3.5 Characteristics of Travel Demand

3.5.1 Characteristics of Person Trip Demand

(1) Home Interview Survey

The Home Interview Survey was conducted by the Study Team in Klang Valley region in 1997. Table 3.5.1 shows sample size of the Study.

Table 3.5.1 Sample Size of the Home Interview Survey

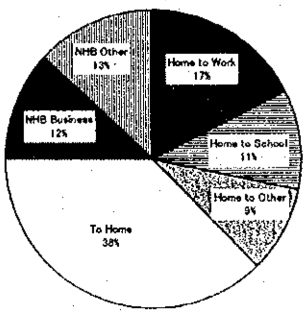
	Accepted Sample:	No. of Househiold	Sample Ratio
Kuala Lumpur	15,356	334,901	0.046
Gomback	2,570	99,786	0.026
Hulu Langat	5,237	119,672	0.044
Petaling	8,605	181,293	0.047
Kla	2,681	106,774	0.025
Tota	34,449	842,426	0.0#1

Note:No. ofhouseholds in 1997 is estimated by the Study Team

Person trip demand made by the residents aged seven years old and above in the Klang Valley region was estimated to be 8.3 million trips on a typical weekday in 1997 based on the Home Interview Survey.

(2) Trip Purpose Composition

Home-based trips are major constituents of the urban travel demand, which include "home to work place," 17%, "home to school," 11%, "home to other places" 9%, and "back to home" trips 38%. Around 75% of the travel demand are produced or



Source : SMURT-KL Home Interview Survey, 1997

Figure 3.5.1 Trip Purpose Composition

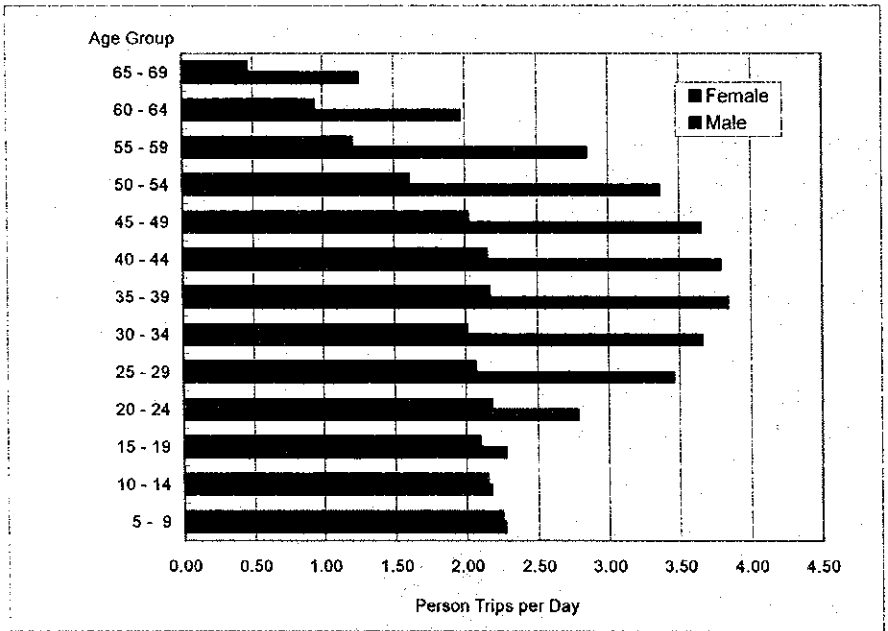
attracted to and from home. The remaining trips such as "non-home based business and "non-home based other", account for 12 percent and 13 percent respectively.

(4) Trip Production Rate

Trip production rate of the residents aged 7 years and above was estimated at 2.57 trips per day. Correlation between trip production rate and household and personal attributes has been analysed to understand the travel characteristics of the Klang Valley residents. The analysed household and individual attributes include sex and age group, employment and educational status, occupation, vehicle ownership, and monthly gross household income.

1) Sex and Age Group

Remarkable differences in trip production rate are observed with the stratification of sex and age group as depicted in Figure 3.5.2. Although there are no significant difference in trip production rate between male and female up to the age group of 15 to 19 years old, it is clear that the mobility of male is much higher than female, especially for the groups of 20 years old and above.

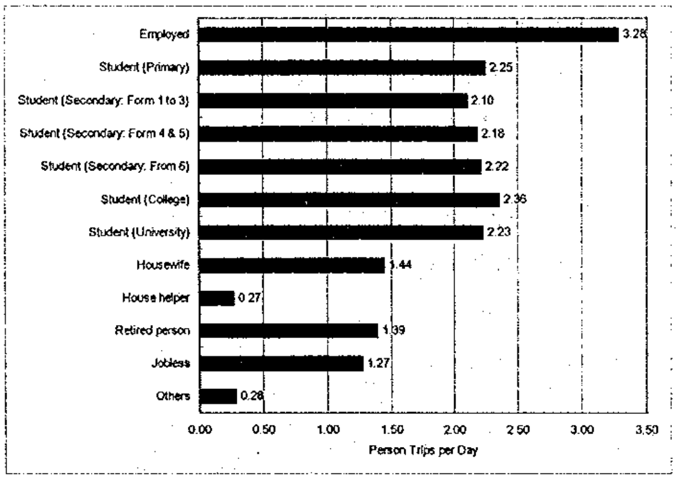


Source : SMURT-KL Home Interview Survey, 1997

Figure 3.5.2 Trip Production Rate by Sex and Age Group

2) Employment and Educational Status

As shown in Figure 3.5.3, the trip production rates of students by school type, which falls in the range from 2.10 to 2.36, do not show significant difference. University and college students make more Non-Home Based trips than those in lower grade of schools. Individuals such as housewife, retired, and jobless who are not active in labour force make fewer trips than other groups in the society. The trip production rates for this group are between 1.27 and 1.44. House helper indicates the lowest trip production rate of 0.27 trips per day.



Source : SMURT-KL Home Interview Survey, 1997

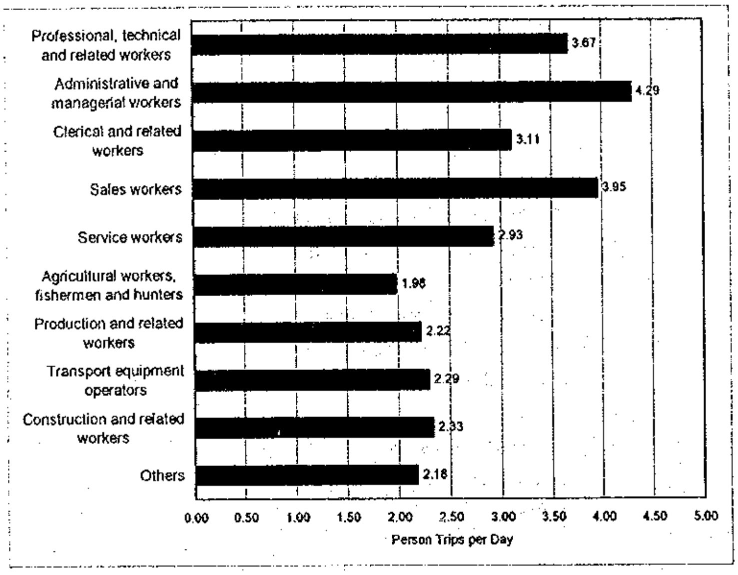
Figure 3.5.3 Trip Production Rate by Employment and Educational Status

3) Occupation

Trip production rate varies widely in occupation as shown in Figure 3.5.4. Among working persons, agricultural workers show relatively low trip rate of 1.98 trips per day compared to other occupations. In contrast, administrative and managerial workers, sales workers, and professional and technical workers indicate higher trip production rates of 4.29, 3.95, and 3.67 trips per day.

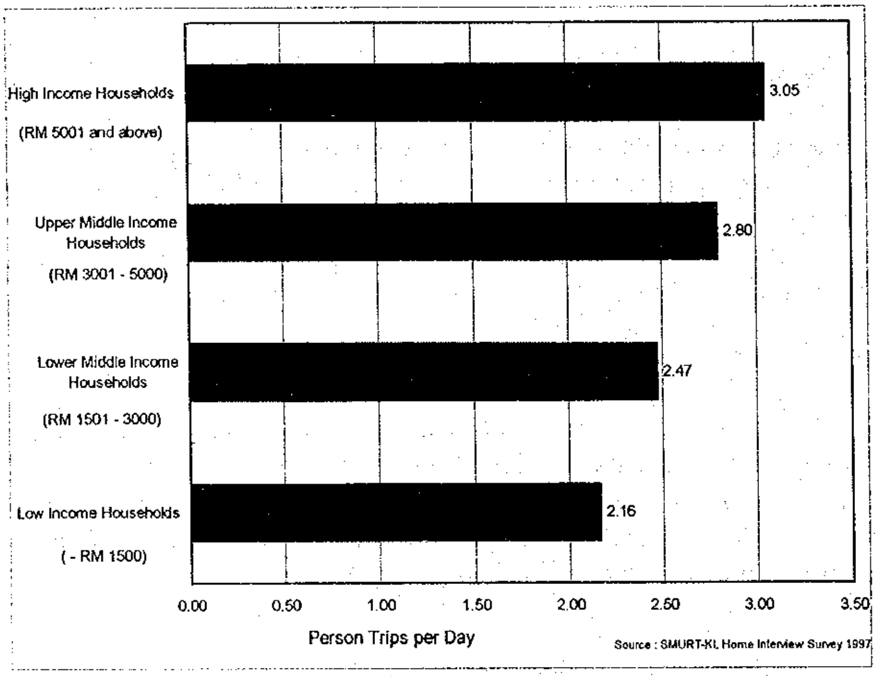
4) Household Income

Trip production rate increases as household income increases. Household members in high income households above RM 5,000 and above make 3.05 trips on average, while those in low income households make merely 2.16 trips a day as illustrated in Figure 3.5.5. High mobility of higher income households could be attributed to the availability of private vehicles.



Source: SMURT-KL Home Interview Survey in 1997

Figure 3.5.4 Trip Production Rate by Occupation

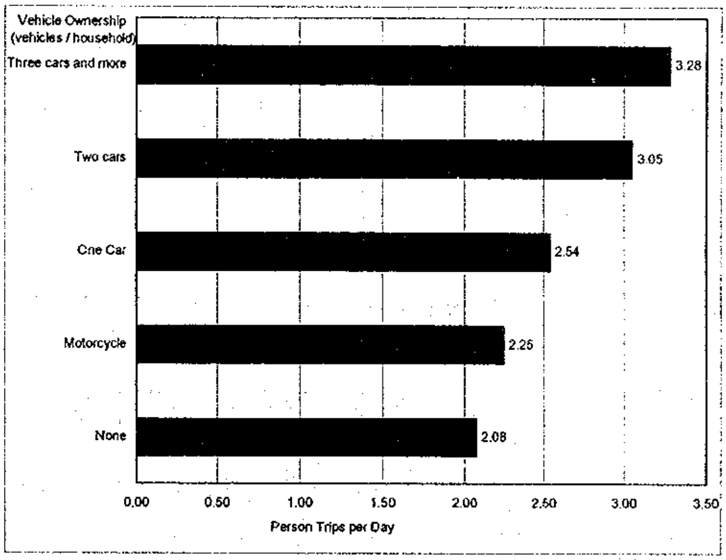


Source : SMURT-KL Home Interview Survey, 1997

Figure 3.5.5 Trip Production Rate by Household Income

5) Vehicle Ownership

Apparently ownership of private vehicles significantly affects on trip production rate as depicted in Figure 3.5.6. Members of the households with three cars and more make as much as 3.28 trips on average, whereas those which do not own any private vehicles make only 2.08 trips a day.



Source : SMURT-KL Home Interview Survey, 1997

Figure 3.5.6 Trip Production Rate by Vehicle Ownership

(3) Modal Composition

1) Change in Modal Composition

Among all the trips made by the Klang Valley residents, 24 percent are made by non-motorised modes of transport such as walking and bicycle as shown in Figure 3.5.7. When travel demand is limited to the trips made by motorised mode of transport, 57 percent are made by cars, 24 percent by motorcycles, 10 percent by factory and school buses, and 8 percent by stage buses and mini buses. At present private modes of transport, i.e. motorcycle & car contribute to as much as 80 percent of the total trips made by motorised mode of transport. On the other hand, contribution by public transport modes is insufficient in the person travel demand.

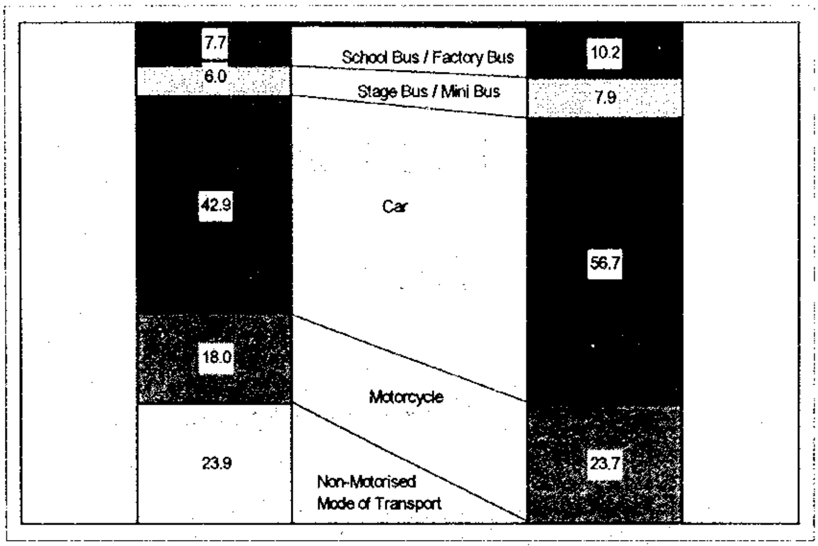
"Home based other" trips and "non-home based other" trips show similar modal composition. Around 40 percent of the trips are made by cars and 15 percent by motorcycles respectively. Non-motorised modes of transport are also widely used for these two trip purposes.

Compared with the modal composition in 1985, the share of cars has increased drastically from 47 percent to 57 percent as indicated in Table 3.5.2. The share of motorcycle users has also increased from 19 percent to 24 percent in the same period. On the contrary, stage buses and mini buses have lost their share dramatically from 24 percent to 8 percent. In conclusion, motorization has rapidly proceeded in the last 12 years and daily life of the residents have come to a strong dependence on private modes of transport in the Klang Valley region.

Table 3.5.2 Change in Modal Composition : 1985 - 1997

	Person Trip Demand		Growth	% Composition			
	1985	1997	97/85	1985	1997	1985	1997
Non-Motorised Mode of Transport	**1,775,500**	**1,980,600**	**1.12**	**27.6**	**23.9**		
Private Mode of Transport							
Motorcycle	884,200	1,492,200	1.69	13.8	18.0	19.0	23.7
Car	2,170,000	3,555,200	1.64	33.8	42.9	46.7	56.6
Subtotal	**3,054,200**	**5,047,400**	**1.65**	**47.5**	**60.9**	**65.7**	**80.3**
Public Mode of Transport							
Stage Bus / Mini Bus	1,129,900	493,900	0.44	17.6	6.0	24.3	7.9
Factory Bus / School Bus	465,900	638,700	1.37	7.3	7.7	10.0	10.2
Rail-Based Transport	-	103,200	-	-	1.2	-	1.6
Subtotal	**1,595,800**	**1,235,800**	**0.77**	**24.8**	**14.9**	**34.3**	**19.7**
Motorised Mode of Transport	**4,650,000**	**6,283,200**	**1.35**	**72.4**	**75.8**	**100.0**	**100.0**
Other Mode	-	29,300	-	-	0.4	-	-
Total	**6,425,500**	**8,293,100**	**1.29**	**100.0**	**100.0**	-	-

Source: SMURT-KL Home Interview Survey, 1997
Klang Valley Transportation Study, 1987



Source: SMURT-KL Home Interview Survey, 1997

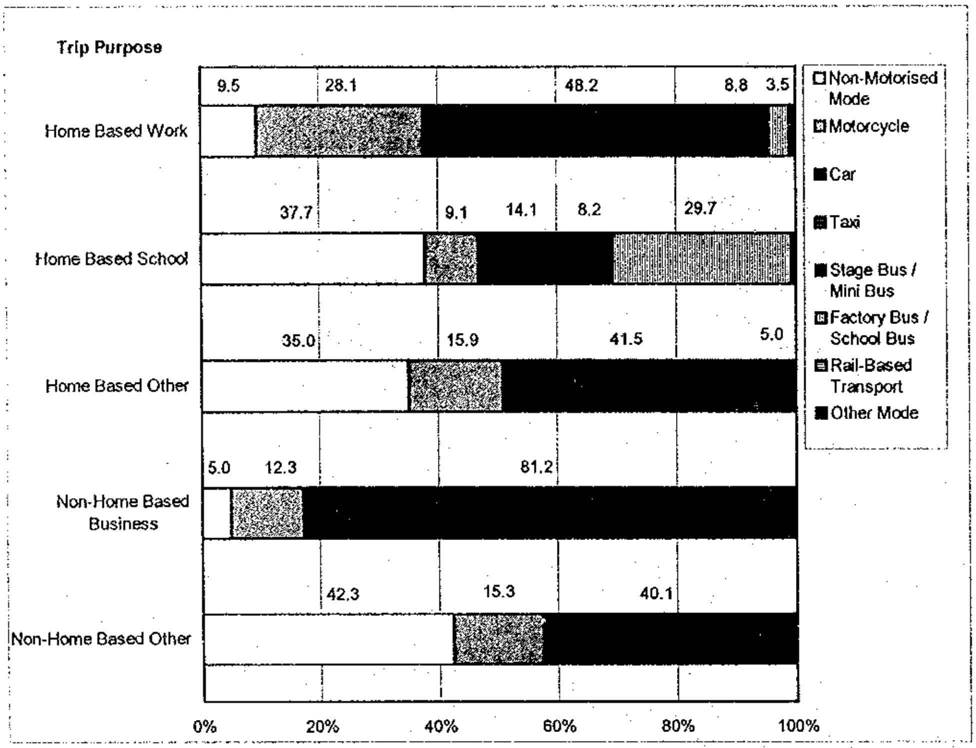
Figure 3.5.7 Modal Composition in 1997

2) Modal Composition by Trip Purpose

Modal composition varies substantially depending on trip purpose as shown in Figure 3.5.8. 48 percent of "home based work" trips, which are major components of morning and evening peaks, are made by cars, followed by 28 percent of motorcycles. Merely 8.8 percent are made by public modes of transport.

"Non-home based business" trips such as attending a meeting, sales, and delivering heavily depends on private mode of transport. More than 80 percent of business trips are made by car and 12 percent are made by motorcycle.

Non-motorised modes of transport are most commonly used for "home based school" trips. Around 38 percent of students go to school or return to home either on foot or by bicycle. School bus is also a popular mode for "home based school" trips in Klang Valley, carrying 30 percent of students to the school. It is noted that even in the category of "to school" trips, private cars and motorcycles carry 14 percent and 9 percent of students to their schools respectively.



Source : SMURT-KL Home Interview Survey, 1997

Figure 3.5.8 Modal Composition by Trip Purpose

3) Modal Composition of "To School" Trips by School Type

Modal composition of "home based school" trips is further analysed by school type. Walking and school bus are two major modes of transport for primary school students to go to school and the share of each mode is 38 percent each, as shown in Figure 3.5.9. However it should be noted that 17 percent and 4 percent of school children are sent to school by private car and motorcycle respectively.

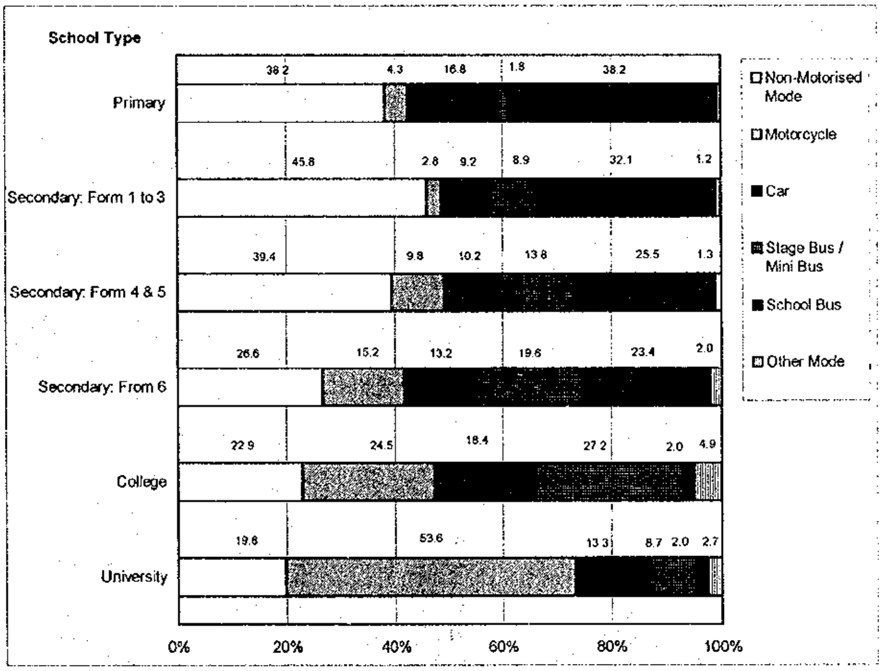
As for secondary school students, the higher grade of students are, the higher is the degree of dependency on motorcycle and public buses. On the contrary the higher grade indicates lower dependency on non-motorised modes and school buses.

"Home based school" trips made by college and university students depend more on motorised modes of transport compared with students in lower grade of schools. 73 percent of "home based school" trips of college students are made by motorised modes of transport and 80 percent of university students use motorised modes. 54 percent of "home based school" trips of university students are made by motorcycles.

4) Modal Composition by Household Income

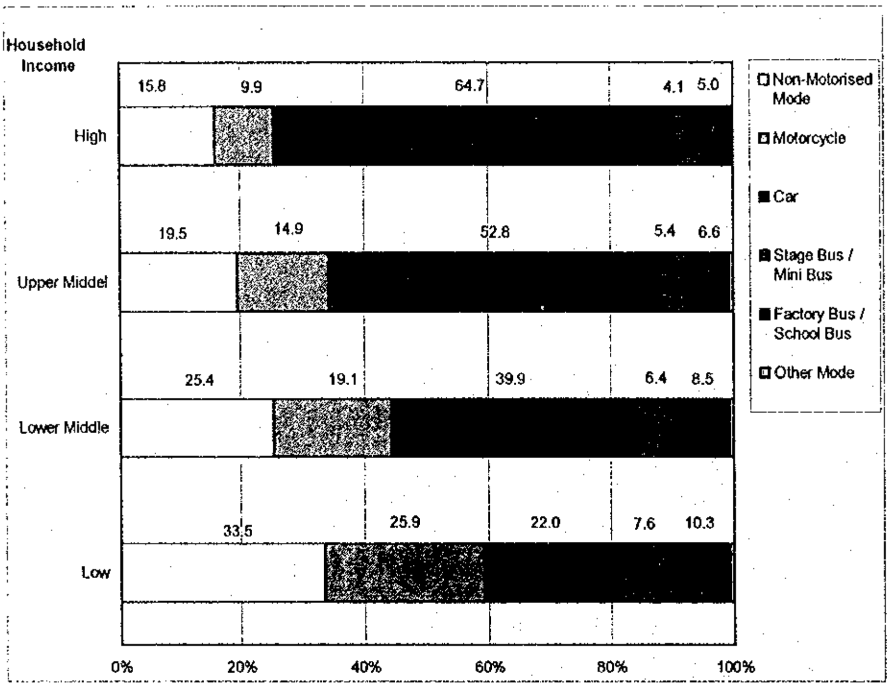
Modal composition varies substantially according to monthly household income as illustrated in Figure 3.5.10. Apparently households with higher income indicate stronger preference on cars for their travel needs since availability of cars is much higher than lower income groups. 65 percent of trips generated by high income households, with monthly income of more than RM 5,000, are made by cars, whereas merely 22 percent of those in low income households, i.e. monthly income is RM 1,500 and below use cars.

Strong correlation between household income and preference to use private car use has been recognised and this implies that further dependence on car use will proceed as real household income increases. Although high income households indicate stronger preference on private car than lower income group, trips made by private cars of upper middle and lower middle income groups are larger, in terms of volume as shown in Figure 3.1.11 because total individuals who belong to these income groups amount to 22.8 percent and 36.9 percent of the total population respectively.



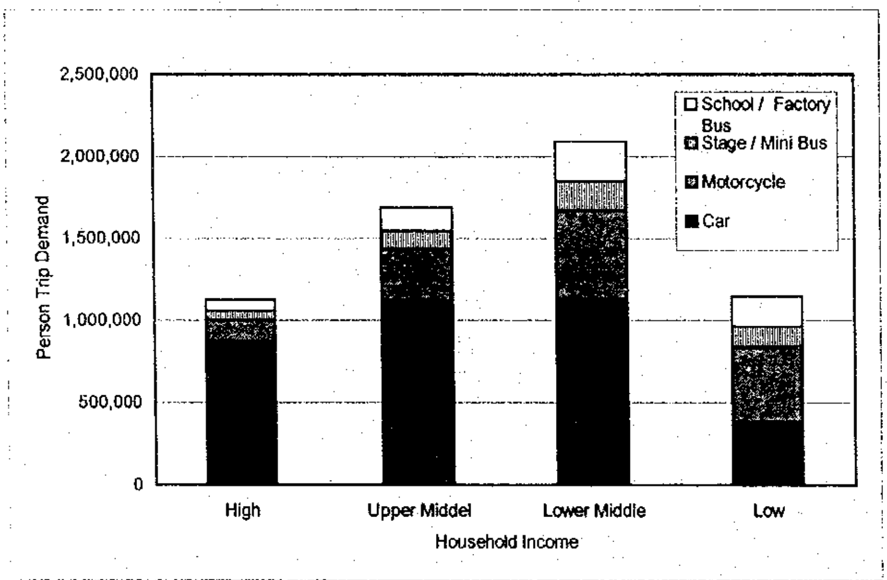
Source : SMURT-KL Home Interview Survey, 1997

Figure 3.5.9 Modal Composition of "Home Based School" Trips by Type of School



Source : SMURT-KL Home Interview Survey, 1997

Figure 3.5.10 Modal Composition by Household Income



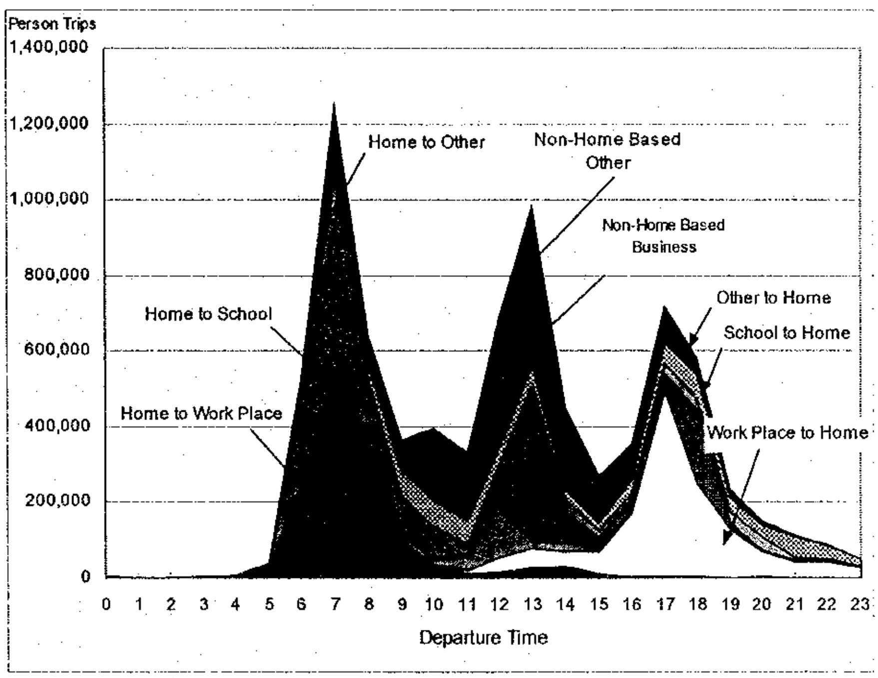
Source : SMURT-KL Home Interview Survey, 1997

Figure 3.5.11 Person Trip Demand by Mode of Transport and Household Income Group

(5) Hourly Fluctuation of Person Trip Demand

1) Hourly Fluctuation of Person Trip Demand by Trip Purpose

Three peak periods for person trip movements are observed in the region as illustrated in Figure 3.5.12. In terms of departure time the sharpest peak appears in the morning period from 7:00 to 8:00, consisting of 14.8 percent of daily trip demand. Commuting trips such as "Home to work place" and "Home to school" trips are major components in the period. The other two peaks are found at noon (13:00 to 14:00) and late afternoon (17:00 to 18:00), comprising 11.2 percent and 7.9 percent of daily trip demand respectively. "Home to school" trips of the students in the afternoon session and "Non-Home Based Other" trips such as going out for lunch are major constituents in the noon peak period, while "work place to home" trips form majority of the afternoon peak period.



Source : SMURT-KL Home Interview Survey, 1997

Figure 3.5.12 Hourly Fluctuation of Person Trip Demand by Trip Purpose

2) Hourly Fluctuation of Person Trip Demand by Mode of Transport

Person trip demand fluctuates significantly according to mode of transport as indicated in Table A 3.5.10. Trip demand made by cars and motorcycles generate two peak periods in the morning and afternoon. 17.7 percent of the daily trip demand using motorcycle, and 15.3 percent of person trips by car, are made during 7:00 and 8:00. Afternoon peak is not shown as steep as those in the morning period, consisting of 11.9 percent for motorcycle and 10.4 percent for cars. These two peaks are mainly formed by "home to work place" and "work place to home" trips. In contrast trips by non-motorised mode of transport and factory bus / school bus form noon peak as well as morning and afternoon peaks since these two modes are widely used for "home based school" trips. Hourly fluctuation of passenger demand for public transport such as stage bus, mini bus, and rail-based transport shows similar pattern to cars and motorcycles, i.e. it has two sharp peaks are produced in the morning and afternoon, while considerably low demand in off-peak period.

(6) Trip Production and Attraction

1) Zonal Trip Production

In the region person trips are concentrated in CPA as illustrated in Figure 3.5.13. Although population in CPA accounts for merely 3.3 percent of the region, trips produced in the area amount to 19 percent of the region. Outside Kuala Lumpur, Petaling Jaya also produces a large amount of person trips. Another significant person trip producing areas appear along the major corridors such as Kuala Lumpur – Klang, Kuala Lumpur- Pahang, and Kuala Lumpur – Kajang corridors.

2) "To Work" Trip Production and Attraction

Comparing the trip production with the trip attraction of "to work place", the zones in CPA indicate much higher trip attraction than trip production as shown in Figure 3.5.14. This implies that many employees from outside the CPA. Other areas where trip attraction of "to work place" exceeds trip production are seen in the zones along Jalan Tun Razak, Bangsar, Damansara, and industrial areas along the Federal Highway in Subang, Shah Alam, and Klang.

3) "To School" Trip Production and Attraction

In CPA trip attraction of "to school" exceeds trip production in the area as shown in Figure 3.5.15. This implies that many students come to CPA from outside the area by motorised mode of transport, thus worsening traffic congestion in the area. Other zones with greater trip attraction of "to school" purpose disperse over the region. The zones where trip attraction exceeds trip production to a large extent can be seen in the zones with universities, such as the zone 107044 where Universiti Malaya is located and zone 414033 where Universiti Putra Malaya is located.

4) Trip Production and Attraction by Mode of Transport

Modal composition of trip production varies from zone to zone in the region as illustrated in Figure 3.5.16. In the western part of Kuala Lumpur such as Damansara and Bangsar, and the northern part of Petaling Jaya, the composition of cars is significantly high, accounting for 60 percent to 70 percent, compared to other parts of the region. Relatively high dependency on bus transport is noted in the eastern part and northern part of Kuala Lumpur. Comparing with the spatial distribution of average household income by zone as shown in Figure 2.3.1, the usage of private cars and the average household income by zone shows strong correlation.

(7) Trip Distribution

1) Person Trip Flows

Person trip flows by all modes of transport in Klang Valley are illustrated in Figure 3.5.17. All the surrounding zones of CPA (1), Kepong (2), Setapak (3), Ampang (4), Cheras (5), OUG (6), Damansara (7) show strong linkage with CPA. Petaling Jaya (12) and Petaling South (14), however, have the largest person trip flows between the two zones. Shah Alam (139), and three zones in Municipal Council of Klang, i.e., Klang Central (16), Klang South (17), and Klang North (18) have larger person trip demand among themselves than trip demand between these zones and other zones.

2) "To Work" and "To School" Trip Flows

Concentration of "to work place" trips to CPA (1) is seen in Figure 3.5.18. Many workers go to work in CPA from outside of CPA on weekday. Although substantial "to work place" flows are observed from Petaling Jaya (12) to CPA (1), Petaling Jaya also attracts "to work place" trips from OUG (6) and Petaling South (14). In Shah Alam (13), Klang Central (16), Klang South (17) and Klang North (18), more workers are seen to commute to work places within these zones than to CPA (1).

In contrast to "to work place" person trip flows, "to school" person trip flows show weak linkages to CPA (1) beyond the adjacent zones as shown in Figure 3.5.19. Most of "to school" person trip flows with neighbourhood zones are observed.

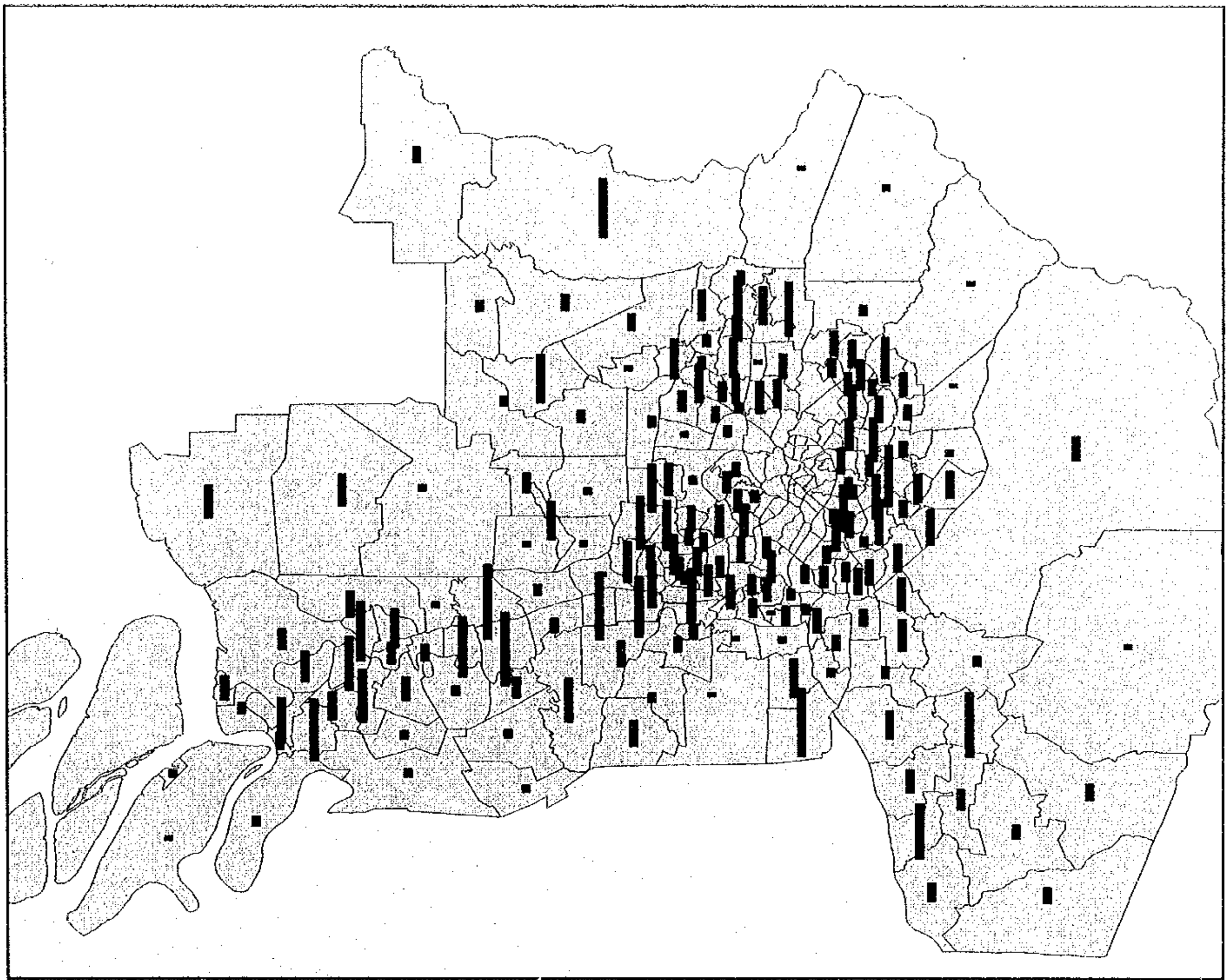
3) Person Trip Flows by Mode of Transport

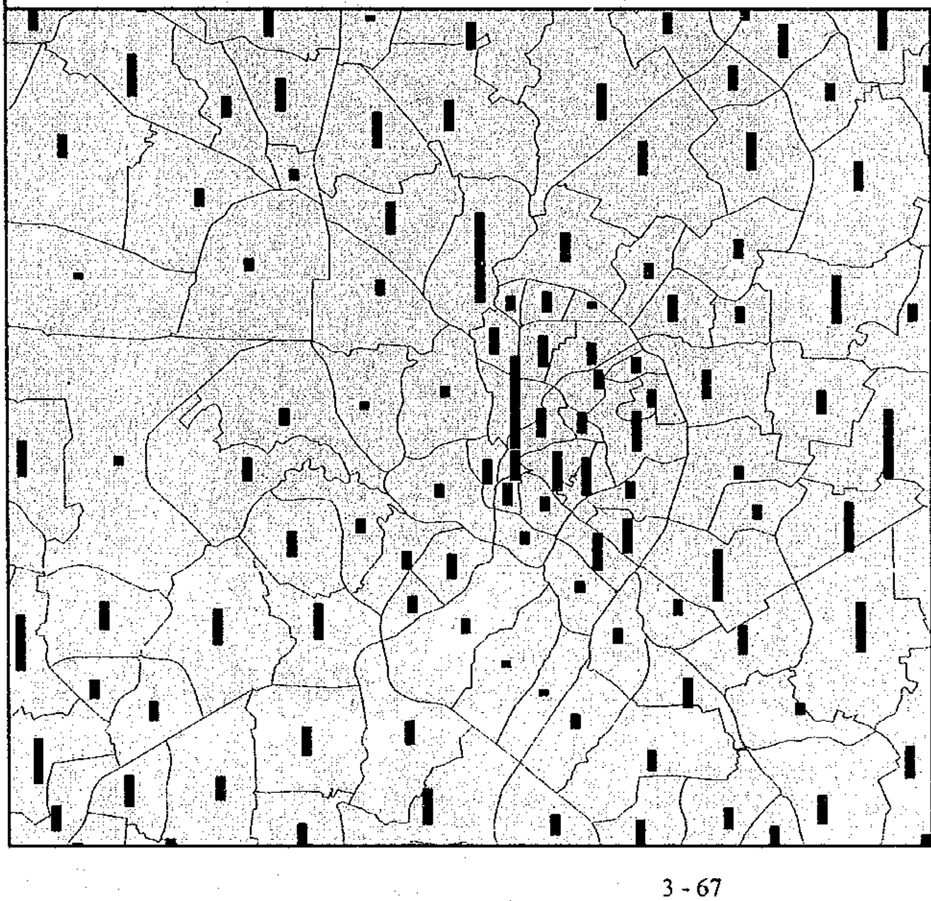
Person trip flows by motorcycles also indicate strong linkage between CPA and the surrounding zones as shown in Figure A 3.5.17 Fewer person trip flows are observed from distant zones, reflecting relatively shorter trip length of the trips made by motorcyclists.

Compared to person trip flows by motorcycles, trips made by cars spread throughout the region as illustrated in Figure A 3.5.18.

Person trip flows made by buses have a similar origin-destination pattern as motorcycles as depicted in Figure A 3.5.19. When compared with the person trip flows by cars, relatively lower bus demands are observed between CPA (1) and Petaling Jaya (12), while the flows between CPA (1) and Sepatak (3), and between CPA (1) and Cheras (5) are well served by buses.

Person trip flows by railway are limited due to the current LRT & KTM service coverage area as shown in Figure A 3.5.20. The largest person trip flows are seen between CPA (1) and Ampang (10) where is served by the LRT System (I).





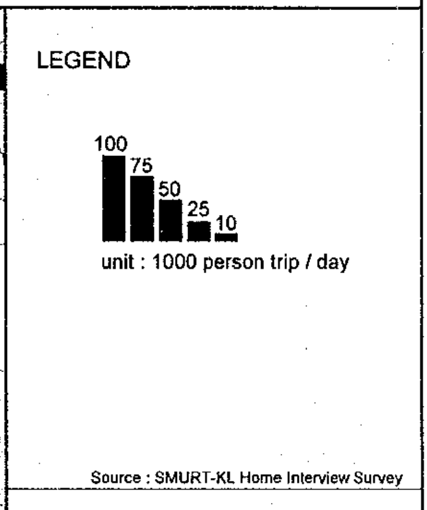


Figure 3.5.13
Zonal Trip Production

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INTEGRATED URBAN
TRANSPORTATION STRATEGIES
FOR ENVIRONMENTAL IMPROVEMENT
IN KUALA LUMPUR

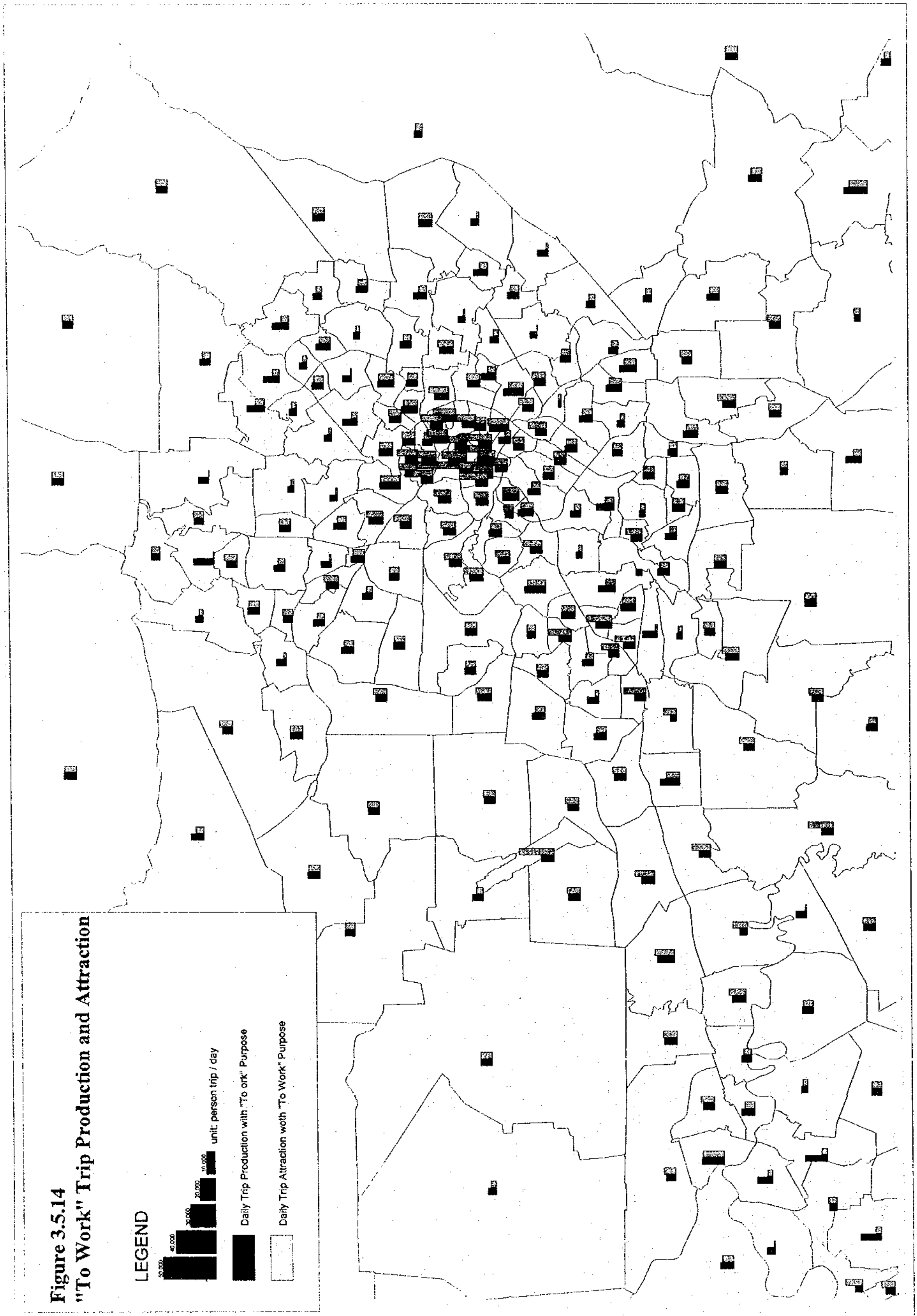

Figure 3.5.14
"To Work" Trip Production and Attraction

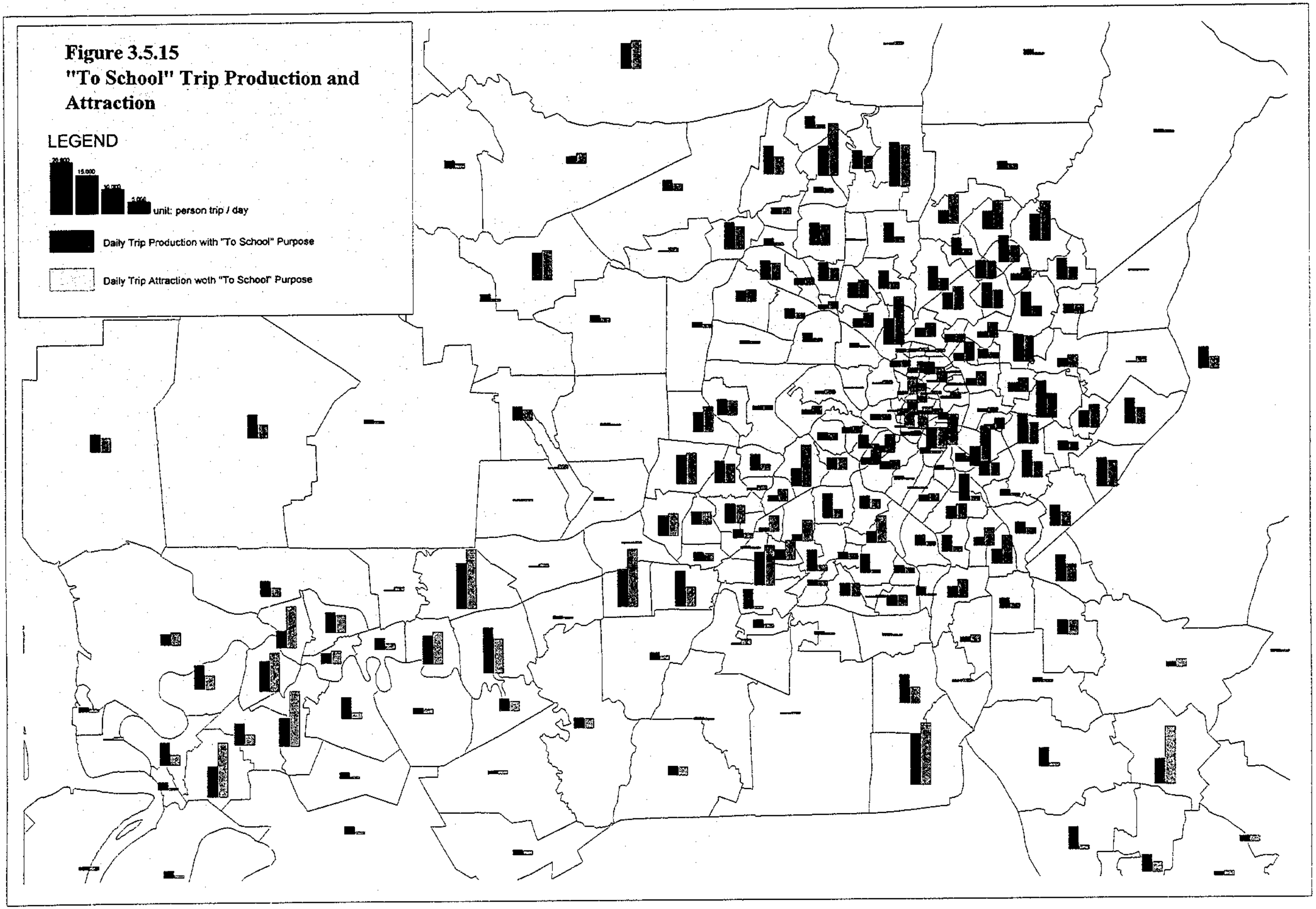

Figure 3.5.15
"To School" Trip Production and Attraction

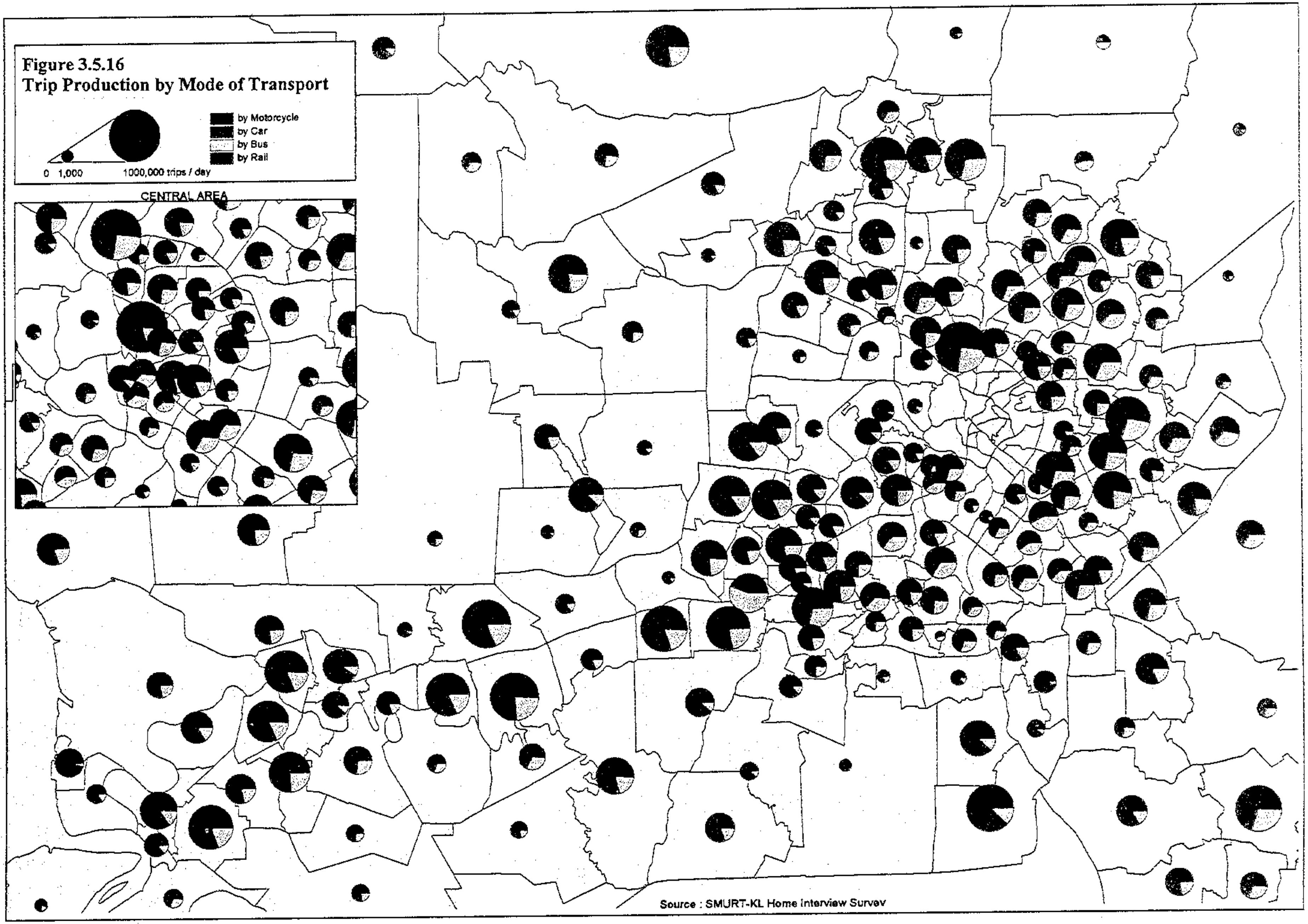

Figure 3.5.16
Trip Production by Mode of Transport

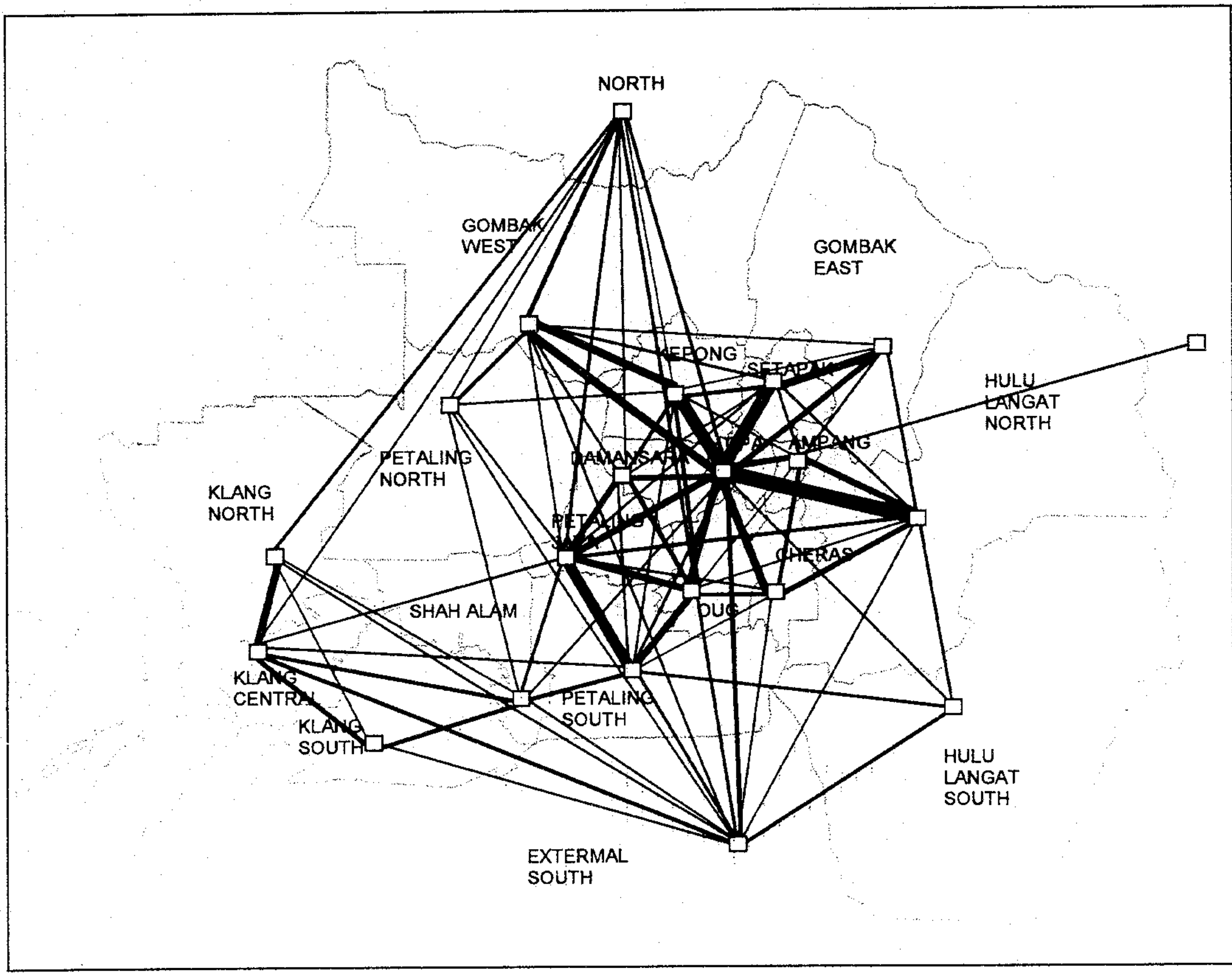

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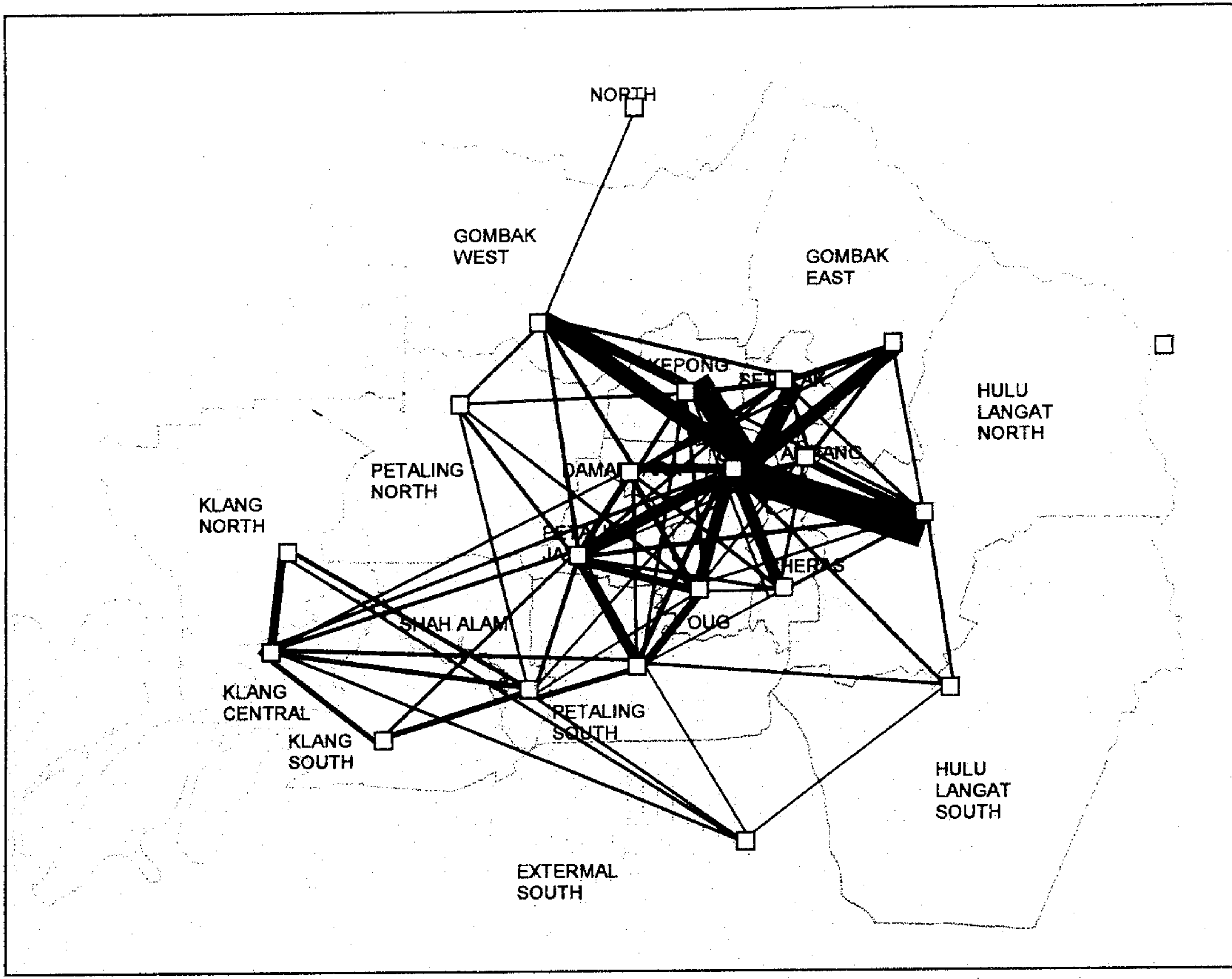
Figure 3.5.17
Person Trip Demand by Trip Purpose
All Purpose



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Legend
(Person Trip per Day)

5000
10000
15000
20000
25000

Note: Trips less than 2000 are omitted.

Figure 3.5.18
Person Trip Demand by Trip Purpose To Work Place

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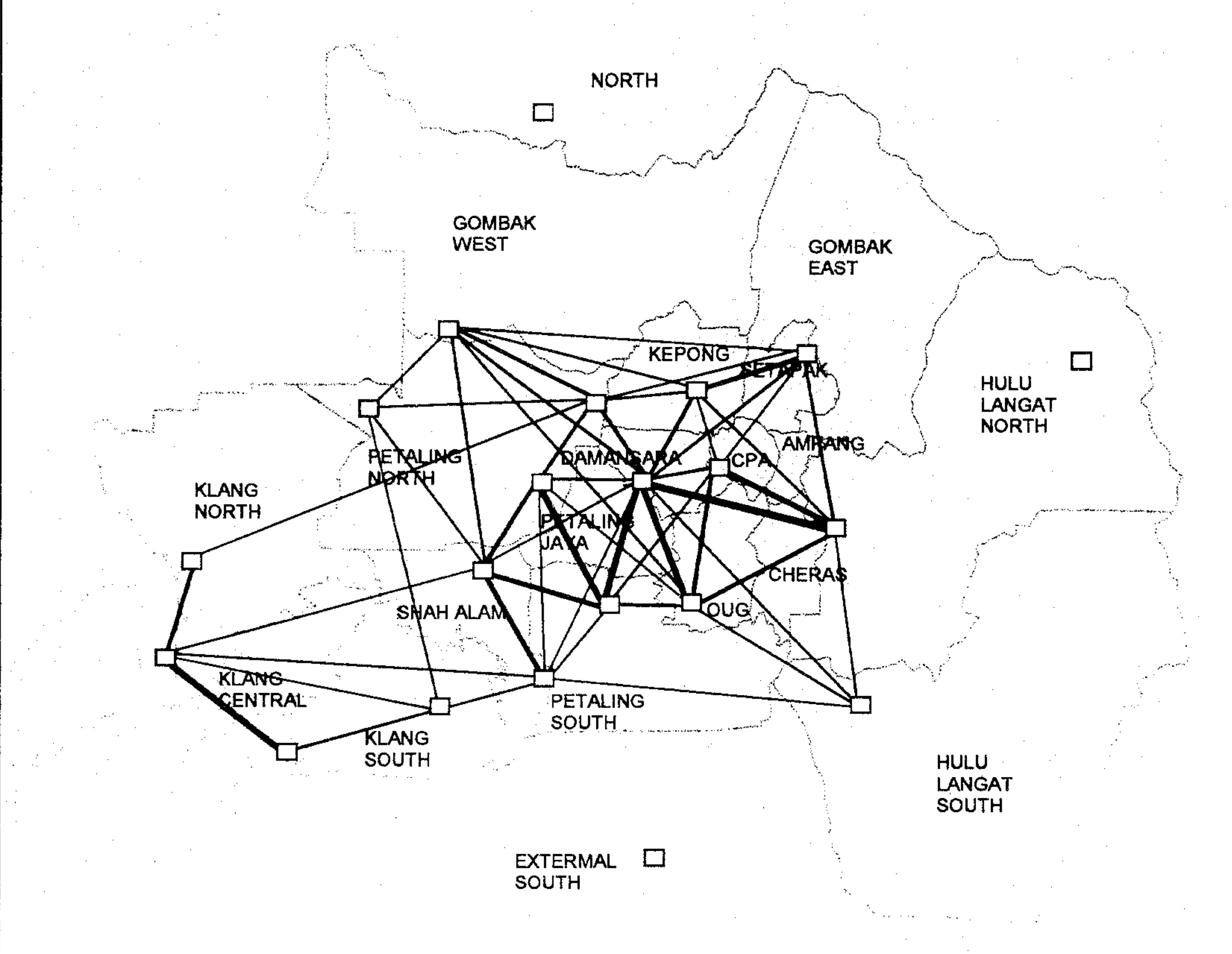


Legend
(Person Trip per Day)

5000
10000
15000
20000
25000

Note: Trips less than 500 are omitted.

Figure 3.5.19
Person Trip Demand by Trip Purpose To School

3.5.2 Characteristics of Lorry Trip Demand

Lorry vehicular trips are examined in order to understand the existing freight movements in the region through Lorry Owner Interview Survey and the Cordon Line Survey.

1) Lorry Vehicular Trip Production

As depicted in Figure A 3.5.21, trip productions by lorries do not concentrated as much in CPA as person trip demand do. Peripheral zones in which industrial parks are located such as zone 414012, i.e., Sg Penaga Industrial Park, zone 412071, i.e., Subang Hi-Tech Park, and zone 415021, i.e., Sg Buloh Industrial area, produce a large amount of lorry trips compare to person trips.

2) Lorry Vehicular Trip Flows

Small lorry vehicular trip flows are spreaded throughout the region as shown in Figure A 3.5.22. Large number of trip flows are observed along the corridors CPA (1) – Kepong (2) – Sepatak (3) and CPA (1) – Cheras (5). Vehicular trip flows of heavy lorry are similar to the flows of small lorry as illustrated in Figure A 3.5.23, but remarkable differences are observed in the flows between external zones in the south (21) and Klang Central (16), Klang South (17), and Shah Alam (13). Heavy lorries carry a large amount of goods to these zones from outside the region. In addition, considerable amount of heavy lorries also pass through the region from south to north and vice versa.

3.6 Problems and Issues

3.6.1 Problem and Issues of the Current Road System

The problems and issues of the road network in Kuala Lumpur & its outskirts are summarised below.

1) Heavy Burden on Federal Highway;

The Federal Highway is located alongside the current development corridor between Shah Alam and Kuala Lumpur. The area alongside the Federal Highway has been well developed and consists of comparatively high-class residential areas. In addition, there is no definite detour route connecting to the centre of KL. These circumstances result in high traffic generation and heavy traffic on the Federal Highway. Although the Shah Alam Expressway is located to the southern area, parallel to the Federal Highway, its traffic volume is small at present. A more effective expressway / highway which link these city centres, or another type of transportation should be build, so that the burden on the Federal Highway could be alleviated in the future.

2) No North South Connection in Damansara;

There is no major arterial road connecting the north and south of the Damansara area. This makes it inconvenient for the vehicle traffic generated in this area and force them to concentrate on specific roads, such as Jln. Duta and Jln. Bangsar. Provision of a well-functioning major arterial road is therefore necessary.

3) CPA

In terms of the road network in the CPA, there are several arterial radial roads but only Jln. Tun Razak serves as a ring road for the area. With the shortage of land, it looks rather difficult to construct new roads in the CPA. Nevertheless, it is necessary to provide some local roads to complement and connect the arterial roads. For example, a connecting road between Jln. Sultan Ismail and Jln. Tun Razak (Jln. Sultan Ismail Extension) would be very important. These roads are expected to help create ideal neighbourhoods, in terms of the environmental condition as well.

4) Road Width.

Most of the major arterial roads are composed of dual carriageways and are six lanes in total. The condition of the roads and the geometric design standard of the major arterial roads look well. Besides, most of the arterial roads with single or dual carriageways adversely. As it would be difficult to widen these roads, traffic control and management measures will play an important role in making the most use of the facilities.

3.6.2 Problems and Issues on Traffic Flow/Control and Management Facilities

(1) Problems and Issues on Traffic Flow

The following problems and issues concerning traffic flow were identified in Kuala Lumpur:

1) Traffic Flows Concentrated in the Central Area

Within the area that constitutes the city's business and commercial centre, a substantial volume of traffic is concentrated in the area bordered by Jln. Mahmeru, Jln. Ipoh, Jln. Tun Razak, Jln. Yew, Jln. Sungai Besi and Jln. Istana, including the vicinity of these ring roads. Particularly, a substantial volume of traffic is concentrated on Jln. Kuching, Jln. Raja Laut and Jln. Tuanku Abdul Rahman running from north to south. In addition, Jln. Ampang which runs from east to west, and the ring roads of Jln. Tun Razak and Jln. Sultan Ismail show chronic congestion.

2) Average Travel Speed on Major Roads is Lower than 10 km/h

Congestion in the above mentioned area is severe during the peak hour, when the major signalised intersections become saturated, as indicated by the hourly traffic volume per lane. Moreover, travel speeds during the morning and evening peak hours fall to less than 10km/h, and nearly all the stopping is caused by intersection waiting time, spillback and other conflicts. In the morning peak hour, the area surrounded by Jln. Tun Razak, Jln. Loke Yew and Jln. Duta covering approximately 38 sq.-km is heavily congested. However, in the midday peak hour, the congested area is reduced to a 17 sq.-km area of the city centre, where the traffic generated is mainly for business purposes within the city's business and commercial centre. In the evening peak hour, the area is more or less the same as in the morning. However, traffic is more aggravated in the congested area of about 24 sq.-km, and it concentrates further inside the Middle Ring Road than in the morning.

3) Main Causes of Traffic Congestion

The main causes for the congested segments with a travel speed of 10 km/h or less during the peak hour can be classified into 7 types as shown below. Countermeasures to achieve a smooth traffic flow and to mitigate the traffic congestion at the bottlenecks are required.

- Waiting for the traffic light change due to the long multi-phasing cycle length and manual control by police etc.
- Congestion of buses near bus stops caused by buses occupying 2 lanes
- Traffic spill-back due to bottlenecks caused by over-saturation
- Traffic merging from side roads without a traffic light
- Disturbance by cars turning to the left on 4-lanes roads
- Narrow roads due to construction work

- Intersection/Roundabout without a traffic light

4) High Accident Rate

The numbers of accidents per registered vehicle in the rural area (Selangor) has continued to increase over the past decade, and angular collisions and head-on collisions have been dominant. Such types of accidents are generally caused by a poor traffic control system. Thus, there is a need for better traffic safety measures, such as the installation of signal light and safety traffic signs.

Motorcycles have a tendency to have a high accident rate in Kuala Lumpur. The main types of motorcycle accidents are straight road collision, dangerous driving caused by zigzagging, turning and driving too close to other vehicles. Countermeasures to reduce accidents involving motorcycles, such as safety education, are essential.

In addition, regarding accidents involving pedestrians, rear collision-type accidents were the most numerous in Kuala Lumpur. Rear collisions in the urban area were mainly caused by traffic congestion due to the traffic spill-back caused by insufficient road capacity, sudden or frequent lane change without indicating, jumping of queues and blocking of intersections, and obstruction of near bus stops located at the intersections. Therefore, a good countermeasure to mitigate traffic congestion is essential.

In addition to rear collisions, driveway accident were numerous as well. The accidents involving pedestrians were caused mainly by the pedestrians' ignorance when crossing the street (jay-walking) between intersections. Therefore, the pedestrian education system should be strengthened.

5) Traffic education for drivers and pedestrians

Malaysian drivers have been described as being relatively law abiding and disciplined, and their driving habits are considered to be one of the better ones in Asia. However, ignorance of the traffic laws is common on the roads in Kuala Lumpur. For instance, sometimes, they ignore red lights at the traffic lights, make sudden and frequent lane change without indicating, ignore speed limits, jump queues, and block intersections. Mini-bus drivers stop outside of the bus stop lane and change the route on a whim in order to pick up extra passengers. Motorcycle drivers, especially run close between vehicles and zigzag on the road. Such driving behaviour result in a lower traffic flow rate even in the presence of traffic co-ordinated control systems as seen in the results of travel time survey, and result in traffic accidents. Therefore, effective traffic education programs and campaigns should be promoted to improve the drivers' compliance with traffic laws and regulations.

The behaviour of pedestrians in Kuala Lumpur is seen as being lawless in some cases. For instance, they cross streets by ignoring the signal lights, in between intersections (Jay-walking), or they may wander into vehicle lanes to shortern their journey. At bus station, they would overflow onto the vehicle lanes. Therefore, an appropriate pedestrian education programme is required to improve the pedestrians' discipline.

Regarding the driver license system in Kuala Lumpur, although a more detailed investigation is required, the quality of instruction given to student-drivers is generally insufficient. The balance between practice and classroom seems unduly skewed toward driving practice with insufficient classroom instruction being provided. As a consequence, a proper attitude toward driving and law enforcement, which include the need for self-discipline and social responsibility, is not adequately stressed.

(2) Problems and Issues on Traffic Control and Management Facilities

From a traffic-engineering point of view, the following problems and issues concerning traffic control/management facilities were identified in Kuala Lumpur.

1) Traffic Signal Control System

Some problems related to operation & facilities were identified in the existing traffic signal control system. Most of the traffic lights are mounted on low poles and have small lenses, resulting to poor visibility. The signal lights for pedestrians are also insufficiently in number.

The current traffic congestion is mainly due to bottlenecks that lead to a spillback effect. The signal control system works effectively when the traffic shows a stable fluctuation pattern. However, it should be noted that SCATS is applicable to under-saturated traffic conditions. The locations of SCATS detector at stop lines are suitable for measuring the degree of saturation only in the range of low degree saturation. At over-saturated intersections, different measure should be taken to alleviate the traffic congestion.

During peak hours, traffic policemen manually control most of the major signalised intersections. They carry out the task through visual observation and exchange the information through transceivers. This is because the current over-saturated traffic congestion in Kuala Lumpur is difficult to control using the existing system. However, this manual control is generally very difficult to co-ordinate, and sometimes result in longer cycle time. An advanced traffic response system for over-saturated conditions is necessary instead of manual operation by the traffic police.

Most of the installed traffic signals are multiphase system, which is based on changing one phase per one direction. Such a signal phase result in a long cycle time. Therefore, a countermeasure to improve the traffic phase should be considered.

2) Traffic Regulation

In terms of the present traffic control regulation, the current practice of reversible lanes show its effectiveness against the perplexing changes in traffic demand. However traffic facilities such as overhead lane direction signals and signs attached to the gantry or pedestrian bridge, and different lane line colour should be properly installed to create safety awareness among road users.

As for the bus / taxi exclusive lane regulation, the current exclusive lanes are often jammed up during rush hour with buses at the main signalised intersection. The effect of the bus lane , therefore, is limited due to its poor continuity. On the other hand, during the off-peak hour, these lanes are also not effective due to the low demand from the buses. Therefore, a more advanced bus priority scheme including a bus priority network (not limited to separate road segments), bus priority signals phasing, and flexible time regulation, should be introduced.

3) Traffic Safety Facilities

Pedestrian bridges are insufficient in number, especially on busy main trunk roads. In order to reduce accidents involving pedestrians, more pedestrian bridges are needed along arterial roads.

Safety guard devices are not sufficient not only in number, but also in terms of their quality and maintenance condition. Guard facilities which divide sidewalks and carriageways are needed along arterial roads, especially before and after intersections and pedestrian bridges, in order to protect pedestrians from vehicles in the carriageway, as well as to prevent jaywalking.

Road signs are generally small and unnoticeable. Some are badly installed using low poles even though they are at the right location. More visible and bold road signs are needed.

Most sidewalks are not friendly to pedestrians due to their narrow width and poor condition. In particular, the sidewalks on the major roads inside the Inner Ring road are poorly maintained. Friendly sidewalks which enhance urban amenity and safety for pedestrians should be designed and constructed.

3.6.3 Issues on Public Transport

This subsection describes issues on public transport. It includes the problems indicated and discussed in Subsection 2.3 and 2.4 as well as, problems expected in the future based on the on-going developments and the perspective for the KL metropolitan area in the year 2020.

(1) Issues on Rail Transport

1) Need for Additional Rail-Based Transport System

By the year 2000, several rail-based systems would have been introduced to support the people's desire to travel in the city. The profile of the transport system is listed in Table 3.6.1. The limitation of the LRT and PRT systems in their transport capacity could lead to a capacity shortage in the public transport network as a whole. It is predicted that an additional rail-based system will be needed in the long-term transportation plan. Quantitative analysis will be given in the following Chapters.

Table 3.6.1 Profile of Rail-based Transport System

System	Current Status	Development Plan
KTM Komuter	Existing	- Addition of transport capacity - Extension to Batu Cave
LRT System I (STAR)	Existing	- Extension of the existing line up to Sentul Timur - Addition of the new line between Chan Sow Lin and Komanwel
LRT System II (PUTRA)	Under Construction	Lembah Subang – Gombak Terminal
People-mover Rapid Transit System (PRT)	Under Construction	Tun Razak – Kg. Pasir with the appendix between Tun Sambanthan and KL Central Station
Express Rail Link (ERT)	Under Construction	KL Central Station - KLIA

2) Improvement of Bus Feeder Service

In order to make most use of the existing and planned rail-based systems, bus feeder services system should be strengthened. At present the LRT STAR and PUTRA provide feeder bus services to make their system more attractive. Although the bus feeder service itself does not yield sufficient profit for the operator under the current fare level of 50 cents, such services need to be maintained and enhanced in future.

(2) Issues on Bus Transport

1) Reorganisation and Rationalisation of Bus Route Structure

The existing bus route structure has been improved and developed by adding new routes when additional passenger demand was noticed by bus operators. Before the current amalgamation practice, bus companies segmented bus transport market. Now is a good time for the relevant agencies to review the bus route structure comprehensively since competition between bus operators has diminished. The existing bus routes provide direct services between suburban areas and the city centre. This structure can be categorized into three types of bus services; namely, line haul bus services, feeder bus services in suburban areas, and a CBD circulation bus service. The reorganisation of the bus route structure will be examined with the existing passenger demand pattern and the forecasted future demand pattern.

2) Improvement of Bus Terminal Facility

In the KL metropolitan area, many people cannot complete their trip by one ride either on the rail or the bus. Therefore interchange facilities such as railway stations and bus terminals are important in making transfer more smooth and efficient. Bus terminal facilities should be improved in terms of amenity and by providing travel information required by the passengers.

3) Provision of More Priority Lanes to Public Road Transport

As observed in many large cities, the road traffic demand overwhelmingly exceeds the capacity of the road network, causing severe traffic congestion especially in the CBD. In the urban context, since road space is scarce, buses should be given priority over private passenger cars to make efficient use of the limited road space. The possibility of extending bus priority lanes and/or introduction of transit mall should be examined.

(3) Issues on Integration of Public Transport

1) Integration of Rail-based Transport System and Bus Transport

Although the planned rail-based system will start its operation in a couple of years, it will not be able to cover all of the travel demand within the metropolitan area. Consequently bus transport is expected to supplement and to co-ordinate with the rail-based transport system, particularly, in areas outside of the rail-based transport service area. A reorganisation of the bus route structure will be required based on the development of the rail-based transport system.

2) Integrated Public Transport Fare System (Network Fare System)

Currently the introduction of a common fare system is being discussed among transport operators. This automatic fare collection system will not only reduce the fare collection cost, but also minimise cases of fraud. Besides, it is convenient to the public transport passengers, since they can utilise just one ticket for several modes. Further enhancement with regard to the fare and ticketing system would be in the form of an integrated common public transport fare system. The integrated fare system would allow free transfers between different modes of public transport. It also encourages interchanges between the bus and rail-based transport systems by eliminating the need to pay separate fare as in a segregated fare system.

(4) Issues on Integration of Transportation and Land Use

At present, many large-scale projects are being implemented in the KL metropolitan area. The most significant development is Putra Jaya and Cyber Jaya and other related projects in the Multimedia Super Corridor. Among others, the KL City Centre (KLCC) project and the Gigaworld project, both of which plan to have office building, shopping malls, hotels, recreational facilities and other facilities, will have significant impacts in terms of traffic generation. Those facilities are to be developed in parallel with the planned rail-based transport system. Putra Jaya will be supported by the Express Rail Link, which will provide a direct transport service for air passengers arriving at or departing from the new KL International Airport, while the KLCC will be served by the LRT System II (Putra). Gigaworld will introduce a new concept of an integrated development composed of a business and commercial facility as well as a rail-based transport system. The basic structure is an egg-shaped tube with some tall towers, and it will be constructed along the People-mover Rapid Transit (PRT) System. The building will contain five PRT stations, so that people can easily access their destination. This kind of development would encourage the use of the public transport system.

It is of great importance to make the urban structure convenient for the public transport users through proper land use, by establishing planning and zoning regulations for the long-term. More specifically, high density person trip attractors such as office buildings and large scale shopping complexes should be located within walking distance from railway/LRT stations. In contrast, low density person trip attractors such as industrial areas should be located in the suburbs. Setting high floor area ratio for the area surrounding existing and planned stations will induce a considerable amount of person trip generation and attraction, which are could easily be accessed using the rail-based transport system. Consequently, the enhancement of the zoning system would be an effective measure in promoting public transport use in the long term.

(5) Institutional Issues

1) Enhancement of Bus Operation Monitoring System

Bus transport provides a basic means of transport for the public. Therefore, bus operators need to ensure their level of service in terms of safety, convenience, comfort and reliability of bus operation. Relevant agencies are also fully responsible in ensuring a well supervised bus operation. Unfortunately, human resources are limited at these agencies at present. As a result, they are unable to carefully monitor the actual bus operation. The bus operation monitoring system should thus be enhanced to ensure the quality of service offered by bus operators.

2) Establishment of Urban Information Database

Without recognition of the current situation, good plans cannot be established. Insufficiency of data such as the present population, number of employees at work place, and number of students at school would hinder the development of a good structure local plan as well as a transportation master plan. It is suggested that such data be included in the next census survey. Common use of the collected database among the relevant agencies will contribute to an efficient urban land use planning and transportation planning.

Chapter 4

Transport Modelling

Chapter 4 Transport Modelling

4.1 Methodology Overview

4.1.1 Basic Concept

In this study, the conventional stepwise traffic demand forecast procedure is applied. A series of transportation demand will be estimated in the following process.

(1) Trip Generation

(2) Trip Production and Attraction

(3) Trip Distribution

(4) Modal Split

(5) Traffic Assignment

Special effort was made in developing the modal split models, that is, in addition to the conventional models, discrete choice models were developed to understand the public's responses to some of the proposed transport policies in this report.

During each step of the modelling process, TRANPLAN/NIS[1] software for almost all of the analysis and SAS[2] for modelling the discrete choice models were employed.

4.1.2 Definitions

To execute the transportation analysis, the following basic definitions are required.

(1) Zone System

The study area is subdivided into traffic analysis zones, where all movement to and from a zone can be adequately represented as starting or ending at a single point in the zone - zone centroid. This point represents the zonal centre of transport activities.

The zone system for the current study was established by taking the following points into account.

- Compatibility with the previous study, the Klang Valley Transportation Study in 1986

[1] TRANPLAN (Transportation Planning Modeling Software) and NIS (Network Information System), a set of transportation planning programs distributed by the Urban Analysis Group, Danville,California, U.S.A.

[2] SAS The SAS System, a set of statistical analysis software distributed by SAS Institute Inc.,Cary, NC, USA.

- Degree of accuracy required for the urban transportation analysis

The traffic zone system adopted in the Study has hierarchical structure according to the objective of the analysis. A zone is identical to District in the Klang Valley region, and has been utilised to understand the total trip volume of each District. B zone has been used for understanding the OD trip distribution pattern by mode of transport or by trip purpose in the region. C zone has been utilised for understanding trip distribution of the total person trip demands. D zone was considered as a basic zone for Home Interview Survey and was used for sampling of households to be surveyed. In addition, D zone is a basis of estimation of zonal trip production and attraction. A D zone is subdivided into the traffic analysis zones(TAZs), assuming homogenous distribution of population and job opportunities in the D zone. TAZ is utilised for traffic assignment to examine road capacity sufficiency as well as the basis of dynamic simulation in the CPA.

Table 4.1.1 Composition of Traffic Analysis Zones

Classification	A Zone	B Zone	C Zone	D Zone	TAZ
Kuala Lumpur	1	1-7	40	1 – 108	1 – 246
Gombak	2	8-9	8	109 – 132	247 – 270
Hulu Langat	3	10-11	7	133 – 155	271 – 293
Petaling	4	12-15	22	156 – 201	294 – 339
Klang	5	16-18	13	202 – 228	340 – 366
Other Selangor	6	19-23	6	229 – 234	367 – 372
External	7	24-27	11	235 – 245	373 – 383
Total	7	27	107	245	383

4.2 Computerised Network

The development of base and future network within the study area was performed along the following three steps.

(1) Highway Network

- Convert the digitized highway links (AUTO CAD files) at a scale of 1:10,000 into ARC/INFO[3] and ARCVIEW format under RSO projection;
- Modify the network to the meet transport modeling purpose, generally excluding local roads, adding toll dummy links, future highway project information and bus stops;
- Develop a computer-based network by adding link attributes in order to use in TRANPLAN/NIS, a transportation planning program.

[3] ARC/INFO A geographic information software distributed by Environmental Research Institute, Inc (ESRI). CA, USA.

The TRANPLAN highway network simulation program requires the following data for each link.

- A-Node and B-Node Numbers
- Link Distance
- Free Flow Speed
- Link Capacity
- Assignment Group Code
- Link Group Code

(2) Transit Network

- Collect bus operation information from bus operating companies including Intrakota, Park May, and among others;
- Conduct a supplemental field survey e.g. bus service frequency and operation routes to verify the information;
- Develop a computer-based transit network by adding link and route attributes in order to utilize the TRANPLAN / TRANSIT NIS program.

The TRANPLAN transit network simulation program requires the following data for each link.

- A-Node and B-Node Numbers
- Link Distance
- Speed or Time

In terms of route attributes, the following information are necessary:

- Company (the number of transit company operating the route)
- Mode
- Headway
- Route (A series of node numbers to formulate the route)

The above information is stored in a digital form using the geographic information software: ARCVIEW as well as ASCII text format. Accordingly, the information can be used in transportation simulation software such as STRADA (distributed by the Japan International Cooperation Agency) and TRANSCAD (this software can import ArcView shape files and TRANPLAN text data directly as well.).

CPA: 1 - 102

KEPONG: 103 - 134

SETAPAK:135 - 171

AMPANG: 172 - 184

CHERAS: 185 - 199

OUG: 200 - 231

DAMANSARA: 232 - 246

Figure 4.1.1 Traffic Analtsis Zone (KL)

SMURT-KL

INTEGRATED URBAN TRANSPORT STRATEGIES
FOR ENVIRONMENTAK IMPROVEMENT IN KL

JAPAN INTERNATIONAL COOPERATION AGENCY

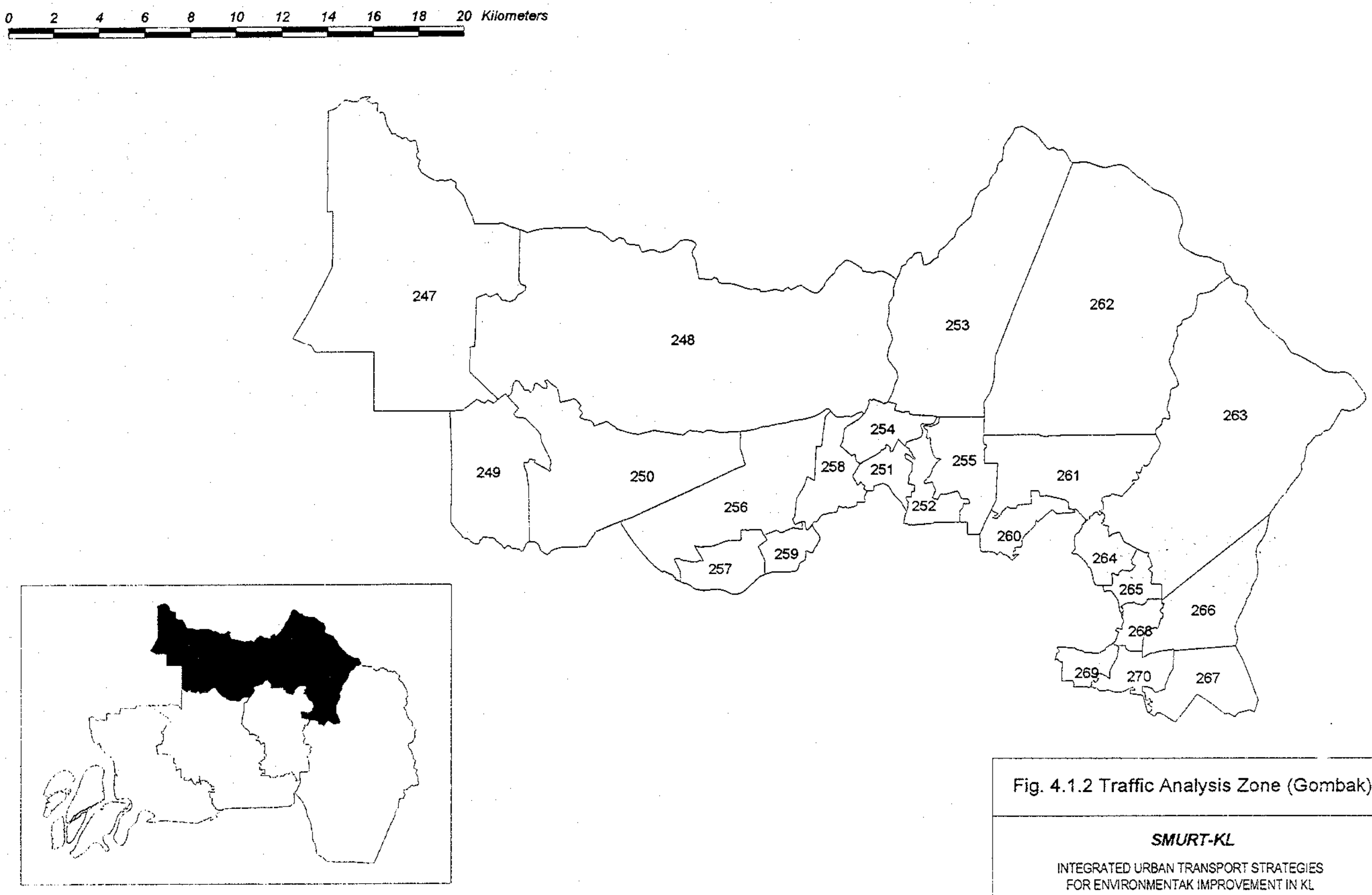


Fig. 4.1.2 Traffic Analysis Zone (Gombak)

SMURT-KL

INTEGRATED URBAN TRANSPORT STRATEGIES
FOR ENVIRONMENTAK IMPROVEMENT IN KL

JAPAN INTERNATIONAL COOPERATION AGENCY

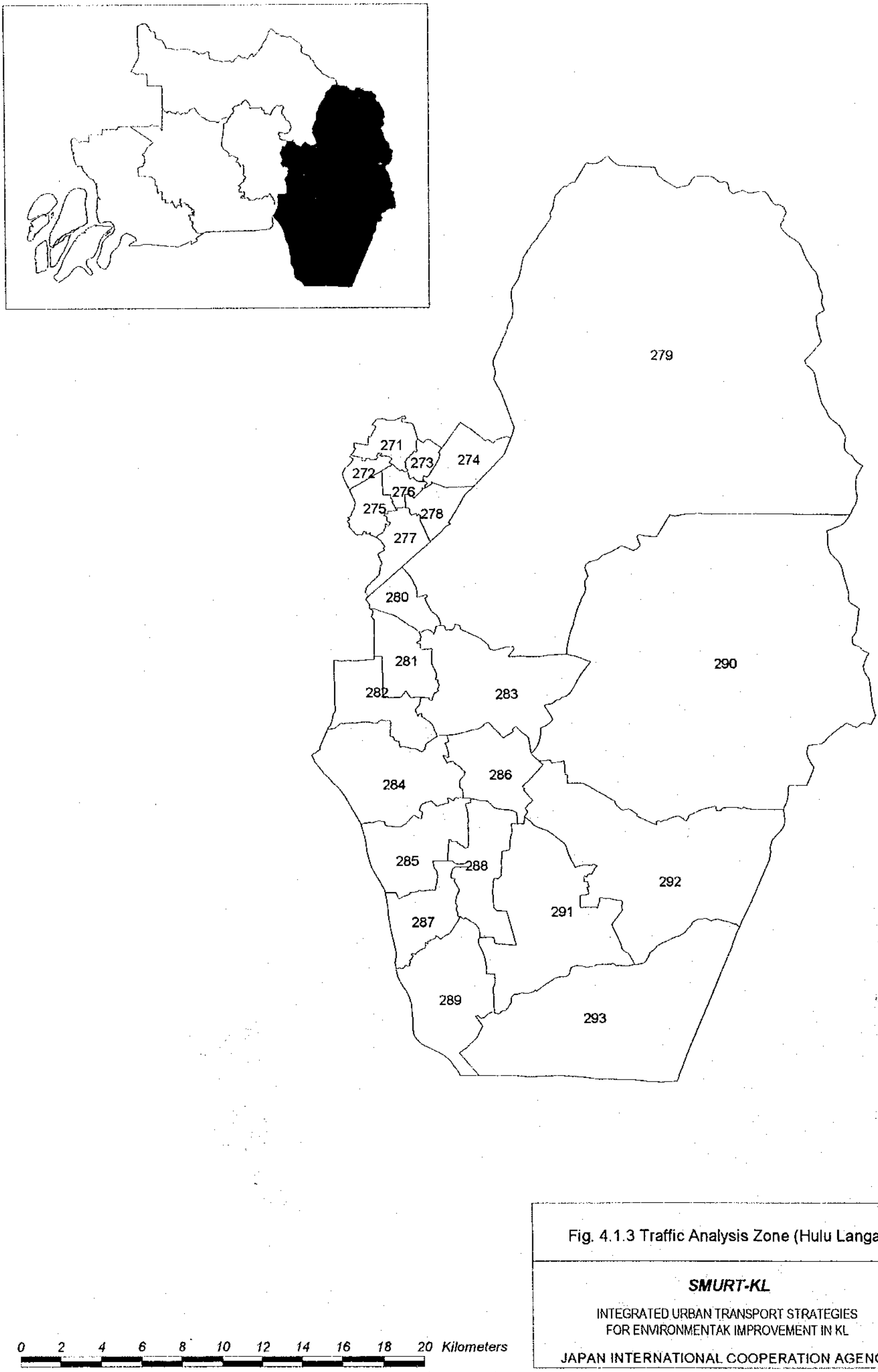


Fig. 4.1.3 Traffic Analysis Zone (Hulu Langat)

SMURT-KL

INTEGRATED URBAN TRANSPORT STRATEGIES
FOR ENVIRONMENTAK IMPROVEMENT IN KL

JAPAN INTERNATIONAL COOPERATION AGENCY

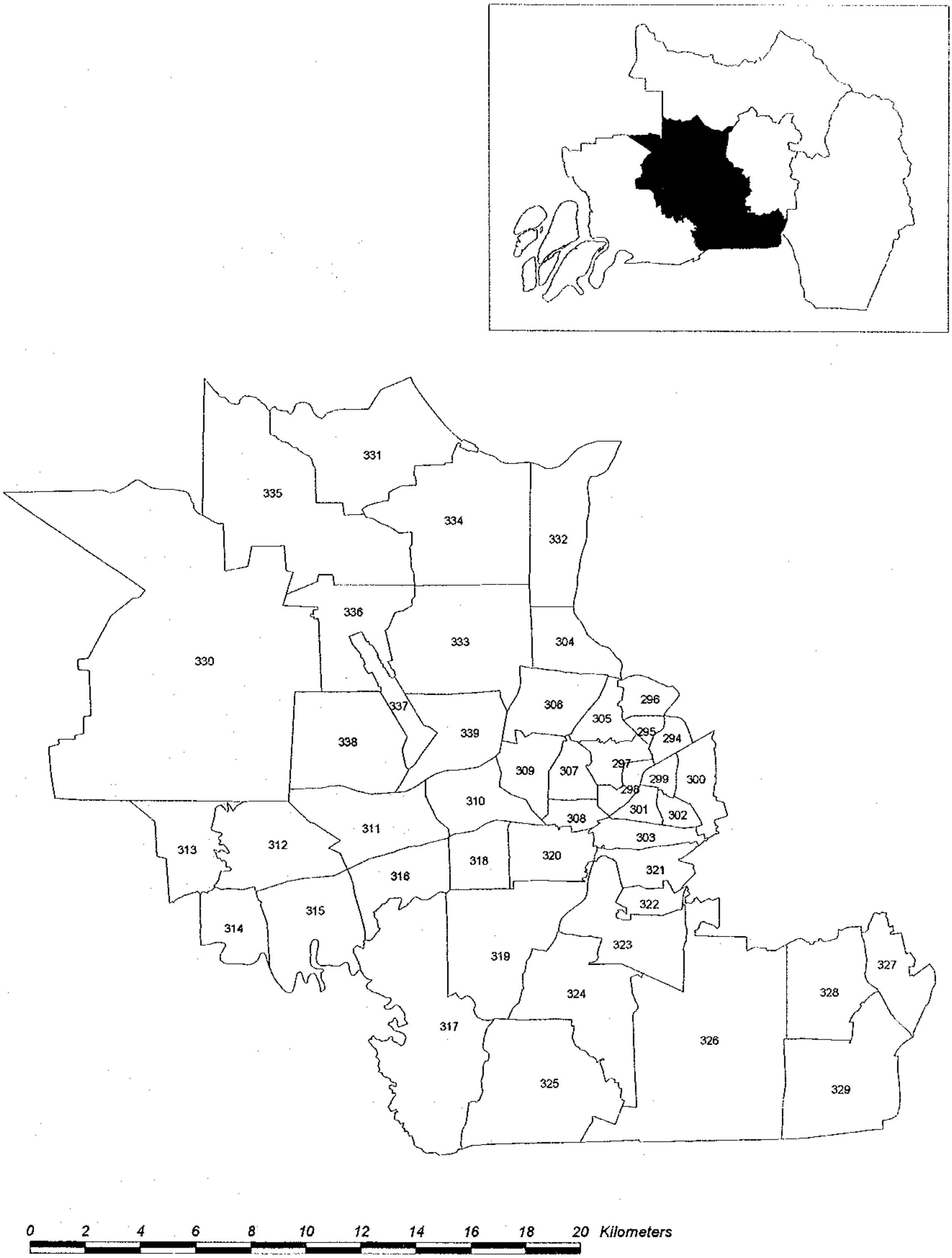


Fig. 4.1.4 Traffic Analysis Zone (Petaling)

SMURT-KL

INTEGRATED URBAN TRANSPORT STRATEGIES
FOR ENVIRONMENTAK IMPROVEMENT IN KL

JAPAN INTERNATIONAL COOPERATION AGENCY

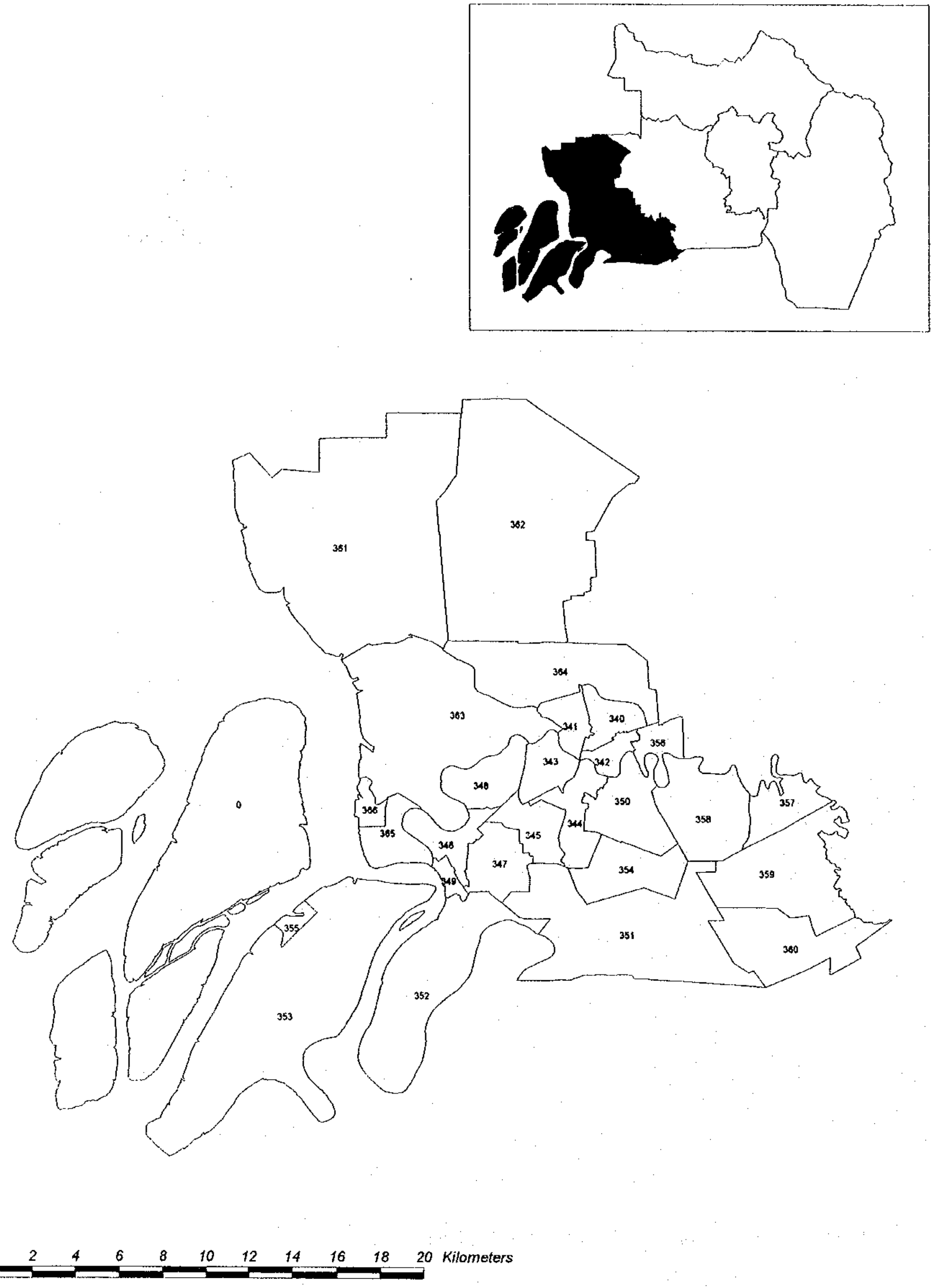


Fig. 4.1.5 Traffic Analysis Zone (Klang)

SMURT-KL

INTEGRATED URBAN TRANSPORT STRATEGIES
FOR ENVIRONMENTAK IMPROVEMENT IN KL

JAPAN INTERNATIONAL COOPERATION AGENCY

4.3 Transport Modelling

This section briefly discusses the analysis of travel characteristics and developed sub-models in the traffic demand forecast procedure, whose has been described in Section 4.1.

4.3.1 Trip Generation

The number of trips generated in a certain area depends on changes in the individual's transport activity as well as the socio-economic situation of the area. It is generally considered that the average trip rate of a homogeneous group in a region, within which most of the trips begins and ends, should be fairly stable over a period.

The trip generation rates for the Klang Valley region were calculated from the results of the Home Interview Survey conducted by the Study Team in 1997. Trip generation rates by purpose and by household income level, and by school type are listed below.

Table 4.3.1 Trip Generation Rate by Household Income Level

	Home to Work Place	Work Place to Home	Home to School	School to Home	Home to Business	Business to Home	Home to Others	Others to Home	NHBB	NHBO	Total
Low	0.334	0.327	0.336	0.331	0.013	0.014	0.241	0.242	0.113	0.208	2.160
Lower Middle	0.438	0.430	0.282	0.280	0.012	0.013	0.225	0.223	0.245	0.326	2.472
Upper Middle	0.521	0.508	0.230	0.227	0.012	0.016	0.219	0.218	0.437	0.410	2.798
High	0.576	0.563	0.183	0.180	0.013	0.021	0.208	0.206	0.646	0.454	3.051

Table 4.3.2 Trip Generation Rate by School Type

School Type		Number of Students	Number of Trips		Trip Rate	
			Home to School	School to Home	Home to School	School to Home
Primary		396,083	417,720	417,116	1.055	1.053
Secondary	Form 1 - 3	202,414	202,073	201,385	0.998	0.995
	Form 4 - 5	128,573	129,512	128,203	1.007	0.997
	Form 6	14,352	14,629	14,427	1.019	1.005
College		89,663	87,518	81,612	0.976	0.910
University		42,451	40,343	38,410	0.950	0.905

In the context of the Klang Valley region in 1997, it seems reasonable to suppose that the levels of household income greatly affects the trip generation rates in the region. That is, the trip production rate increases in proportion to an increase in the household income. The "home to/from school" trip, however, shows a completely opposite phenomenon. This is due to the fact that the average composition rate of workers in a high-income household group is higher than that of lower income groups. On the other hand, there are more children aged between 7 to 14 years in the lower income household groups.

4.3.2 Trip Production and Attraction Models

The trip production of Home-Based Work and Home-Based School were estimated based on the trip production rate as shown in Table 4.3.3. In the same manner, trip attraction models of these two purposes were based on the trip attraction rate tabulated in Table 4.3.4.

Table 4.3.3 Trip Production Model for HBW and HBS

Purpose	Parameter	Unit
Home to Work		
Low	0.334	Trip / person
Low Middle	0.438	Trip / person
Upper Middle	0.521	Trip / person
High	0.576	Trip / person
Work to Home		
Low	0.979	× Trip attraction (Home to Work)
Low Middle	0.982	× Trip attraction (Home to Work)
Upper Middle	0.975	× Trip attraction (Home to Work)
High	0.977	× Trip attraction (Home to Work)
Home to School		
Primary	1.054	Trip / students at residential place
Secondary	1.003	Trip / students at residential place
College and University	0.968	Trip / students at residential place
School to Home		
Primary	0.999	× Trip attraction (Home to School)
Secondary	0.994	× Trip attraction (Home to School)
College and University	0.939	× Trip attraction (Home to School)

Table 4.3.4 Trip Attraction Model for HBW and HBS

Purpose	Parameter	Unit
Home to Work	0.894	Ttrip / Job
Farmer	0.707	Ttrip / Job
Others	0.900	Ttrip / Job
Work to Home		
Low	0.979	×Trip production (Home to Work)
Low Middle	0.982	×Trip production (Home to Work)
Upper Middle	0.975	×Trip production (Home to Work)
High	0.977	×Trip production (Home to Work)
Home to School		
Primary	1.054	Trip / students at school place
Secondary	1.003	Trip / students at school place
College and University	0.968	Trip / students at school place
School to Home		
Primary	0.999	×Trip production (Home to School)
Secondary	0.994	×Trip production (Home to School)
College and University	0.939	×Trip production (Home to School)

As discussed in the previous section, the level of income greatly influences trip production for other purposes. Thus, explanatory variables for the trip production / attraction models should include population by household income-level, and job opportunity by type of facility.

Table 4.3.5 Explanatory Variables for Trip Production/Attraction Models for Home-Based Others, Non-Home-Based Business, and Non-Home Based Others

Trip Production Side

Trip Purpose	Income Level	Variables
HBO	Low	Population in Low Income household group
	Low Middle	Population in Low Middle Income household group
	Upper Middle	Population in Upper Middle Income household group
	High	Population in high Income household group
NHBB	ALL	Job Opportunity
NHBO	ALL	Job Opportunity

Trip Attraction Side

Trip Purpose	Income Level	Variables
HBO	ALL	Population in Low Income household group
NHBB	ALL	Job Opportunity
NHBO	ALL	Job Opportunity

The trip production model for HBO was developed based on the trip production rate by household income group. For the other purposes, the parameters were estimated through regression analyses as tabulated below:

Table 4.3.6 Trip Production and Attraction Models for HBO, NHBB, and NHBO

Trip Purpose	INCOME	PARAMETER	UNIT
HBO	LOW	0.254	trip/person
	LOW MIDDLE	0.237	trip/person
	UPPER MIDDLE	0.234	trip/person
	HIGH	0.221	trip/person

Trip Purpose	Estimated Equation	Correlation Coefficient	Adjusted R2	Standard Error
HBO	0.1079 x POP + 0.2127 x JOB - 21.2 (11.8) (11.46) (-0.1)	0.80	0.64	1,807.2
NHBB	0.9358 x JOB_Office (30.62)	0.90	0.80	2,531.3
NHBO	1.7337 x JOB_Comm + 0.7533 x JOB_Office (5.69) (22.1)	0.93	0.87	2,107.0

Note : Figures in parentheses indicate t-value
POP: Population
JOB : Number of workers
JOB_Office : Number of workers excluding workers working in agricultural fields. manufacturing factories, schools
JOB_Comm : Number of workers in commerce industry and working at shops, markets, and restaurant
Trip production models for NHBB and NHBO are as same as those of attraction.

4.3.3 Trip Distribution Model

(1) Trip Length Distribution

The trip lengths of each zonal pair were calculated from the results of the Home Interview Survey together with the computerised highway network. The average trip lengths by trip purpose were 8.64 km for HBW, 4.12 km for HBS, 4.72 for HBO, 9.34 km for NHBB, and 4.45 km for NHBO respectively. It is a valid assumption that there are statistical confidential differences between the different trip purposes in terms of trip length. Contrary to the trip production or trip attraction rate presented in the previous section, no significant differences were observed between the different household income groups.

Table 4.3.7 Average Trip Length

Trip Purpose	Distance (km)
HBW	8.64
HBS	4.12
HBO	4.72
NHBB	9.34
NHBO	4.45

1) Home-Based Work Trips by Occupation

The trip length of Home-Based Work trips was 8.64 km. The distance is approximately equivalent to the distance from central area of Kuala Lumpur, along the Federal Highway II, to PJ Hilton Hotel, or to the intersection of Jln. Ipoh and Jln. Kepong along Jln. Kuching, or to Taman Connaught just before the East – West Expressway along Jln. Cheras. Such a distance is the average trip length of Home-Based Work trip in the Klang Valley region. Assuming a 15 km / hour travel speed for the trip, the average commuting time is calculated to be around 35 minutes, which seems to be reasonable. On the other hand, the average commuting time of car users working in the CPA is calculated to be about 61 minutes and about 88 minutes for bus users according to the Opinion Survey. This shows that there is a huge time loss in commuting trips due to traffic congestion and/or due to insufficient opportunity in accessing effective transport modes.

2) Home-Based School Trips by School Type

In general, the trip length of HBS purpose should be shorter because the lower educational facilities are usually located close to one's residence. The 4.12 km trip length, however, seems rather long in comparison with the figure in Japan.

(2) Gravity Model

Trip distribution, a technique where trips produced in each traffic analysis zone are linked with all other zones accessible through the road network, is accomplished with the use of Gravity Model. This model reflects the level of service of the network in the travel deterrence function, and is sensitive to changes in trip distribution patterns catalyzed by highway system modifications (new roads) and/or improvements (widening, etc.).

The Gravity Model employed in the study is expressed by the following formula.

$$T_{ij} = k \frac{P_i^a A_j^b}{D_{ij}^c}$$

where T_{ij} : Trips from zone i to zone j
P_i : Trips produced in zone i
A_j : Trips attracted to zone j
k: constant

The Gravity Model was developed based on the HIS data together with the computerised highway network. The input required for the Gravity Model Calibration procedure are:

- Origin-destination pair trip data by purpose and by household income level;
- Trip length distribution by trip purpose and by household income level from the HIS data;
- Travel impedance in the form of minimum inter-zonal distance from the 1997 highway network.

By taking the logarithm of the formula, the following linear equation was obtained:

$$\mathrm{Log}(Tij) = \mathrm{Log}(k) + a\,\mathrm{Log}(Pi) + b\,\mathrm{Log}(Aj) - c\,\mathrm{Log}(Dij)$$

Then, through the linear regression method, each parameter was estimated as tabulated in Table 4.3.8.

Figures Figure 4.3.1 through Figure 4.3.5 show the estimated trip distribution and the present trip distribution.

Table 4.3.8 Estimated Parameters of the Gravity Model

Purpose			LN(K)	a	b	-c
HBW	Home to Work		-2.373	0.472	0.376	-1.664
	Work to Home		-2.263	0.368	0.470	-1.682
HBS	Prime	Home to School	0.875	0.262	0.267	-2.112
		School to Home	0.871	0.270	0.260	-2.109
	Secondary	Home to School	0.625	0.278	0.275	-2.016
		School to Home	0.600	0.277	0.278	-2.025
	U&C	Home to School	1.604	0.244	0.149	-1.730
		School to Home	1.685	0.149	0.232	-1.702
HBO	Home to Others		0.582	0.284	0.244	-1.980
	Others to Home		0.890	0.230	0.262	-1.975
NHBB			1.869	0.193	0.248	-1.084
NHBO			2.836	0.108	0.112	-1.701

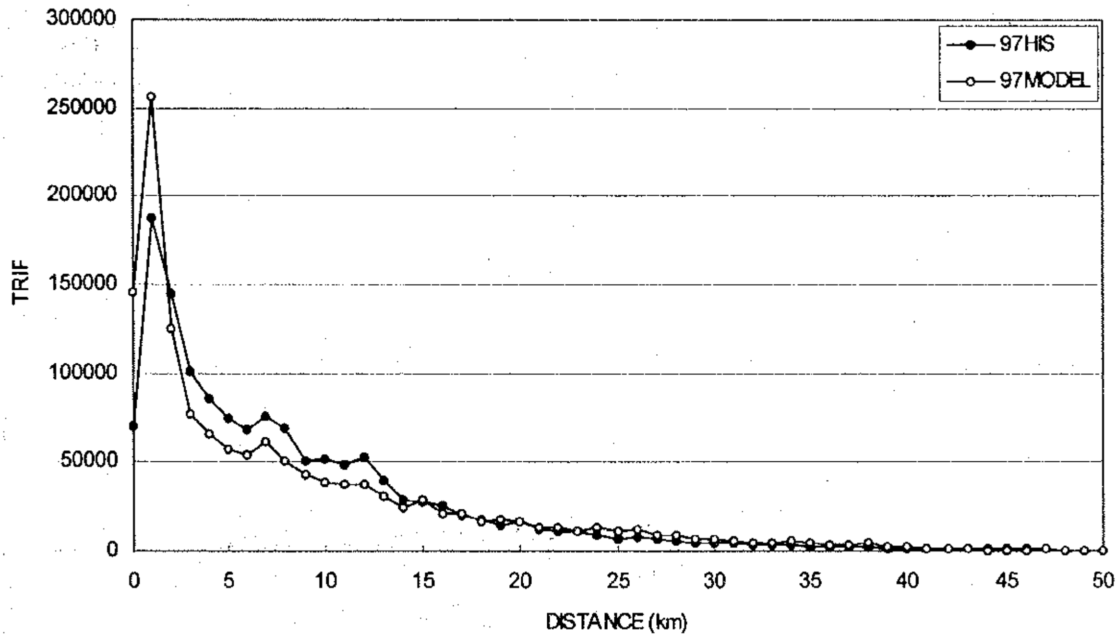


Figure 4.3.1 Trip Length Distribution of Home to Work Trips

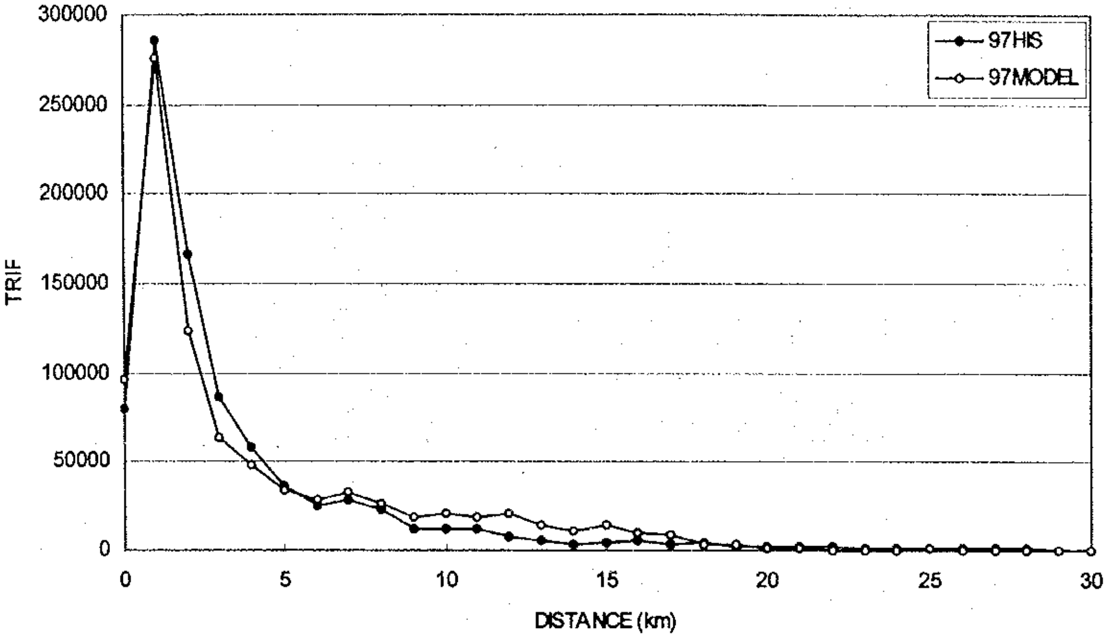


Figure 4.3.2 Trip Length Distribution of Home to School Trips

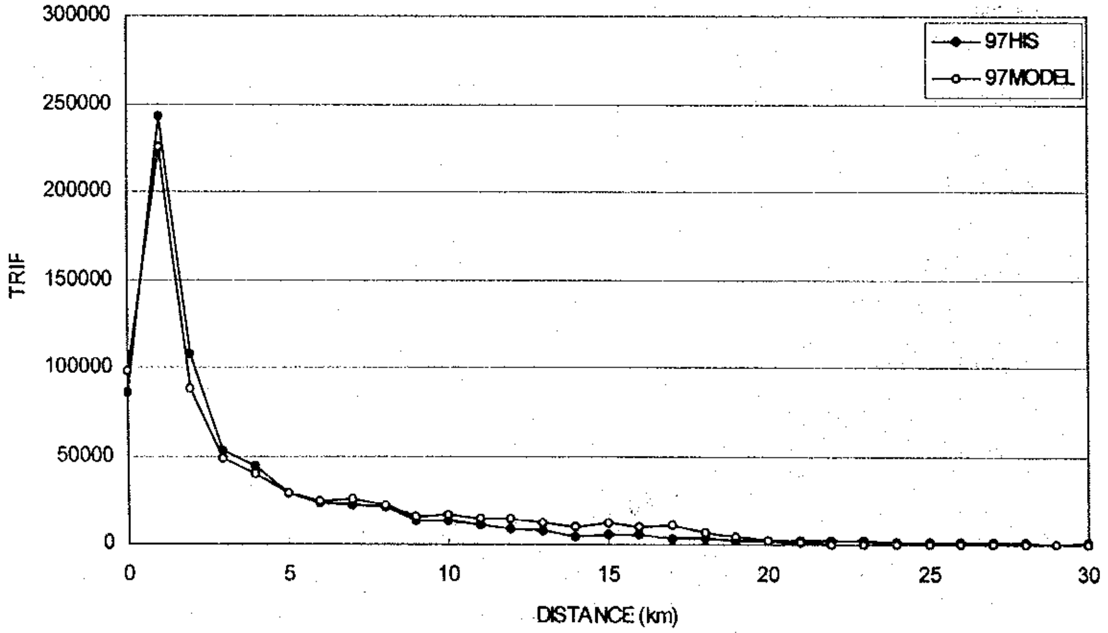


Figure 4.3.3 Trip Length Distribution of Home to Others Trips

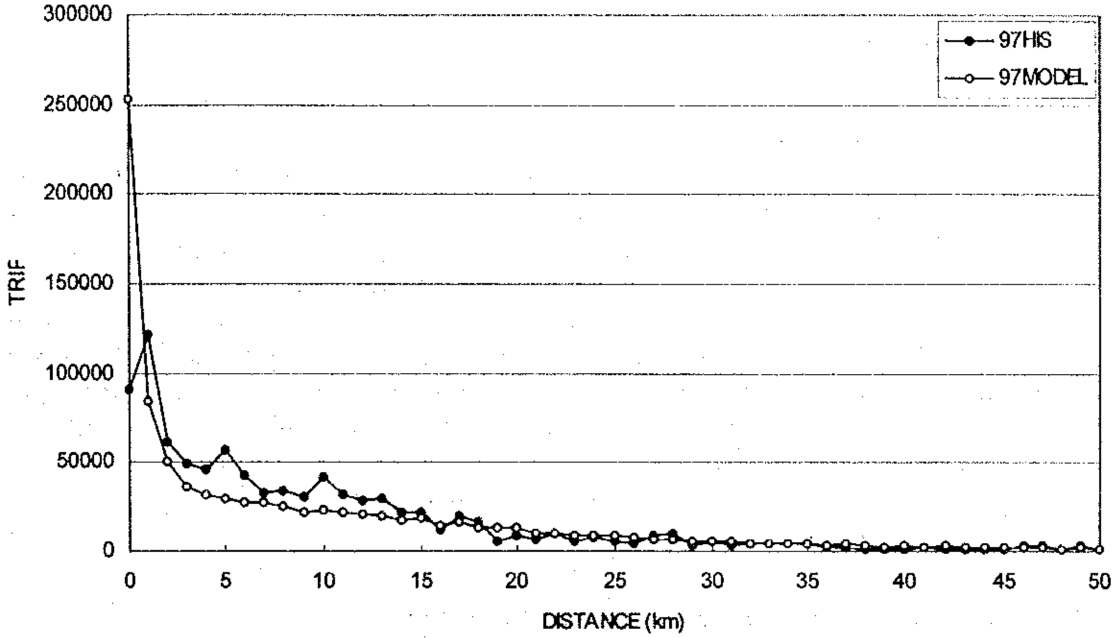


Figure 4.3.4 Trip Length Distribution of Non Home-Based Business Trips

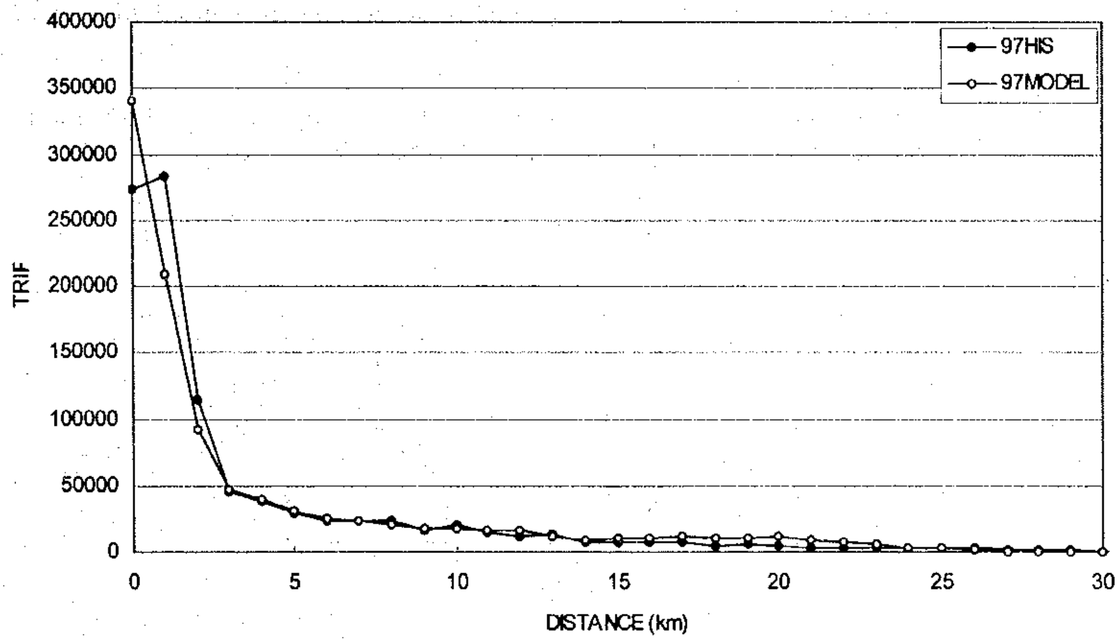


Figure 4.3.5 Trip Length Distribution of Non Home-Based Others Trips

4.3.4 Modal Split Model

Since Kuala Lumpur needs to be transformed into a more public transport friendly city, a modal choice model with the capability to test various transport policies and strategies such as road pricing and changes in public transport fare structure is required. In this study two different types of modal split model were developed for this purpose: one is a conventional diversion curve type model and the other is a discrete choice model. The conventional model for this study is a trip-interchange model, which determines the use of alternative modes separately for each zonal (origin – destination) pair in accordance with the time or cost difference between the alternative modes of transport in an aggregated manner (expressed in %share). On the other hand, the discrete choice model tells us the probability of an individual's choice of transport mode in accordance with the utilities associated with choice alternatives. A detailed discussion of the discrete choice model will be given in separately Section 4.4.

(1) Modal Composition by Trip Purpose and by Income level

As discussed in Chapter 3, modal composition largely depends on trip purposes. Around half of the Home-Based Work trips were made by cars followed by 28 percent by motorcycles. The Non Home-Based Business trips depended much mainly on private modes of transport. Besides, the household income-level strongly affects the individual modal choice, that is, household members from higher income groups show a much stronger preference to using private cars for their travel needs than those from the lower income groups. Figure 4.3.6 shows the modal composition (private modes vs. public modes of transport) by household income group.

In this study, modal choice models have been developed using household income as one of the important factors as well as an impedance between the zones.

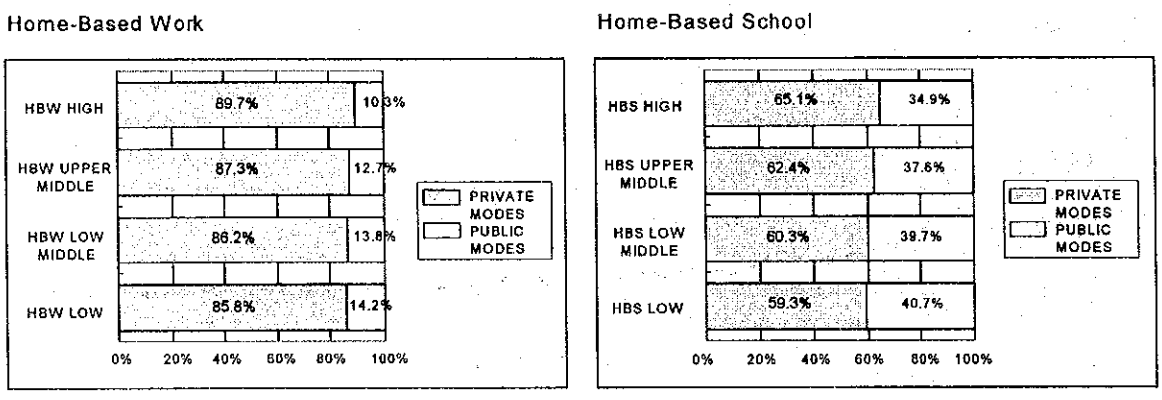
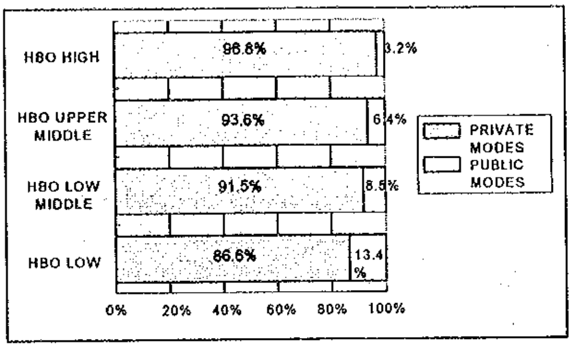
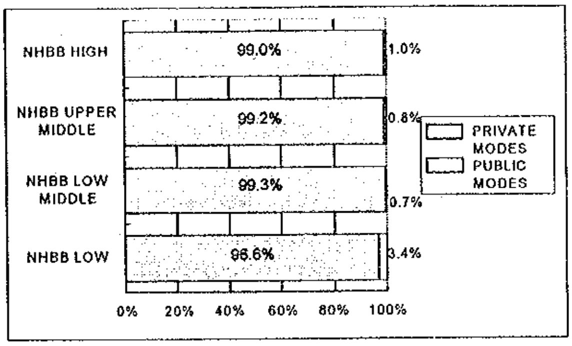


Figure 4.3.6 Modal Composition by Trip Purpose and by Income Level

Home-Based Others



Non Home-Based Business



Non Home-Based Others

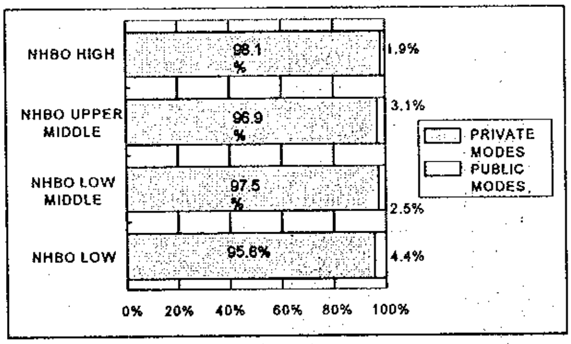


Figure 4.3.6 Modal Composition by Trip Purpose and by Income Level (cnt'd)

(2) Diversion Curve Model

The diversion curve model for this study was developed based on the decision tree depicted in the Figure 4.3.7. The curve (or the share) is represented by a logit function, which predicts the relative use of a mode in terms of the differences in cost and/or distance between the two modes.

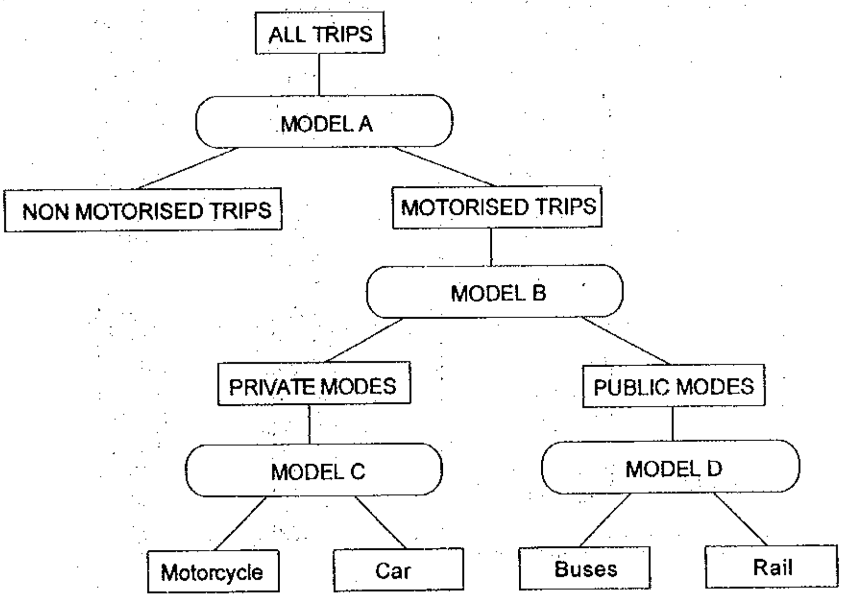


Figure 4.3.7 Binary Choice Alternative

The modal distribution curve is derived from the following formula :

$P1 = 1/(1 + \exp(a + b \times \Delta d))$

where P1 is the share of Mode 1

Δd is the Travel Time Difference(Mode 1 / Mode 2)

Through regression analyses, the following parameters were estimated as tabulated in Table 4.3.9 for Non Motorised vs. Motorised mode, Table 4.3.10 for Public Transport vs. Private Transport and Table 4.3.11 for Buses vs. Railway

Table 4.3.9 Estimated Parameters for Model A

Purpose	Income Level	a	b
HBW	Low	-0.1877	0.0081
	Lower Mid	0.3739	0.0058
	Upper Mid	0.6349	0.0060
	High	0.6450	0.0071
HBS	Low	-0.8270	0.0049
	Lower Mid	-0.6608	0.0052
	Upper Mid	-0.3489	0.0040
	High	0.0379	0.0034
HBO	Low	-0.9412	0.0044
	Lower Mid	-0.6050	0.0053
	Upper Mid	-0.1426	0.0055
	High	-0.1299	0.0077
NHBB	Low	-2.6940	0.0349
	Lower Mid	-2.6940	0.0349
	Upper Mid	-2.6940	0.0349
	High	-2.6940	0.0349
NHBO	Low	-1.0688	0.0089
	Lower Mid	-0.9584	0.0091
	Upper Mid	-1.0420	0.0085
	High	-1.0751	0.0087

P = Non Motorised Mode Share

Table 4.3.10 Estimated Parameters for Model B

Purpose	Income Level	a	b
HBW	Low	0.1491	0.5702
	Lower Mid	0.2825	0.5350
	Upper Mid	0.1564	0.5520
	High	0.2560	0.4720
HBS	Low	-1.4655	0.0812
	Lower Mid	-1.1299	0.0797
	Upper Mid	-1.2663	0.1594
	High	-1.2040	0.2011
HBO	Low	0.6167	0.2886
	Lower Mid	0.9005	0.4237
	Upper Mid	1.1487	0.5157
	High	1.4802	0.7568
NHBB	Low	2.5499	0.4150
	Lower Mid	2.5499	0.4150
	Upper Mid	2.5499	0.4150
	High	2.5499	0.4150
NHBO	Low	0.8041	0.8685
	Lower Mid	1.3451	0.9572
	Upper Mid	0.9560	1.4454
	High	0.7276	1.8645

P = Public Transport Mode Share

Table 4.3.11 Estimated Parameters for Model D

Purpose	Income Level	A	B
HBW	Low	1.4629	-5.3972
	Lower Mid	1.4629	-5.3972
	Upper Mid	1.4629	-5.3972
	High	1.4629	-5.3972
HBS	Low	0.7271	-6.3679
	Lower Mid	0.7271	-6.3679
	Upper Mid	0.7271	-6.3679
	High	0.7271	-6.3679
HBO	Low	1.7568	-5.9557
	Lower Mid	1.7568	-5.9557
	Upper Mid	1.7568	-5.9557
	High	1.7568	-5.9557
NHBB	Low	1.4366	-4.5951
	Lower Mid	1.4366	-4.5951
	Upper Mid	1.4366	-4.5951
	High	1.4366	-4.5951
NHBO	Low	1.4778	-5.0721
	Lower Mid	1.4778	-5.0721
	Upper Mid	1.4778	-5.0721
	High	1.4778	-5.0721

P = Bus Share

The modal distribution curves of Model C is derived based on the following formula :

$P1 = a + b \times d$

where P1 is the share of Mode 1

d is the Distance

Table 4.3.12 Estimated Parameters for Model C

Purpose	Income Level	a	b
HBW	Low	0.6518	-0.000030
	Lower Mid	0.4293	-0.000030
	Upper Mid	0.3368	-0.000050
	High	0.2299	-0.000003
HBS	Low	0.5408	-0.000030
	Lower Mid	0.3806	-0.000006
	Upper Mid	0.3132	-0.000030
	High	0.2181	-0.000030
HBO	Low	0.4262	-0.000007
	Lower Mid	0.2723	-0.000004
	Upper Mid	0.2220	-0.000010
	High	0.1284	-0.000020
NHBB	Low	0.4882	-0.000030
	Lower Mid	0.1595	-0.000010
	Upper Mid	0.0995	-0.000003
	High	0.0395	-0.000002
NHBO	Low	0.6111	-0.000070
	Lower Mid	0.3257	-0.000020
	Upper Mid	0.2529	-0.000040
	High	0.1336	-0.000006

P = Motorcycle Share

(3) Model Validation

To test the reliability of the modal choice models, the derived diversion equations were applied to the existing person trip tables by purpose and by income group. The following Tables summarise the predicted figures and the results of the Home Interview Survey. Predicted OD matrices were also assigned on the network, then checked at the screen lines and at several highway corridors.

Table 4.3.13 Predicted Modal Share by the Model: Non Motorised Trips

Purpose	Income Level	All Mode Trip (HIS)	N_M Trip (HIS)	N_M Trip (model)	Share(HIS)	Share(Model)
HBW	Low	522,175	67,331	49,765	12.9%	9.5%
	Lower Mid	975,833	96,207	107,832	9.9%	11.1%
	Upper Mid	765,118	56,564	35,050	7.4%	4.6%
	High	494,970	29,142	16,534	5.9%	3.3%
HBS	Low	522,074	226,025	186,069	43.3%	35.6%
	Lower Mid	627,226	240,014	203,510	38.3%	32.4%
	Upper Mid	338,802	111,416	96,771	32.9%	28.6%
	High	157,866	39,242	31,663	24.9%	20.1%
HBO	Low	455,764	276,092	188,690	60.6%	41.4%
	Lower Mid	595,152	275,982	186,688	46.4%	31.4%
	Upper Mid	360,434	121,394	74,067	33.7%	20.5%
	High	195,467	49,029	27,168	25.1%	13.9%
NHBB	Low	86,443	4,255	1,416	4.9%	1.6%
	Lower Mid	255,674	13,882	8,658	5.4%	3.4%
	Upper Mid	291,253	5,883	2,314	2.0%	0.8%
	High	254,800	8,156	4,346	3.2%	1.7%
NHBO	Low	144,243	56,837	44,899	39.4%	31.1%
	Lower Mid	311,580	106,339	89,192	34.1%	28.6%
	Upper Mid	258,754	95,250	77,774	36.8%	30.1%
	High	164,585	60,301	48,710	36.6%	29.6%

Table 4.3.14 Predicted Modal Share by the Model: Motorcycle vs. Car

Purpose	Income Level	Private Trip (HIS)	MC Trip (HIS)	MC Trip (model)	Share(HIS)	Share(Model)
HBW	Low	383,416	238,309	240,461	62.2%	62.7%
	Lower Mid	743,531	295,570	299,587	39.8%	40.3%
	Upper Mid	609,267	175,054	177,853	28.7%	29.2%
	High	413,601	79,585	83,956	19.2%	20.3%
HBS	Low	94,739	46,717	50,015	49.3%	52.8%
	Lower Mid	134,954	47,282	51,024	35.0%	37.8%
	Upper Mid	91,508	26,487	27,345	28.9%	29.9%
	High	55,332	11,086	11,184	20.0%	20.2%
HBO	Low	178,717	80,434	75,547	45.0%	42.3%
	Lower Mid	310,391	88,907	83,879	28.6%	27.0%
	Upper Mid	240,913	49,058	52,160	20.4%	21.7%
	High	151,605	18,226	17,850	12.0%	11.8%
NHBB	Low	82,640	34,687	38,027	42.0%	46.0%
	Lower Mid	250,093	41,116	37,503	16.4%	15.0%
	Upper Mid	301,664	28,506	29,117	9.4%	9.7%
	High	252,451	12,285	9,496	4.9%	3.8%
NHBO	Low	88,550	48,752	50,696	55.1%	57.3%
	Lower Mid	212,317	64,578	66,694	30.4%	31.4%
	Upper Mid	168,641	34,684	38,571	20.6%	22.9%
	High	111,136	11,992	14,410	10.8%	13.0%

Table 4.3.15 Predicted Modal Share by the Model: Public Modes

Purpose	Income Level	M Trip (HIS)	Public Trip (HIS)	PublicTrip (model)	Share(HIS)	Share(Model)
HBW	Low	459,244	75,828	88,045	16.5%	19.2%
	Lower Mid	884,813	141,282	154,479	16.0%	17.5%
	Upper Mid	712,880	103,613	109,876	14.5%	15.4%
	High	467,423	53,822	67,353	11.5%	14.4%
HBS	Low	301,037	206,298	191,266	68.5%	63.5%
	Lower Mid	395,494	260,540	239,986	65.9%	60.7%
	Upper Mid	230,637	139,129	137,280	60.3%	59.5%
	High	119,486	64,154	69,822	53.7%	58.4%
HBO	Low	211,354	32,637	30,868	15.4%	14.6%
	Lower Mid	342,030	31,639	32,348	9.3%	9.5%
	Upper Mid	258,484	17,571	19,408	6.8%	7.5%
	High	156,856	5,251	4,715	3.3%	3.0%
NHBB	Low	85,620	2,980	2,982	3.5%	3.5%
	Lower Mid	251,789	1,696	7,897	0.7%	3.1%
	Upper Mid	303,972	2,308	8,294	0.8%	2.7%
	High	255,123	2,672	5,855	1.0%	2.3%
NHBO	Low	92,784	4,234	5,454	4.6%	5.9%
	Lower Mid	217,974	5,657	5,931	2.6%	2.7%
	Upper Mid	174,134	5,493	4,202	3.2%	2.4%
	High	113,383	2,247	2,230	2.0%	2.0%

Table 4.3.16 Predicted Modal Share by the Model: Buses vs. Rail

Purpose	Income Level	Public Trip (HIS)	BS Trip (HIS)	BS Trip (model)	Share(HIS)	Share(Model)
HBW	Low	74,575	72,372	69,972	97.0%	93.8%
	Lower Mid	137,818	130,949	130,668	95.0%	94.8%
	Upper Mid	101,752	96,005	97,733	94.4%	96.1%
	High	52,939	49,494	50,752	93.5%	95.9%
HBS	Low	202,334	201,430	201,243	99.6%	99.5%
	Lower Mid	256,496	254,977	255,197	99.4%	99.5%
	Upper Mid	137,056	135,418	136,496	98.8%	99.6%
	High	63,202	62,535	62,925	98.9%	99.6%
HBO	Low	31,668	30,453	29,383	96.2%	92.8%
	Lower Mid	31,317	29,780	29,742	95.1%	95.0%
	Upper Mid	16,894	16,054	16,208	95.0%	95.9%
	High	5,110	5,065	4,954	99.1%	96.9%
NHBB	Low	2,783	2,389	2,561	85.8%	92.0%
	Lower Mid	1,183	1,183	1,085	100.0%	91.7%
	Upper Mid	2,247	1,035	2,071	46.1%	92.2%
	High	2,672	2,672	2,429	100.0%	90.9%
NHBO	Low	4,203	3,981	3,906	94.7%	92.9%
	Lower Mid	5,543	5,430	5,209	98.0%	94.0%
	Upper Mid	5,224	4,935	4,934	94.5%	94.5%
	High	2,223	2,175	2,110	97.8%	94.9%