.5 years in total.

8.2.2 System Functions

The system will have the functions summarised in Table 8.2.1 for Phase 1 and Phase 2. In the first phase system, the prime objectives of the system are to collect and disseminated traffic information such as traffic congestion, accident, construction work, etc. of the road network covered by the system. Vehicle detectors will be installed at all road sections, and closed circuit television cameras will be installed at key intersections in the network. Data exchange with other systems will also be established. Traffic information will also be collected manually through communication with other relevant agencies and the general public.

Traffic information thus gathered will be processed at the ITIS Centre and disseminated as pre-trip traveller information and en-route driver information through various media. Pre-trip traveller information will be delivered through radio broadcasting, TV broadcasting, cable TV service, telephone inquiry, and the Internet. En-route driver information will be provided to drivers on the road through variable message sign, graphic display panel, travel time display and roadside highway radio.

In the second phase, the system will expand its coverage area. Functionally, travel time measurement and travel time estimate functions will be added to the system and car navigation service will start. Travel time of all links of the road network covered by the system will be determined either by measurement or estimation. Such real-time travel time information will then be distributed through FM broadcasting using sub-carriers. To receive and utilise the travel time information by individual vehicle, on-board car navigation unit is required.

Conceptual system configuration of the traffic information system at the final stage is presented in *Figure 8.2.1.*

Table 8.2.1 System Functions

	Phase 1	Phase 2
Concept	Basic traffic information system	Advanced in-vehicle traffic information system
Information collection	**Objective** • Monitor traffic flow/condition • Detect incidents/queues • Estimate travel times along selected routes • Exchange data with other systems	**Objective (additional)** • Compute travel time • Estimate travel time for car navigation service
	Location • All toll roads and highways • Frequent congestion/queue and bottleneck road section/spots • High traffic volume road sections on arterial and major distributors	**Location (additional)** • Other arterial and distributor roads within the study area
	Equipment • Vehicle detector (ultrasonic and inductive loop) • TV camera	**Equipment** • AVI detector • Additional detector • Additional TV camera
Information processing	**Information to be processed and compiled :** • Congestion levels • Queue length • Incident • Travel time • Other information manually collected and input (accident, roadwork, regulation, events, etc.) • Processing of data obtained from other systems	**Information to be processed and compiled :** • Enhancement of coverage area and accuracy of information processed in Phase 1 • Link travel time for car navigation

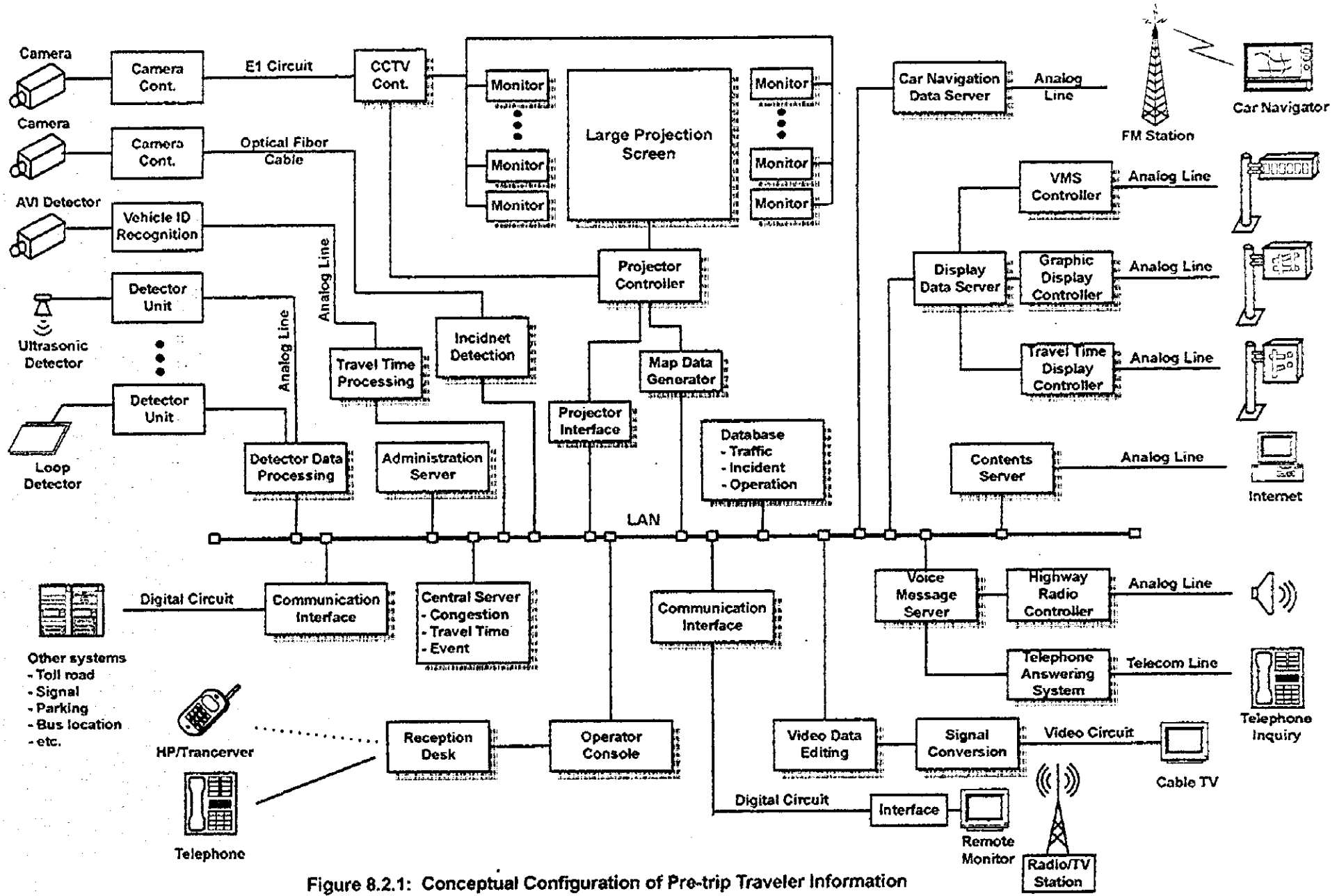


Figure 8.2.1: Conceptual Configuration of Pre-trip Traveler Information and En-route Driver Information Systems

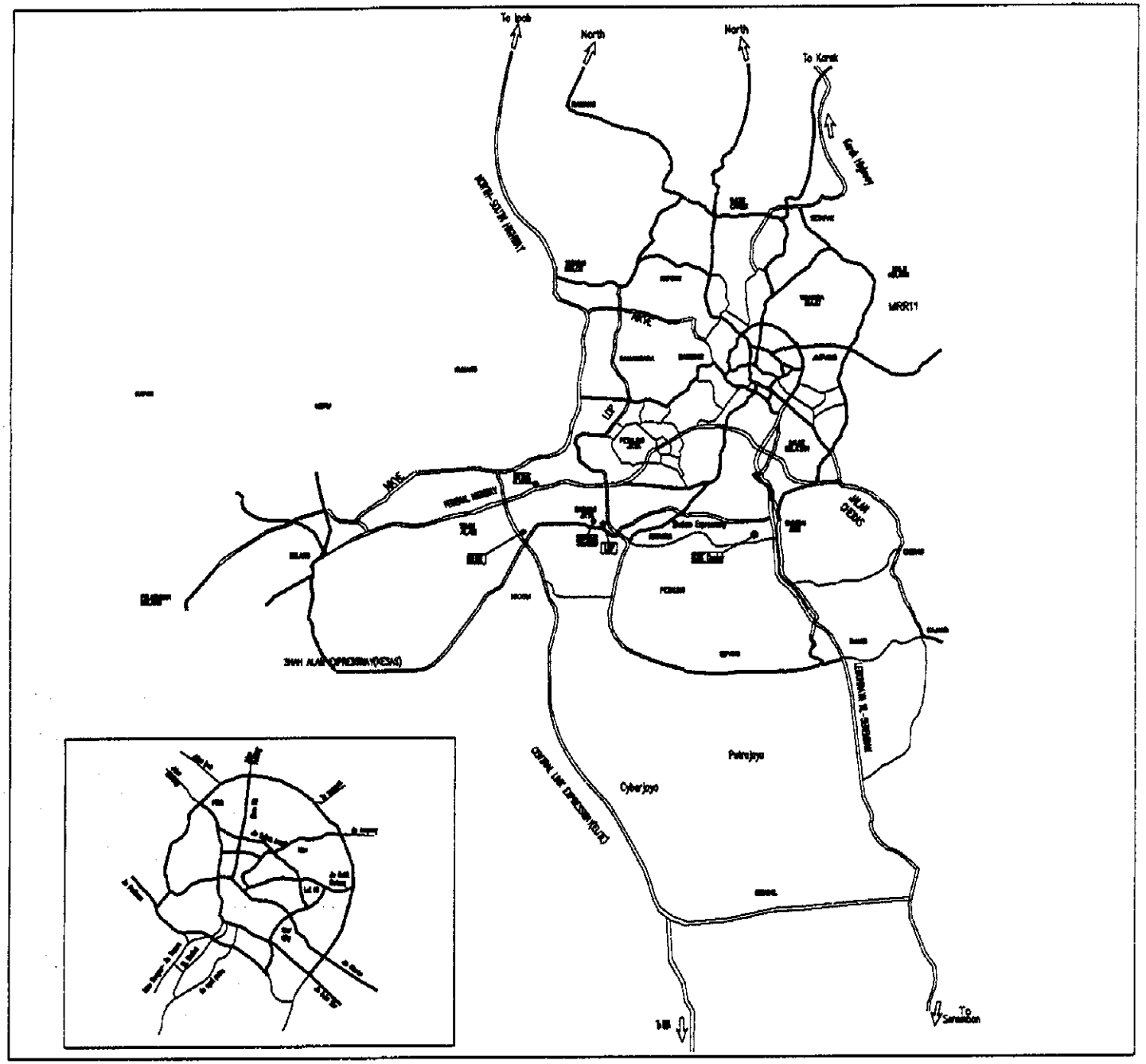
	Phase 1	Phase 2
Information dissemination	**Information to be disseminated :** • Congestion levels • Incident • Travel time • Manually input information	**Additional information to be disseminated :** • Travel time for car navigation
	Equipment for pre-trip • Radio broadcasting • Telephone inquiry • Internet • Cable TV	
	Equipment for en-route • Variable message sign • Graphic display panel • Travel time display • Highway radio	**Equipment for en-route** • FM sub-carrier broadcasting

8.2.3 Coverage Area

The proposed system will cover the Klang Valley and the Multimedia Super Corridor with a lesser number of links included in Phase 1. In Phase 1, traffic condition data will be gathered at all the toll roads and highways such as Federal Highway II in the study area, and arterial roads mostly within Kuala Lumpur and Petaling Jaya. In Phase 2, additional links will be added which include newly opened toll roads and highways, if any, and more arterial and distributor roads in the study area. The coverage area is summarised in Table 8.2.2 below. The road network in each phase is shown in *Figures* 8.2.2 and 8.2.3.

Table 8.2.2 Coverage Area

	Phase 1	Phase 2
Toll road and highway	• All toll roads and highways in the study area	• Newly opened toll roads and highways after Phase 1
Other roads	• High standard roads in the study area • Arterial distributor roads within KL • Road with AADT of 50,000pcu or more (one-way)	• Arterial and distributor roads within the study area • Road with AADT of 35,000pcu or more (one-way)



A Study on Integrated Transport Information System (ITIS) in Klang Valley And The MSC in Malaysia

Figure : 8.2.2

Phase 1 Road Network

LEGEND :

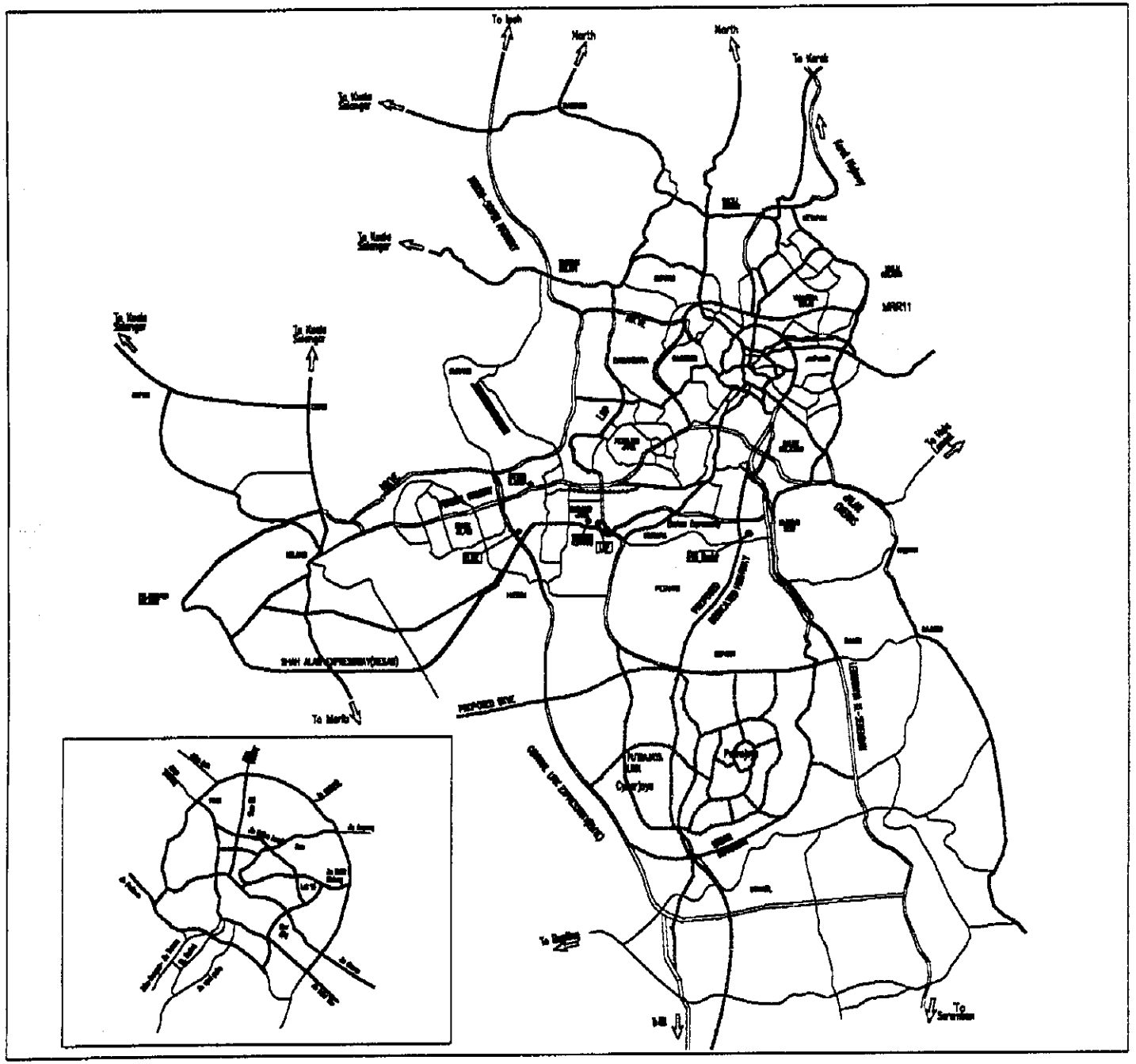
- EXPRESSWAY/HIGHWAY
- MAJOR ARTERIALS
- MAJOR DISTRIBUTORS
- FUTURE ROADS

0 5 10km

Scale :

N

Perunding Trafik Klasik Sdn Bhd



A Study on Integrated Transport Information System (ITIS) in Klang Valley And The MSC in Malaysia

Figure : 8.2.3

Phase 2 Road Network

LEGEND :

- EXPRESSWAY/HIGHWAY
- MAJOR ARTERIALS
- MAJOR DISTRIBUTORS
- FUTURE ROADS

0 5 10km

Scale :

N

Perunding Trafik Klasik Sdn Bhd

The details of the road networks shown in the figures are given below.

Table 8.2.3 Details of Road Network

		Phase 1	Phase 2	Total
Network	No. of road sections	260	143	403
	No. of links	520	286	806
Distance by road type	Total (km)	564.2	414.4	978.6
	Highway	290.8	69.6	360.4
	Arterial	180.8	55.9	236.7
	Distributor	92.6	288.9	381.5
By Toll & Non-Toll	Toll (km)	276.5	59.7	336.2
	Non-toll	287.7	354.7	642.4
By Traffic volume	Heavy volume (km)	332.7	112.4	445.1
	Medium/light volume	231.5	302.0	544.5

The number of links shown above is obtained by doubling the number of sections, as most of the road sections are two-way streets. The actual number of links will be slightly smaller in fact than the number given above due to the existence of some one-way streets. The classification of sections into heavy volume and medium to light volume in the table is made for the application of detector deployment guidelines, which will be explained later. All road sections are classified either into heavy trafficked or otherwise based on the traffic volume/capacity data derived from the JICA SMURT-KL study and present traffic conditions.

8.2.4 ITIS Centre

The ITIS Centre is a nucleus of the proposed integrated traffic information system where data are gathered and processed, communications directed, decisions made, information and instruction issued and traffic and operation data stored. To perform all these functions effectively, suitable space is required to accommodate both the equipment and the operating staff. Normally most of the equipment including computers and communication devices are located in a machine room while the operators are stationed in the control room with the human-machine interface equipment such as wall map, video monitor, computer terminal, etc. Supporting facilities such as un-interruptible power supply (UPS) and air conditioning system are equally important for normal operation of the system and these are usually housed in a separate room. There are other spaces needed for the operation of the centre, which include office space, conference room, visitor's hall, etc. The requirements for the control centre building are summarised in Table 8.2.4.

Technically, the geographical location of the control centre is not an important issue as long as it is located near central position in relation to the terminal equipment distribution and where high-speed data link is available. The reason is that transmission network will be established to transmit the bulk of data to and from the control centre as well as the terminal equipment which are scattered all over the coverage area. As presented later, it is recommended that the proposed system leases telephone-grade lines from telephone company for data communication with terminal equipment and digital data line for TV camera as lease fee of such lines is not sensitive to distance.

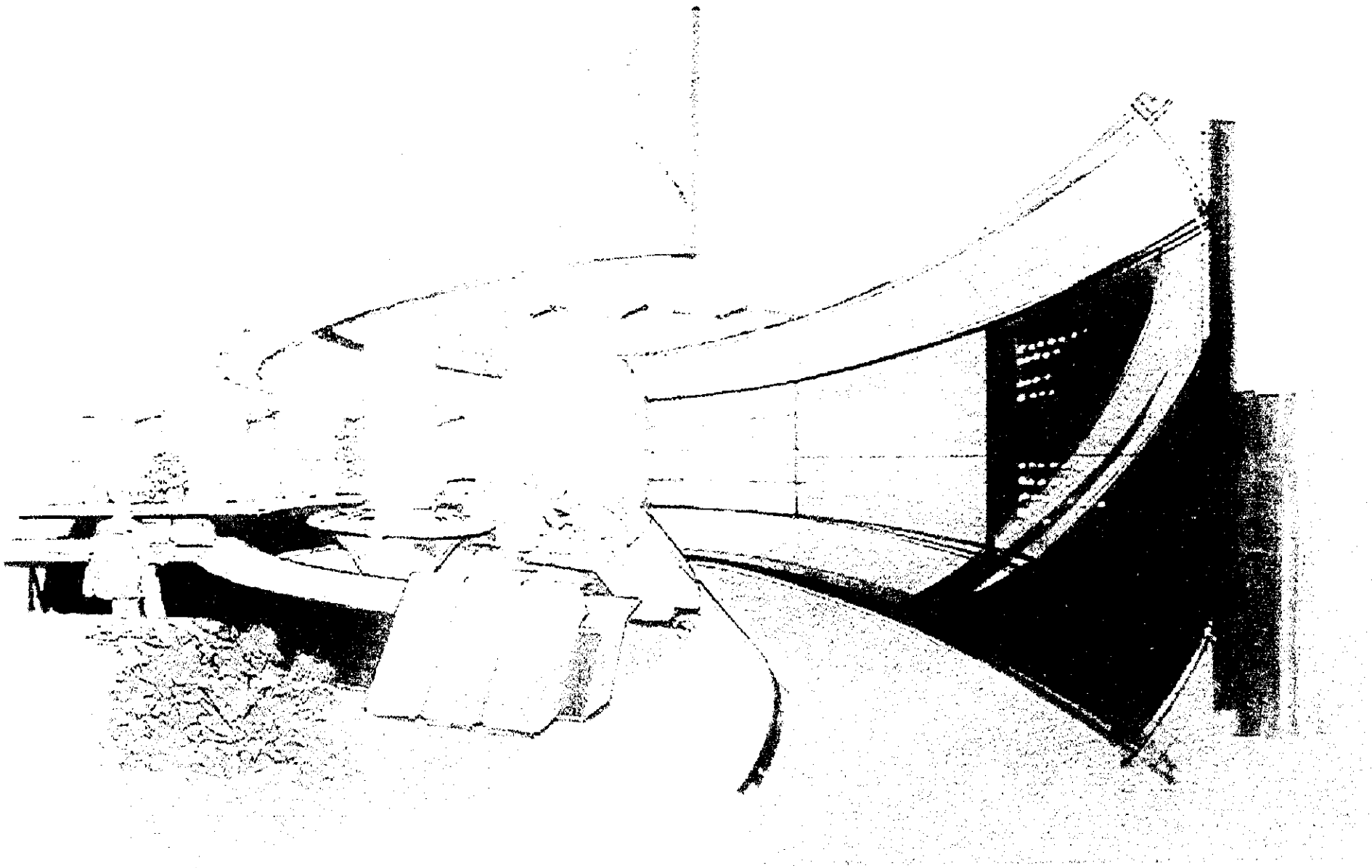
The location is to be selected based instead on the land use, environment, availability and size of land, ease of commuting, accessibility from most toll roads and arterial streets and other non-technical factors. In this study, the location of the ITIS centre is set at Technology Park Malaysia (TPM) in Bukit Jalil after considering several alternative locations including DBKL building where the control centre for the existing ATC system is located. It should be pointed out that the cost of the system will not be seriously affected by the location of the centre at this basic design study level. The proposed TPM site however does have the advantages of being centrally located within the coverage network, within the MSC corridor to enjoy MSC status and in the hub of high technology research activities in Malaysia. A conceptual artist impression of this ITIS Centre is given in the following page.

The proposed ITIS Centre must have very strict control in its building security system. The reason is obvious. The premise must have good alarm system to detect any intrusion. Entry and exit of persons, vehicles, equipment must be carefully screened and recorded. Public viewing hall for visitors shall have separate and easily controlled access point.

Table 8.2.4 Requirements for Control Centre Building

Room	Area	Height	Floor	Equipment/facilities	User	Air-con	Remarks
Control room	200 m²	> 6 meter	Fully or partially Raised	wall map monitor TV control console	operator	24-hour	lighting control
Machine room	200 m²	standard	raised & anti-static electricity	computer systems communication equipment	occasionally operator maintenance staff	24-hour	cable pit
UPS room	100 m²	standard	anti-acid	generator CVCF battery power distribution board	none	none	exhaust pipe cooling fan
Maintenance shop	60 m²	standard	standard	test equipment spare parts	maintenance staff	yes	
Visitor's hall	60 m²	standard	standard		visitors	yes	glass partition
Office	Variable (100 ~ 300 m²)	standard	standard	office equipment office furniture	office staff	yes	
Conference room	100 m²	standard	standard	audio-visual equipment tables and chairs	staff/visitors	yes	for meeting, training, presentation, etc.
Rest room	20 m²	standard	standard	bed	night shift operator	yes	
Air conditioner	50 m²	standard	standard	air conditioner cooling tower (outdoor) air duct/water pipe	none	no	24 hour operation

Note : Standard facilities such as entrance hall, comfort room, etc, are not included



8.3 Parking Guidance System

Parking guidance system is intended to provide parking availability information to the drivers looking for a parking space so that driver can save the time spent in searching for a vacant parking slot. Unnecessary traffic routing around congested area for parking purpose is also minimised by the system. Parking guidance system is effective at the location where parking demand is high and several parking areas are available within a reasonable range. Typical candidate location is the CBD, commercial district and shopping district.

A parking guidance system usually covers a cluster of parking areas within a certain district. Size of the coverage area must not be too large and within the tolerable walking distance from the parking lot to the destination within the district. The size of the coverage area may vary depending on the geographical distribution of parking facilities within this area, total number of parking lots and volume of parking demand.

Parking guidance system typically consists of information collection, information processing, and information dissemination sub-systems. Functions of these sub-systems are summarised in Table 8.3.1 below. The system consists of a workstation or a personal computer with control software, printer and communication device. They can be placed at one of the parking area. Communication with parking control system and on-street guide sign will be made mostly by self-owned line.

Table 8.3.1 Function of Parking Guidance System

Sub-system	Function
Information collection	• Collects information on - Open/close status of parking area - Number of parking lots available
Information processing	• Determines display contents • Monitors the operation of the equipment comprising the system • Exchanges information with ITIS Centre • Logging of system operation
Information dissemination	• Displays on signboard - Open/close status of parking area - Number of parking lots available

Parking lot availability can be expressed in two levels. At a macro level, availability is expressed as the number of remaining parking lots, while at a micro level, location of vacant lot is identified. The former data can be obtained as the difference between the total number of vehicles entered and exited. On the other hand, at the micro level, availability data indicate whether a lot is occupied or not, and requires vehicle detector at each parking lot. Unless there is a strong reason to control the use of each parking lot, macro level information is sufficient for operating a parking guidance system in achieving cost effectiveness of such a system.

Most of the parking areas in Kuala Lumpur use ticketing system in which a ticket is issued by a vending machine at the entrance gate and parking fee is paid at the exit gate. Entrance and exit of the parking area is thus controlled by gates, operation of which is monitored by the parking system. It is therefore reasonable to assume that the existing parking control system possesses the data on the number of remaining parking lots.

Parking guide sign conveys two basic types of information, parking area location and parking lot availability. The former information is shown either in the form of a graphic map or by arrow symbols.

The second type of information is indicated either by the number of available lots, or full/vacant status. The former is preferable as it also shows occupancy status of parking area.

8.4 Public Transport Information System

8.4.1 System Function

Bus location information system is useful to both bus users and bus operators. For bus passengers waiting at bus stop, bus location information provides approximate waiting time until the next bus arrives thus relieves the user's stress of uncertainty. If the next bus will not arrive within a reasonable time, the waiting passenger can then consider taking other modes of transport without waiting in vain at the bus stop. For the bus operator, the system provides useful data for managing the bus operation in a more efficient manner. As mentioned earlier in this report, public transport operation system that is strictly for the operator is not studied in this report.

Bus location system consists of information collection, information processing, and information dissemination sub-systems. Functions of these sub-systems are summarised in Table 8.4.1 below.

Table 8.4.1 Function of Public Transport Information System

Sub-system	Function
Information collection	• Collects information on - Bus ID, route number, status - Geographical location data
Information processing	• Determines bus location along the route • Prepares display data on the signboard • Monitors the operation of the equipment comprising the system • Exchanges with ITIS Centre • Logging of system operation
Information dissemination	• Displays on the signboard at bus stop - Location of bus for the requested route - Arrival time of bus - Bus routes and their destinations/timetables

There are two methods of collecting bus location information. One type adopts communication between bus and roadside equipment, which are installed along the bus route at regular interval at such location as bus stops. Data are exchanged as a bus passes such a roadside device. Information on the bus location will be sent from these roadside devices to the centre either by wireless means or wired method. Another type is to make use of Global Positioning System (GPS) to track the location of buses. On-board unit receives time signal from the GPS satellites and sends this location information to a bus control or monitoring centre together with bus ID and other information through wireless method.

The first type is relatively simple but roadside equipment are required and only discrete information of whether a bus has passed the roadside equipment is known. The second type provides more accurate information but the system is more complex and location data processing is required at the monitoring centre. Considering the popularity of GPS applications and more accurate information on bus location without roadside facility, location detection method based on GPS is preferred.

Data sent from the bus to the operation monitoring centre might include many other informations and data such as bus occupancy, driver's ID, and or even traffic congestion data. But data must be limited to those that can be collected automatically. If manual input is required, reliability of data will be affected. It must also be considered that on-board unit will not be permanently attached to a particular bus. It can be a portable device and often transferred from one bus to another.

Two types of real time bus information can be displayed on signs at bus stops, location of bus and waiting time. Location type displays the location of the next arriving bus. Bus location is indicated either as the approximate location along the route or, more simply, whether the next bus is at the upstream bus stop or has left there and is on the way to the bus stop. Waiting time type displays the expected waiting time until the arrival of next bus. The former method is simpler but does not provide the waiting time information that waiting passengers want to know. The latter type can satisfies the passengers needs, but the estimated time would not be correct unless the traffic condition along the route is properly considered in calculating the waiting time.

8.4.2 Selection of Bus Route

Bus location system must be installed along bus routes where more benefits can be expected to justify its deployment. The following are some of the conditions for selecting bus routes for the deployment of bus location and information system.

- Frequency
- Fluctuation of schedule due to congestion
- Passengers volume (regular and casual) and trip pattern
- Other routes on the same road
- Alternative transport

a) Frequency

Bus location system is not very beneficial to any bus route where bus service is frequent and average headway is short. For example, if buses on a particular service route arrive every five minutes, bus location information is of little value to the passengers. For passengers to gain any benefits, the bus headway must be at least ten minutes or more.

b) Fluctuation of schedule due to congestion

Punctuality of bus arrival is another important factor to consider. If bus arrival is on schedule most of the time, passengers can easily expect when the next bus will come. In such a case, bus location system is again of little value to the passengers.

It is noted that buses in Kuala Lumpur do not have any fixed schedules for the whole day. The first few dispatches in the morning are controlled but subsequent runs are subjected to traffic conditions and there is no time schedule to which bus driver must adhere to. Under such circumstances, bus location system is very useful for the bus users.

c) Passenger volume

For a bus location system to be effective, the number of passengers travelling along the route must be large. More importantly, the number of passengers getting on and off at bus stops equipped with bus location display must be considerable.

The travelling pattern of passengers on buses in Kuala Lumpur appears to be that many passengers board and alight near both ends of the route. Hence road sections, where the adjoining landuse activities are high and there is high demand for buses, should be selected for deploying the bus location system display signs.

d) Buses of other routes plying on the same road

The bus service network in Kuala Lumpur consists of radial routes emanating from the city centre towards the suburbs in all directions. Many buses of different service routes run on the same road near the city centre, typically within the Inner Ring Road. On the other end of the service routes, the number of bus routes gradually decreases as they branch from the arterial street towards individual residential districts.

If a bus location system is to be introduced along a certain route, all buses running on the same road must be fitted with the system. In other words, the system must be applied to all buses plying the same road section. For this reason, the stretch of road where location signs are to be deployed should have a consistent number of bus service routes as much as possible. However, the number of routes cannot be too many like those sections within Inner Ring Road, which are not suitable for bus location system.

e) Other considerations

In the Study Area, buses assigned to a specific route are not fixed. This means that more buses would have to be fitted with on-board units, or on-board units must be portable and easily transferred from one bus to another.

Considering the selection criteria described above, public transport information system is more effective along radial roads in the study area. There are five arterial streets where bus route concentrate, Federal Highway II, Jalan Cheras, Jalan Ampang, Jalan Genting Kelang, and Jalan Ipoh. The number of bus routes and their branch point along the route is studied and, Jalan Ampang is selected for the conduct of a case study on account of the simplicity of bus routes on this radial road.