CHAPTER 4
Existing Traffic And Transport Conditions

4. EXISTING TRAFFIC AND TRANSPORT CONDITIONS

4.1. TRAFFIC AND PASSENGER VOLUME

4.1.1. TRAFFIC VOLUME ON SCREEN LINES

(1) Screen line survey method

The screen line survey was conducted to update the OD trip data in 2000. Two screen lines were set up. One was the same line used in PDTU2001 that crosses three major roads. The other was a new screen line in the suburbs crossing five major roads. Figure 4.1-1 shows the survey locations.

The counting period for bus passengers on board and traffic volume was 14 hours between 6:00 a.m. and 8:00 p.m. at six locations and 24 hours at the other two locations. Passing vehicles were classified into seven (7) types as shown below. Bus passengers on board were assessed in the manner of percentage figures of full seats and standing passengers, because of difficulty of counting each passenger.

1) Passenger car
2) Truck
3) Taxi
4) Bus (regular size)
5) Microbus
6) Motorcycle
7) Bicycle

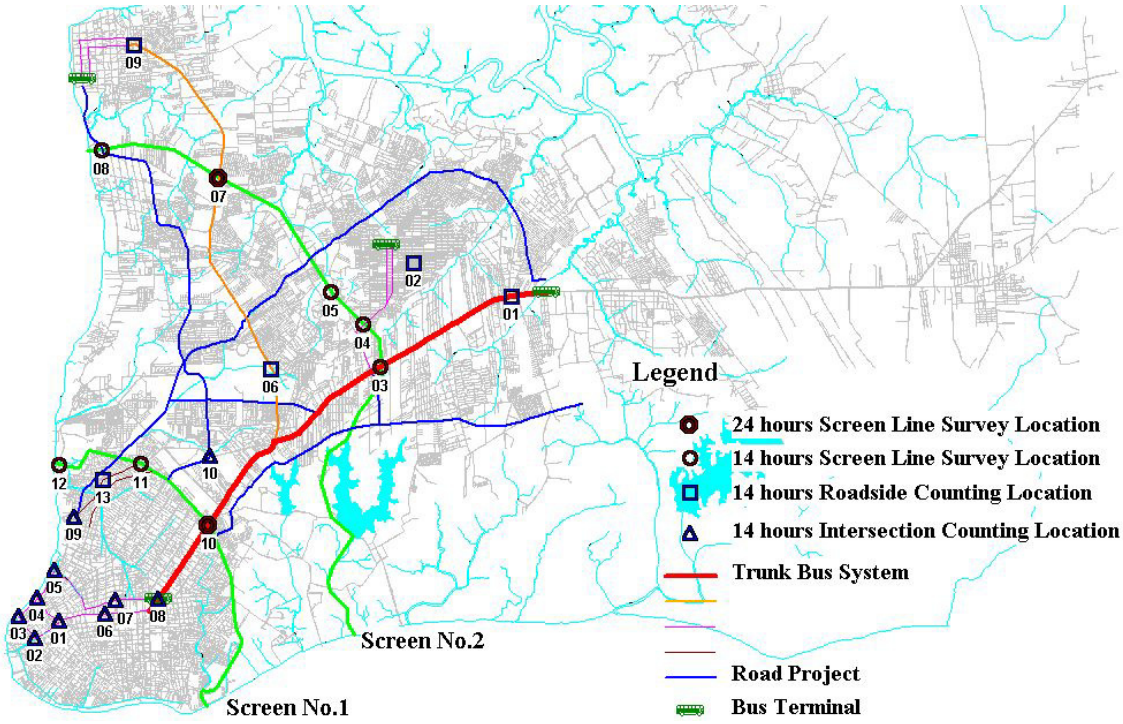

Figure 4.1-1 Supplemental Traffic Survey Locations

(2) Traffic volumes

Table 4.1-1 shows the summary of traffic and passenger volumes on board, and the average occupancy on the screen lines. As can be seen, total daily inbound and outbound traffic volumes on screen line-1 are approximately 74,000 and 75,000 veh/day, exclusive of bicycles, respectively, while on screen line-2, the inbound and outbound traffic volumes are approximately 57,000 and 52,000 veh/day, exclusive of bicycles, respectively, and the inbound and outbound traffic volumes on screen line-2 are approximately 16,000 and 23,000 veh/day lower, respectively.

As for the daily passengers, approximately 439,000 and 480,000 passengers/day pass through on screen line-1 in the inbound and outbound directions, respectively. On the other hand, the daily passenger volumes on screen line-2 are approximately 257,000 in each direction, a difference of roughly 181,000 and 223,000 passengers in each direction.

On screen line-2, passengers in the direction of BR-316 account for approximately 70% of the total passengers and the balance is from/to Icoaraci, in contrast to 64% for the vehicles. In the Belem Metropolitan area, it is obvious that the major corridor is on Av. Almirante Barroso and BR-316 from the viewpoint of traffic flow.

The average occupancies for passenger cars and buses are approximately 2.3-2.4 and 31-34 passengers per vehicle, respectively, on screen line-1. On screen line-2, passenger cars carry approximately 1.9-2.0 passengers on average, in contrast with 2.3-2.4 on screen line-1. The buses carry approximately 27 passengers on average, while 31-34 passengers are carried on screen line-1.

(3) Hourly traffic and passenger volumes

Figure 4.1-2 and Figure 4.1-3 show the hourly traffic volume on the screen lines. As can be seen, those figures show typical patterns of hourly fluctuation. Traffic volume in the inbound direction at peak hour is approximately 7,600 veh/hr (excluding bicycles) from 7:00 a.m. to 8:00 a.m. on screen line-1 and 3,900 veh/hr from 8:00 a.m. to 9:00 a.m. on screen line-2. A peak period of traffic volume cannot be seen in the morning on screen line-2, while the peak period on screen line-1 is clear.

Figure 4.1-4 and Figure 4.1-5 show the hourly passenger volume on the screen lines. As can be seen on screen line-1, passenger volume in the inbound direction at peak hour is approximately 73,000 passengers/hr from 7:00 a.m. to 8:00 a.m., in contrast to 31,000 passengers/hr in the outbound direction. On screen line-2, approximately 29,000 and 14,000 passengers/hr pass through in the inbound and outbound directions, respectively. The hourly fluctuation shows that passenger peak ratios are higher than those of traffic on both screen lines. Those figures in the inbound direction on screen line-1 and line-2 are approximately 17% and 11% of the daily volumes, in contrast to 10% and 7% for traffic volume (see Table 4.1-2). Those figures indicate 11-17% of daily passengers concentrate in the peak hour.

Table 4.1-1 Traffic and Passenger Volumes, and Average Occupancy on the Screen Lines

(1) 24 hours Vehicle Volume

	Location Number	Direction	P.Car / Van	Bus	Micro Bus	Truck	Taxi	Motor cycle	Bicycle	Total (excluding Bicycle)
Screen - 1	10	Inbound	29,463	6,569	683	2,085	2,876	1,505	1,480	43,181
		Outbound	36,183	7,121	922	2,601	3,866	1,743	1,442	52,436
	11	Inbound	16,883	2,319	21	1,394	2,169	1,025	664	23,811
		Outbound	11,790	2,235	30	1,042	1,823	681	646	17,601
	12	Inbound	4,430	563	70	542	680	428	881	6,713
		Outbound	3,198	555	82	426	636	333	577	5,230
	Total	Inbound	50,776	9,451	774	4,021	5,725	2,958	3,025	73,705
		Outbound	51,171	9,911	1,034	4,069	6,325	2,757	2,665	75,267
Screen - 2	3	Inbound	17,287	2,685	702	4,230	943	993	1,625	26,840
		Outbound	13,254	2,568	663	3,837	1,063	1,070	1,237	22,455
	4	Inbound	7,037	1,254	233	588	1,140	743	510	10,995
		Outbound	6,614	1,164	255	474	937	684	513	10,128
	5	Inbound	1,721	575	64	289	236	255	880	3,140
		Outbound	1,881	646	83	300	284	242	832	3,436
	7	Inbound	8,625	1,154	131	1,354	664	884	1,691	12,812
		Outbound	8,719	1,151	135	1,386	661	764	1,448	12,816
	8	Inbound	1,714	333	25	391	266	233	1,176	2,962
		Outbound	1,729	339	14	360	289	243	1,436	2,974
	Total	Inbound	36,384	6,001	1,155	6,852	3,249	3,108	5,882	56,749
		Outbound	32,197	5,868	1,150	6,357	3,234	3,003	5,466	51,809

(2) 24 hours Passenger Volume

	Location Number	Direction	P.Car / Van	Bus	Micro Bus	Truck	Taxi	Motor cycle	Bicycle	Total
Screen - 1	10	Inbound	67,125	223,513	4,003	4,387	2,355	1,505	1,480	304,368
		Outbound	82,022	250,768	5,956	5,376	4,104	1,743	1,442	351,411
	11	Inbound	44,320	58,160	22	3,230	1,913	1,025	664	109,334
		Outbound	30,633	70,729	88	2,410	2,116	681	646	107,303
	12	Inbound	9,186	12,664	141	1,101	405	428	881	24,806
		Outbound	6,215	13,256	258	929	578	333	577	22,146
	Total	Inbound	120,631	294,337	4,166	8,718	4,673	2,958	3,025	438,508
		Outbound	118,870	334,753	6,302	8,715	6,798	2,757	2,665	480,860
Screen - 2	3	Inbound	34,694	82,079	3,501	7,303	428	993	1,625	130,623
		Outbound	31,856	78,629	3,580	7,921	2,328	1,070	1,237	126,621
	4	Inbound	13,311	24,097	723	1,265	664	743	510	41,313
		Outbound	12,287	23,879	1,012	1,003	519	684	513	39,897
	5	Inbound	3,073	12,716	139	588	115	255	880	17,766
		Outbound	3,262	16,320	231	639	207	242	832	21,733
	7	Inbound	15,217	32,393	585	3,015	342	884	1,691	54,127
		Outbound	15,195	33,583	466	2,797	551	764	1,448	54,804
	8	Inbound	2,816	8,227	83	738	180	233	1,176	13,453
		Outbound	3,030	8,431	31	774	239	243	1,436	14,184
	Total	Inbound	69,111	159,512	5,031	12,909	1,729	3,108	5,882	257,282
		Outbound	65,630	160,842	5,320	13,134	3,844	3,003	5,466	257,239

(3) Average Occupancy

Screen - 1	Total	Inbound	2.38	31.14	5.38	2.17	0.82	1.00	1.00
		Outbound	2.32	33.78	6.09	2.14	1.07	1.00	1.00
Screen - 2	Total	Inbound	1.90	26.58	4.36	1.88	0.53	1.00	1.00
		Outbound	2.04	27.41	4.63	2.07	1.19	1.00	1.00

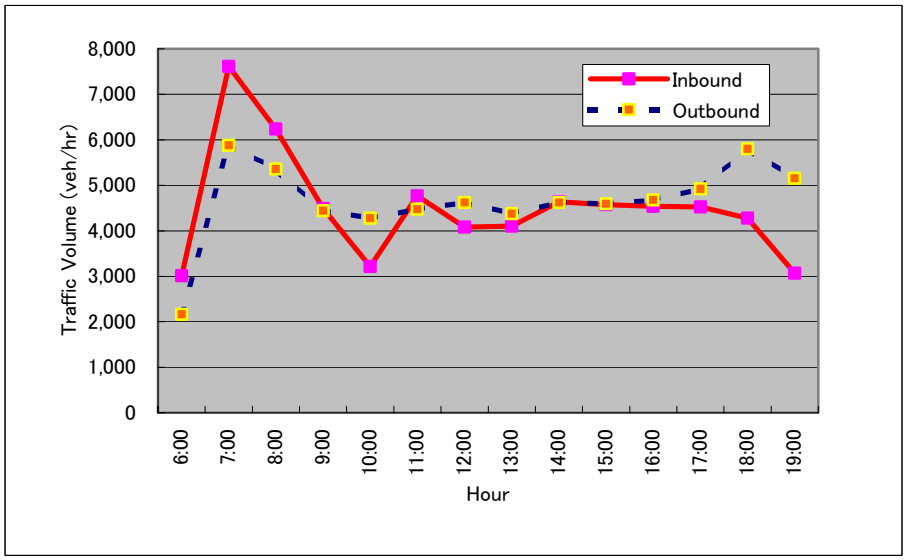

Figure 4.1-2 Hourly Traffic Volume on Screen Line-1

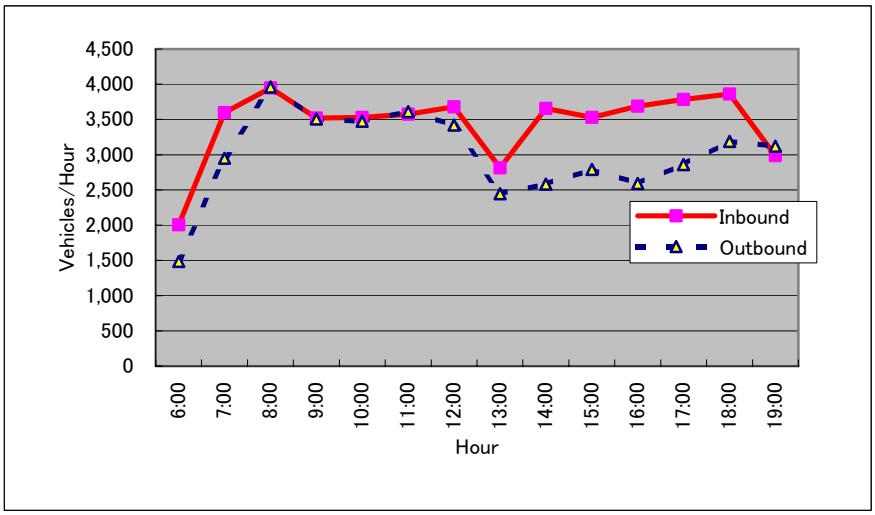

Figure 4.1-3 Hourly Traffic Volume on Screen Line-2

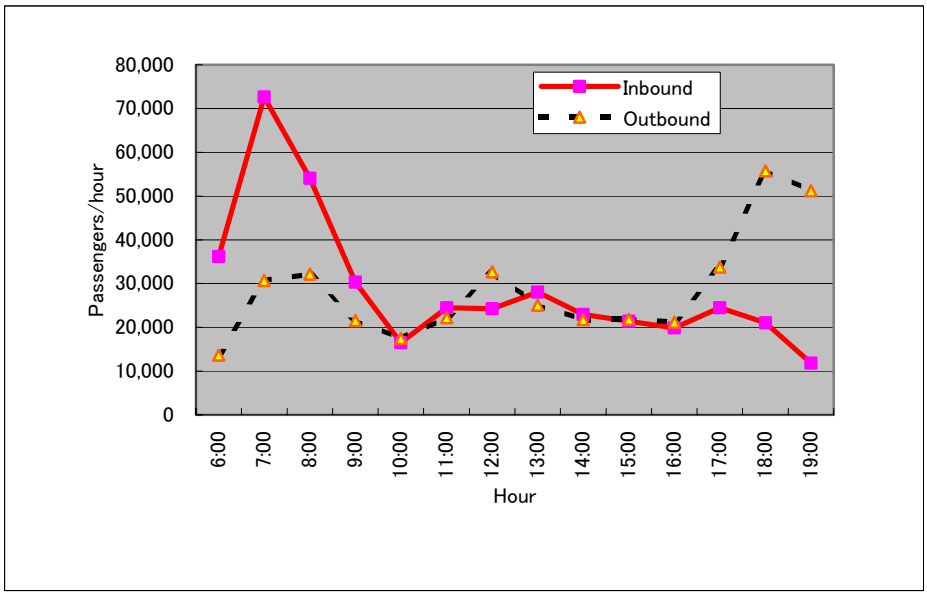

Figure 4.1-4 Hourly Passenger Volume on Screen Line-1

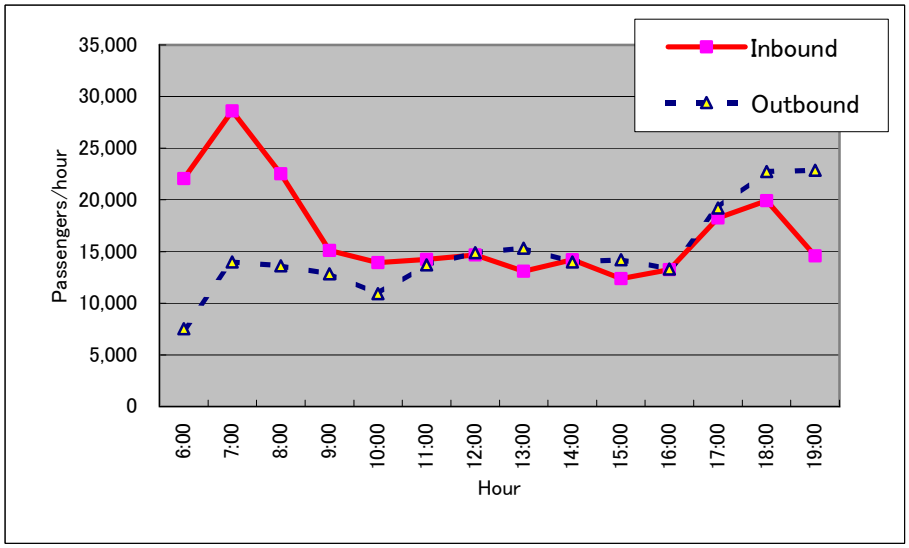

Figure 4.1-5 Hourly Passenger Volume on Screen Line-2

Table 4.1-2 Peak Hour Traffic and Transport Indices (Inbound)

Screen Line	Types	Peak hour	Volume	Peak Ratio by 24 hr
1	Vehicles	7:00-8:00	7,614	10.3%
2	Vehicles	7:00-8:00	3,947	7.0%
1	Passengers	7:00-8:00	72,633	16.6%
2	Passengers	7:00-8:00	28,608	11.1%

(4) Vehicle composition

Figure 4.1-6 shows daily vehicle composition in the inbound direction on the screen lines. The composition ratio in the outbound direction is similar to that in the inbound direction. The higher ratio on screen line-1 is for cars, followed by buses, taxi, and truck. The car ratio is approximately 70%. This tendency is similar to that on screen line-2.

As for passengers by mode (see Figure 4.1-7), the modal share of bus passengers is predominant on the both lines. Approximately 65% are bus passengers. The car share ratios are approximately 30%, in contrast to 60-70% for vehicle composition.

Figure 4.1-8 and Figure 4.1-9 show hourly traffic and passenger volumes in the inbound direction on screen line-1. In the morning from 7:00 a.m. to 8:00 a.m., bus passengers sharply increase, though the number of buses is only slightly increased. This indicates that passenger volume on board rises dramatically.

Figure 4.1-12 shows the vehicle composition and passengers by mode at peak hour in the inbound direction on screen line-1. The passenger ratio at peak hour (7:00 a.m. to 8:00 a.m.) reaches approximately 76%, in contrast to 66% in the day.

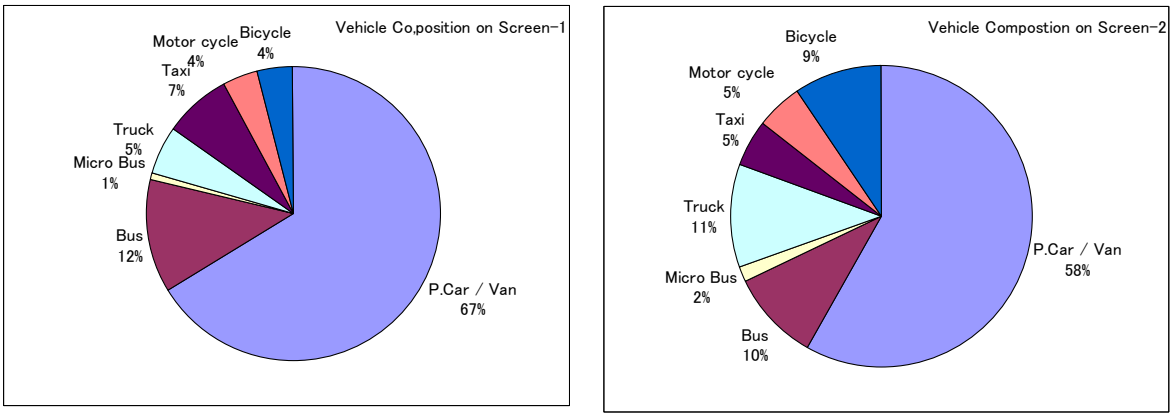

Figure 4.1-6 Vehicle Composition on Screen Lines (Inbound)

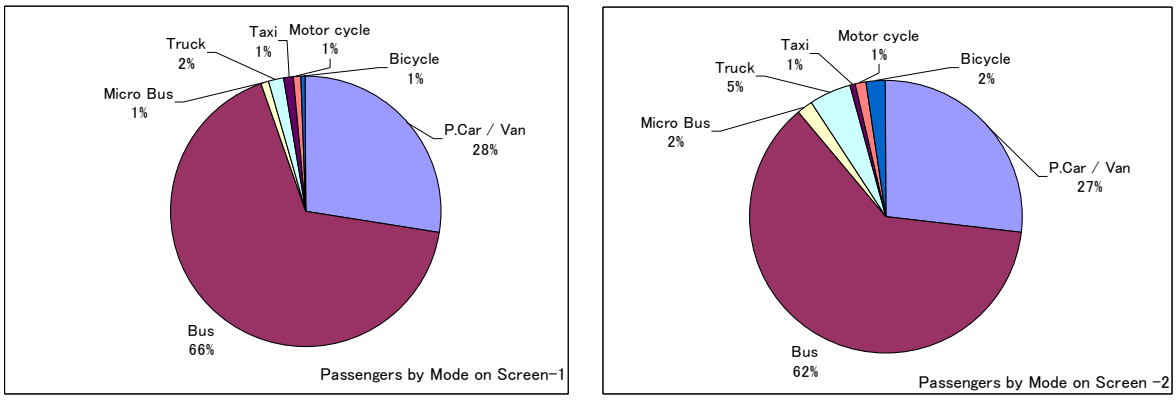

Figure 4.1-7 Passengers by Mode on Screen Lines (Inbound)

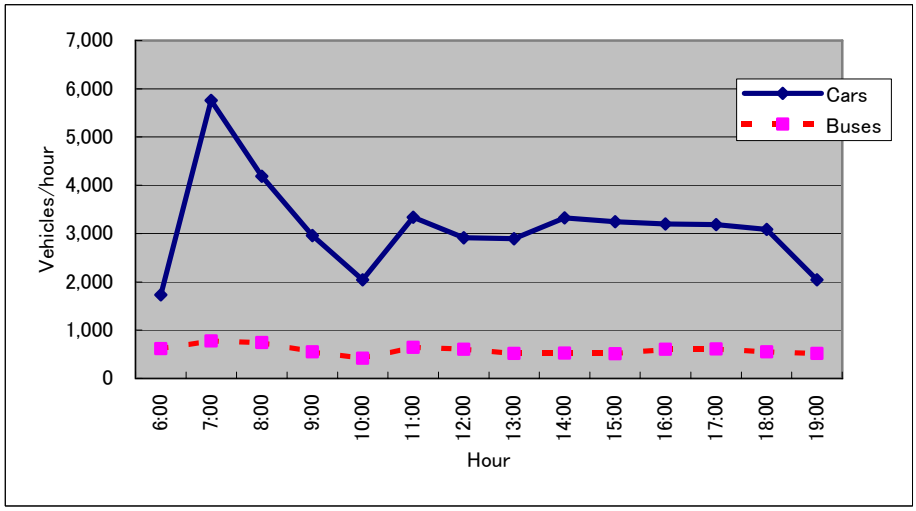

Figure 4.1-8 Hourly Traffic Volume by Mode on Screen Line-1 (Inbound)

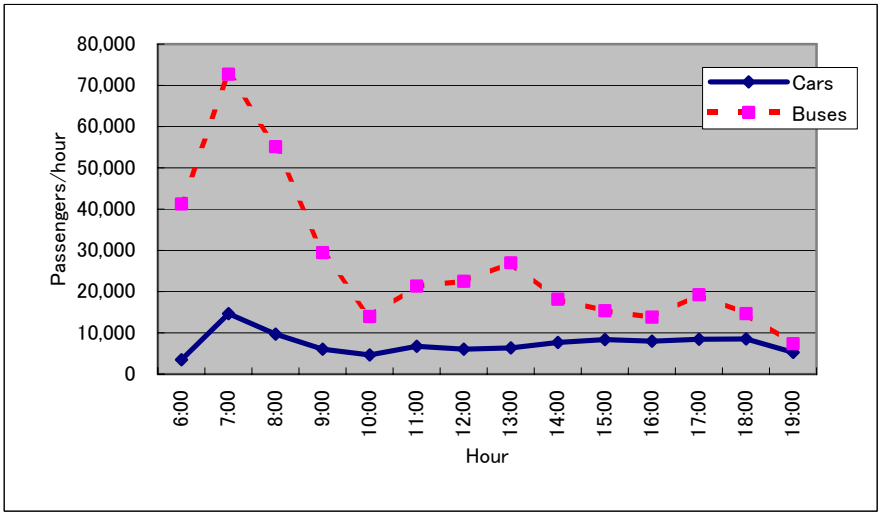

Figure 4.1-9 Hourly Passenger Volume by Mode on Screen Line-1 (Inbound)

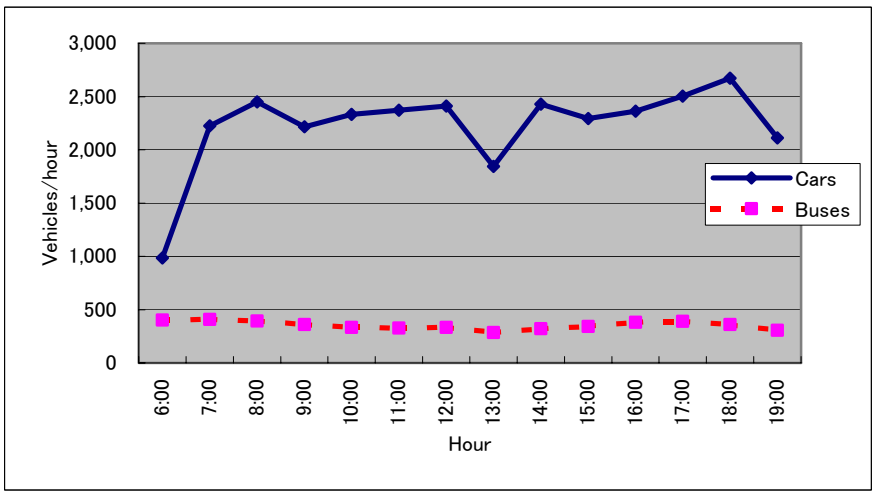

Figure 4.1-10 Hourly Traffic Volume by Mode on Screen Line-2 (Inbound)

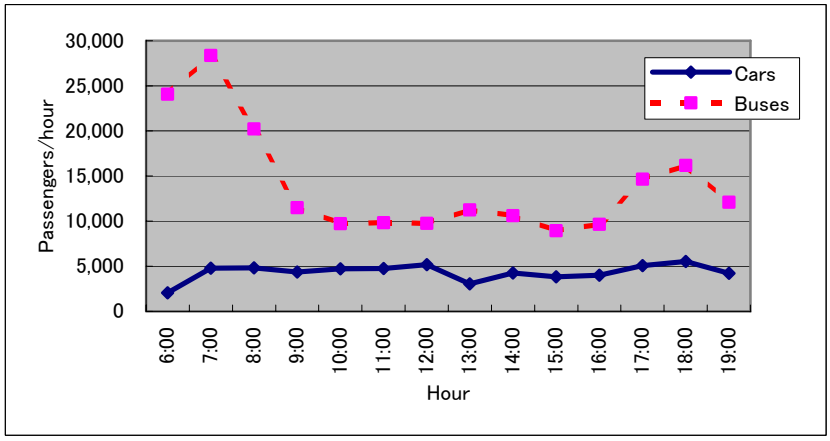

Figure 4.1-11 Hourly Passenger Volume by Mode on Screen Line-2 (Inbound)

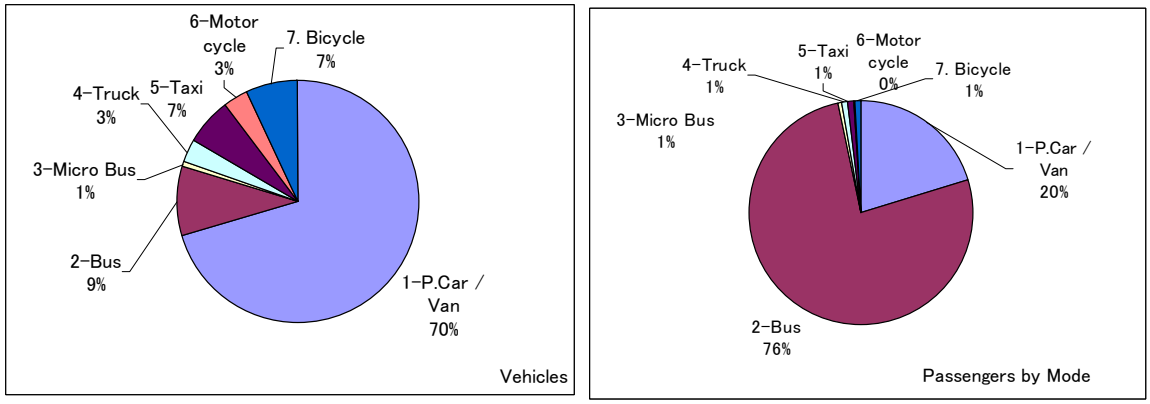

Figure 4.1-12 Vehicle Composition and Passengers by Mode at Peak Hour on Screen Line-1 (Inbound)

4.1.2. TRAFFIC VOLUME ON MAJOR ROADS

Traffic volume was counted to collect and update the traffic data relevant to the target projects. Traffic volume was counted at five major roadside locations and 10 major intersections. Figure 4.1-1 shows the survey locations. The traffic volume was counted using the same methodology as the screen line survey in which vehicles, classified into seven vehicular types, and passengers on board are counted. Intersection traffic volume was counted with vehicles classified into four types as shown below. The counting period was 14 hours between 6:00 a.m. and 8:00 p.m.

1) Passenger car
2) Microbus
3) Bus (regular size)
4) Truck

(1) Traffic Volume on Major Roads

Table 4.1-3 shows daily traffic volumes on major roads by major corridors such as (1) Av. Almirante Barroso-BR-316 (to Ananindeua and Benevides), (2) Rod. Augusto Montenegro (to Icoaraci), (3) Estr. do Tapana (to Icoaraci), (4) Av. Pedro Alvares Cabral and Rod. Arthur Bernardes (inside of Centro). This figure contains traffic volume data observed on the screen lines.

In the BMA, the directions of major traffic flows are on two corridors: (1) Av. Almirante Barroso-BR-316 (to Ananindeua and Benevides), (2) Rod. Augusto Montenegro (to Icoaraci). The heaviest traffic volume is recorded on Av. Almirante Barroso (location No.10). Its daily volumes are approximately 95,600 veh/day in both directions, exclusive of bicycles. Figure 4.1-13 shows hourly fluctuation of traffic volume on Av. Almirante Barroso. In the inbound direction, the peak period occurs from 7:00 a.m. to 8:00 a.m. The peak hour ratio is 9.9% of the daily traffic and its proportion of traffic in the direction is 58% of dual-way traffic (see Table 4.1-4). This peak ratio shows typical urban traffic characteristics. The bus traffic volume and passenger volume at the morning peak period in the inbound are approximately 600 veh/hr/direction and 43,000 passengers/hr/direction (see Table 4.1-5). It shows that those volumes are close to the limit of road capacity.

The traffic volumes on BR-316 are approximately 43,000 to 49,000 veh/day. Those figures decrease with distance from Centro. Ratios of daytime traffic (daily traffic/daytime traffic volumes) on Av. Almirante Barroso and BR-316 are 1.32-1.38 , which shows typical urban traffic characteristics. Bus volumes on this corridor are higher than on others. The bus share is approximately 14%. This corridor is important in transporting bus passengers.

Rod. Augusto Montenegro also carries heavy traffic (25,000 and 41,000 veh/day in both directions). The figures also decrease with distance from Centro. The share of bus volume on the road is also higher (12%) and the road is also important for public transport. Figure 4.1-14 shows hourly fluctuation of traffic volume on Rod. Augusto Montenegro. In the inbound direction, the peak period occurs from 7:00 a.m. to 8:00 a.m. The peak hour ratio is 7.7%-9.4% of the daily traffic and its proportion of traffic in the direction is 58%-66% of dual-way traffic (see Table 4.1-4). The bus passengers in the peak hour are approximately 21,000 passengers/hr/dir (see Table 4.1-5). This figure is also higher.

As for other major roads, Av. Pedro Alvares Cabral carries heavy traffic (41,000 veh/day). The bus passengers in the peak hour are approximately 11,000 passengers/hr/dir (see Table 4.1-5). The passenger volume is somewhat lower than that on Av. Almirante Barroso and Rod. Augusto Montenegro.

Table 4.1-3 Daily Traffic Volumes on Major Roads

Name	Location Number	Direction	P.Car / Van/Taxi	Bus/Micro Bus	Truck/Others	Bicycles	Total	Ratio of Daytime Traffic
BR-316	1	Inbound	12,970	2,851	4,421	2,855	23,097	
		Outbound	14,890	3,143	4,900	1,715	24,649	1.32
BR-316	3	Inbound	18,230	3,387	5,223	1,625	28,465	
		Outbound	14,317	3,231	4,907	1,237	23,692	1.33
Av. Almirante Barroso	10	Inbound	32,339	7,252	3,590	1,480	44,661	
		Outbound	40,049	8,043	4,344	1,442	53,878	1.38
Vehicle Composition		Inbound	0.66	0.14	0.14	0.06	1.00	
		Outbound	0.68	0.14	0.14	0.04	1.00	
Augusto Montenegro	6	Inbound	15,276	3,438	2,360	3,754	24,828	
		Outbound	13,889	3,352	2,667	3,669	23,576	1.35
	7	Inbound	9,289	1,285	2,238	1,691	14,503	
		Outbound	9,380	1,286	2,150	1,448	14,264	1.33
Vehicle Composition		Inbound	0.62	0.12	0.12	0.14	1.00	
		Outbound	0.61	0.12	0.13	0.14	1.00	
Rod Do Tapana	8	Inbound	1,980	358	624	1,176	4,138	
		Outbound	2,018	353	603	1,436	4,410	1.35
Vehicle Composition		Inbound	0.48	0.09	0.15	0.28	1.00	
		Outbound	0.46	0.08	0.14	0.33	1.00	
Av. Pedro Cabral	11	Inbound	19,052	2,340	2,419	664	24,475	
		Outbound	13,613	2,265	1,723	646	18,247	1.36
Rod. Arthur Bemades	12	Inbound	5,110	633	970	881	7,594	
		Outbound	3,834	637	759	577	5,807	1.33
Vehicle Composition		Inbound	0.75	0.09	0.11	0.05	1.00	
		Outbound	0.73	0.12	0.10	0.05	1.00	

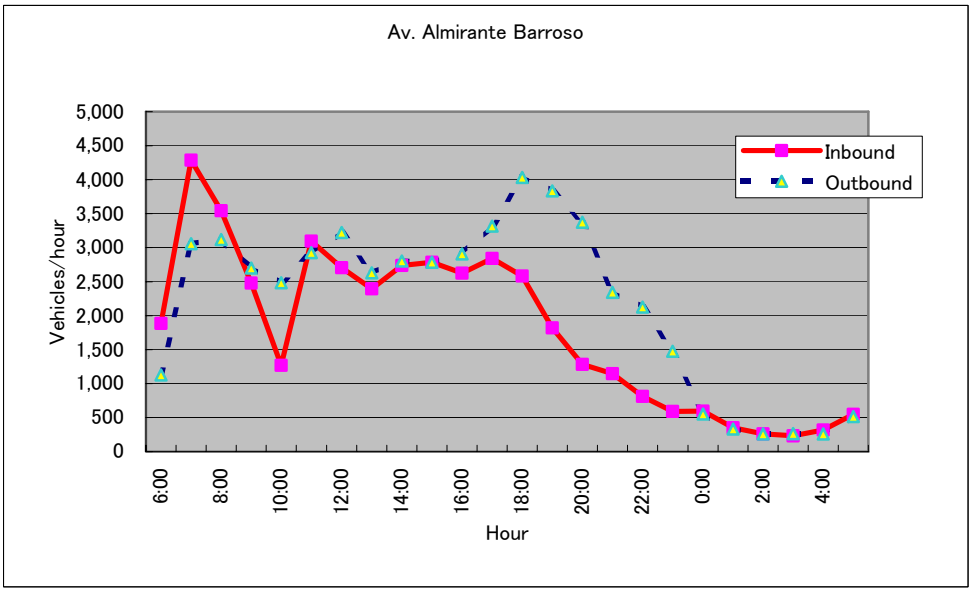

Figure 4.1-13 Hourly Traffic Volume on Av. Almirante Barroso

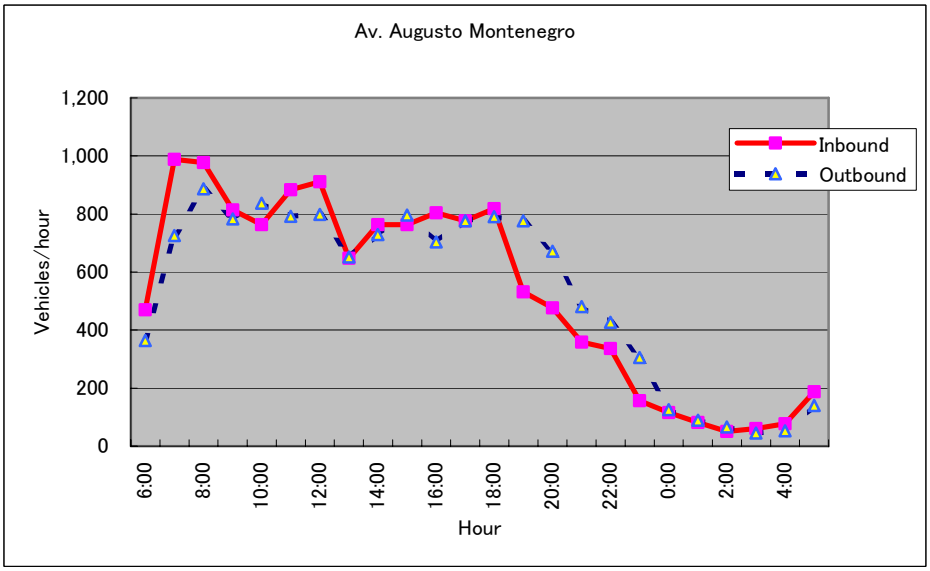

Figure 4.1-14 Hourly Traffic Volume on Rod. Augusto Montenegro

Table 4.1-4 Traffic Volumes at Peak Period on Major Roads (Inbound)

Name	Location Number	Peak Hour	P.Car / Van/Taxi	Bus/Micro Bus	Truck/Others	Total	Peak Ratio	Proportion of Peak-hour Traffic in the Direction
BR-316	1	7:00-8:00	675	178	325	1,178	5.8%	0.52
BR-316	3	7:00-8:00	1,122	219	411	1,752	6.5%	0.50
Av. Almirante Barroso	10	7:00-8:00	3,397	613	280	4,290	9.9%	0.58
Augusto Montenegro	6	7:00-8:00	1,480	285	208	1,973	9.4%	0.66
	7	7:00-8:00	757	86	145	988	7.7%	0.58
Rod Do Tapana	8	7:00-8:00	153	22	39	214	7.2%	0.57
Av. Pedro Cabral	11	7:00-8:00	2,194	161	160	2,515	10.6%	0.75
Rod. Arthur Bemades	12	7:00-8:00	702	49	58	809	12.1%	0.73

Table 4.1-5 Passenger Volumes at Peak Period on Major Roads (Inbound)

Name	Location Number	Peak Hour	P.Car / Van/Taxi	Bus/Micro Bus	Truck/Others	Total
BR-316	1	7:00-8:00	1,243	9,363	569	11,175
BR-316	3	7:00-8:00	2,322	8,663	589	11,574
Av. Almirante Barroso	10	7:00-8:00	6,922	43,072	410	50,404
Augusto Montenegro	6	7:00-8:00	4,115	20,705	355	25,175
	7	7:00-8:00	1,290	4,050	257	5,597
Rod Do Tapana	8	7:00-8:00	213	1,075	53	1,341
Av. Pedro Cabral	11	7:00-8:00	7,027	10,556	282	17,865
Rod. Arthur Bemades	12	7:00-8:00	1,410	2,296	82	3,788

(2) Traffic Volumes during the past ten years

PDTU1991 and PDTU2001 counted traffic volumes on major roads. This section 3.1.2 (2) compares them to traffic volumes during the past ten (10) years to see the increase of traffic volumes and use for road planning. Figure 4.1-15 and Table 4.1-6 show traffic volumes at seven (7) major locations during the past 10 years, which are shown in Figure 4.1-16, counted by PDTU1991, PDTU2001 and the study.

As can be seen, Av. Almirante Barroso (No. AV0446) and BR-316 (RO0380) shows the increase of traffic volume with constant ratio during the decade. On the other hand, the increase ratios of traffic volumes on Rod. Augusto Montenegro (RO0181 and RO0196) are rapid during the decade since 1990. However, after the year 2000, the ratios are as low as –13% to 8% per annum, in contrast to 10%-21% from 1990 to 2000.

Traffic volume on Av. Nazare fluctuates in a range of –3% per annum during the decade since 1990 and then of 30% per annum after 2000.

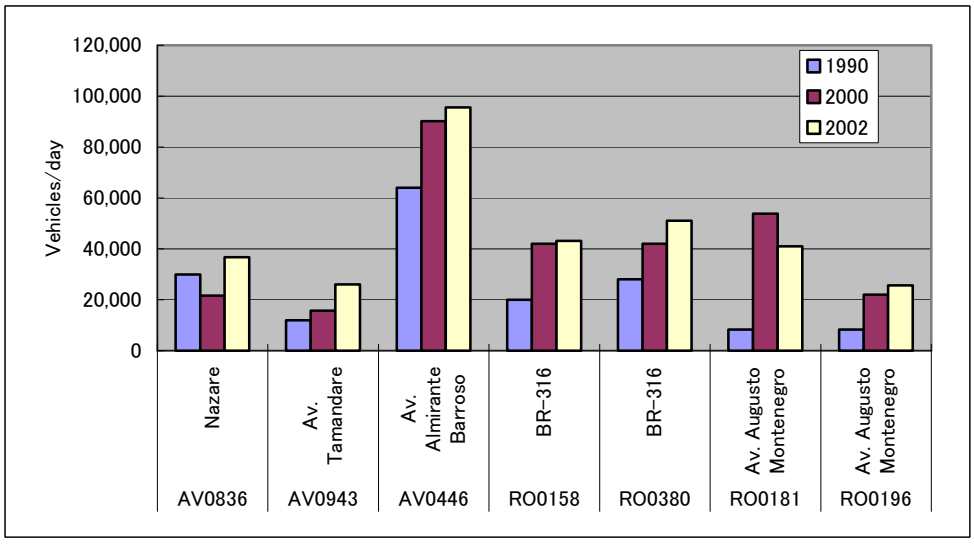

Figure 4.1-15 Traffic Volumes during the Past Ten Years on Major Roads

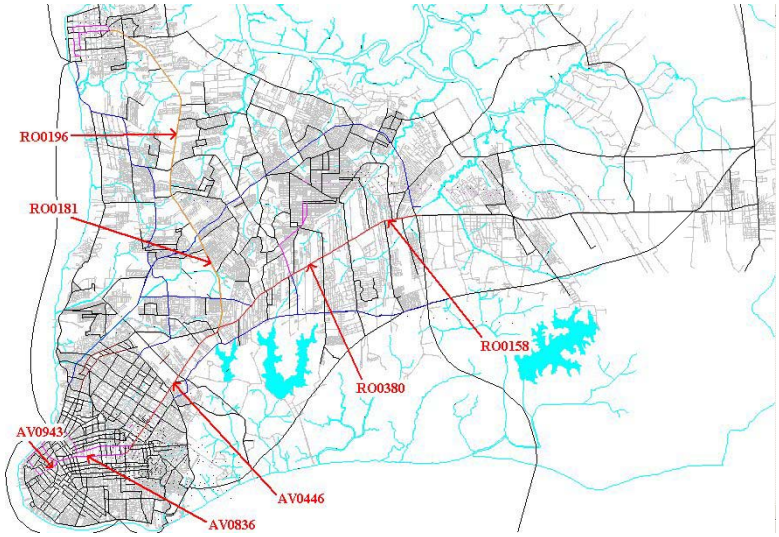

Figure 4.1-16 Locations of Traffic Counting

Table 4.1-6 Traffic Volumes during the Past Ten Years on Major Roads

Link No.	OneWay/ Dual	No. of Lanes	Road Name	1990	2000	2002	2000/1990	2002/2000
AV0836	One Way	3	Nazare	30,000	21,614	36,707	-3.2%	30.3%
AV0943	One Way	4	Av. Tamandare	12,000	15,778	26,030	2.8%	28.4%
AV0446	Both	5	Av. Almirante Barroso	64,000	90,159	95,617	3.5%	3.0%
RO0158	Both	5	Rod. BR-316	20,000	42,012	43,176	7.7%	1.4%
RO0380	Both	5	Rod. BR-316	28,000	42,012	51,091	4.1%	10.3%
RO0181	Both	4	Rod. Augusto Montenegro	8,300	53,875	40,981	20.6%	-12.8%
RO0196	Both	4	Rod. Augusto Montenegro	8,300	22,014	25,628	10.2%	7.9%

Figure 4.1-17 to Figure 4.1-19 show traffic volumes on major roads by traffic counting during the past 10 years. In those figures, the traffic volume on each road is drawn with a narrow band whose width is proportional to the counted traffic volume. When comparing the traffic volume in those figures, it can be understood that the traffic conditions become more severe year after year.

4.1.3. TRAFFIC VOLUME AT MAJOR INTERSECTIONS

The intersection traffic volume diagrams were drawn for the following typical intersections, which are shown in Figure 4.1-20. The figure shows the directional movement and its volume with arrow lines whose width is in proportion to traffic volume at the morning peak hour from 7:00 a.m. to 8:00 a.m.

1) Intersection No.1: Av. Nazare- President Vargas
2) Intersection No.6: Av. Nazare- 14 de Marco
3) Intersection No.8: Av. Almirante Barroso- Av. Ceara and Av. Governador Jose Malcher
4) Intersection No.9: Rod. Arthur Bernardes- Av. Pedro Alvares Cabral

At the intersection No.1, the main traffic flow in the morning peak hour is a stream of vehicles coming from Rua. Gama Abreu to Av. Nazare. Its figure is 1101 veh/hr. The traffic flow from Av. Presidente Vargus to Av. Serzedelo Correa, which crosses Av. Nazare is minor (494 veh/hr).

At the intersection No.6, the main flow is from Av. Nazare to Av. Magalhaes Barata. Traffic volume is predominant at this intersection. The two main flows on Av. Almirante Barroso are predominant at the intersection No. 8: one is in the outbound direction (1,546 veh/hr) and the other is in the inbound direction turning toward Av. Governador Jose Malcher (1,070 veh/hr).

The intersection No.9 shows three main traffic flows related to Av. Pedro Alvares Cabral, which are (1) inbound traffic flow on Av. Pedro Alvares Cabral (1,165 veh/hr), (2) outbound traffic flow on Av. Pedro Alvares Cabral (388 veh/hr), and (3) inbound traffic flow merging from Rod. Arthur Bernardes to Av. Pedro Alvares Cabral (463 veh/hr). In the morning peak, approximately 1,600 veh/hr flow on Av. Pedro Alvares in the direction of the Centro.

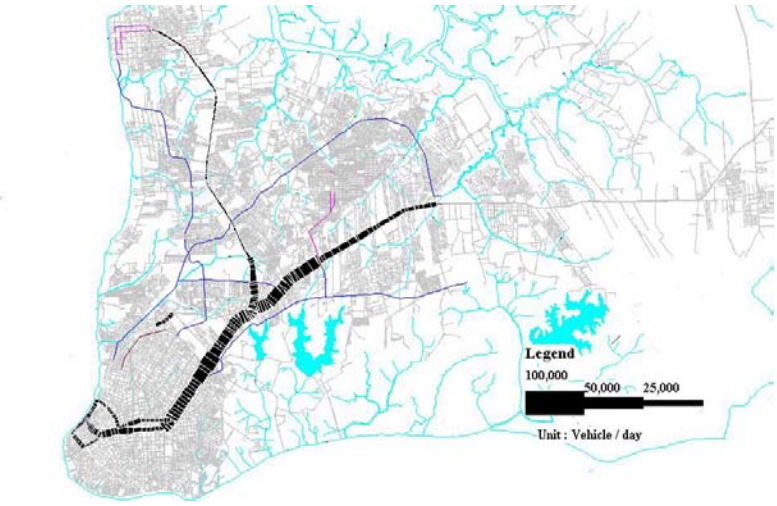

Figure 4.1-17 Traffic Volume on Major Roads by Traffic Count in 1990 (All vehicles/ day)

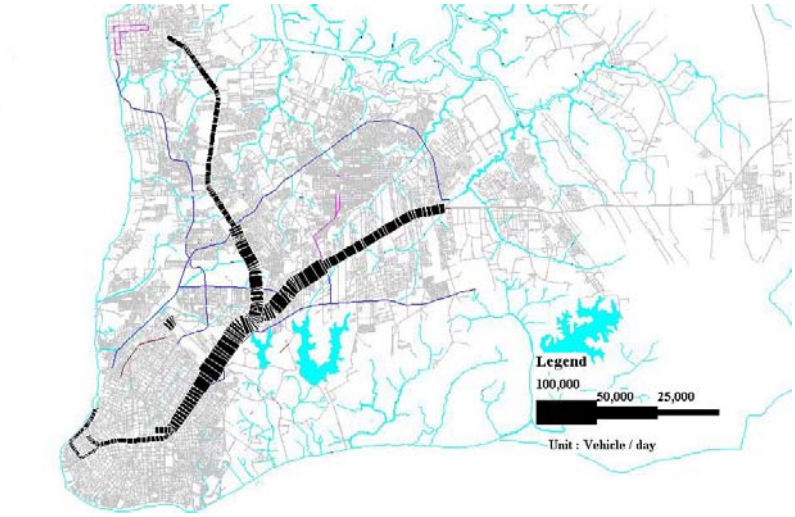

Figure 4.1-18 Traffic Volume on Major Roads by Traffic Count in 2000 (All vehicles/ day)

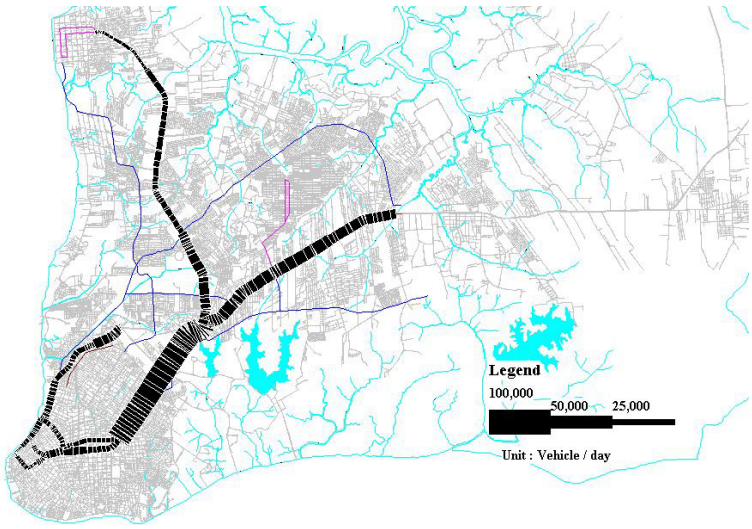

Figure 4.1-19 Traffic Volume on Major Roads by Traffic Count in 2002 (All vehicles/ day)

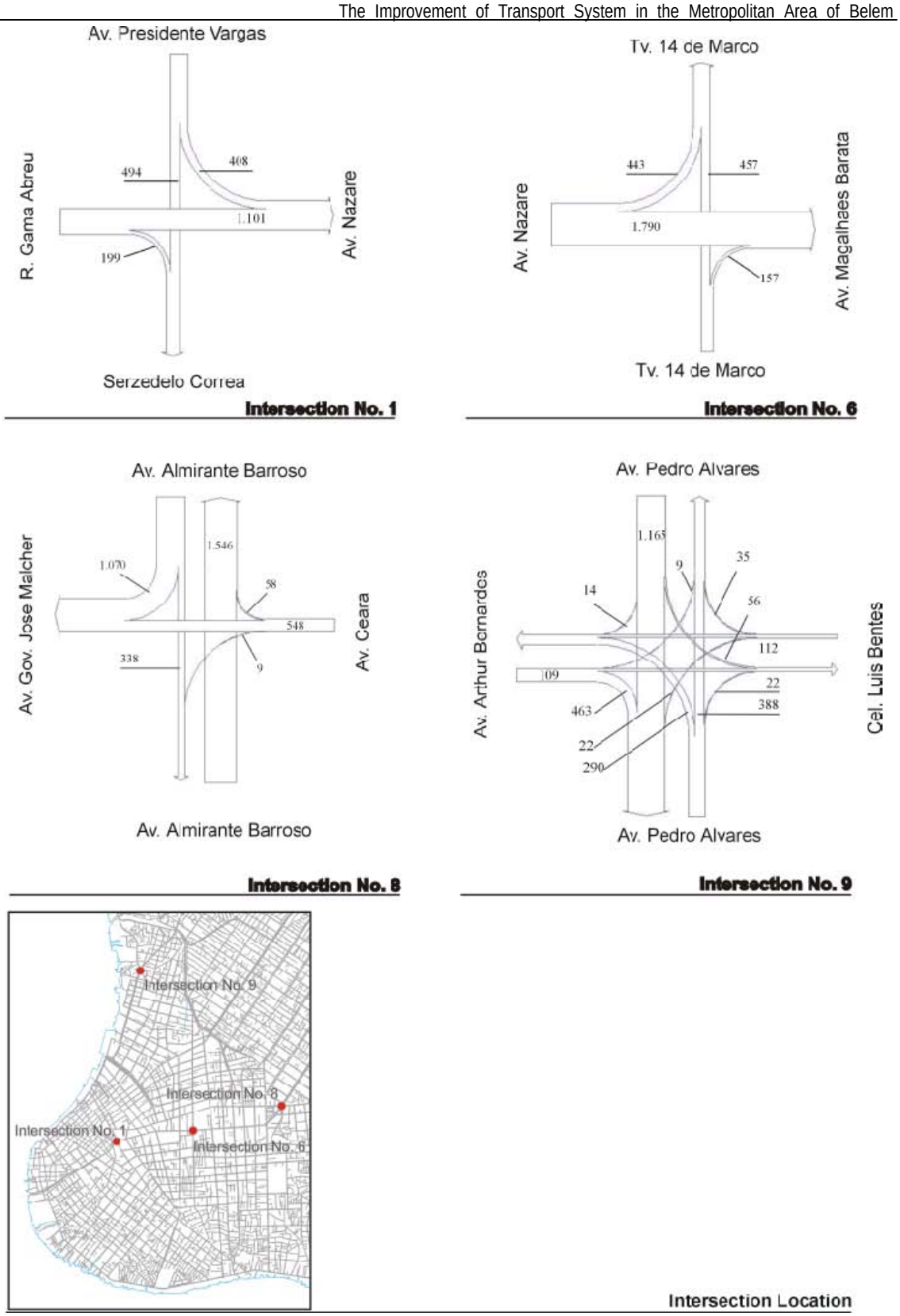

Figure 4.1-20 Intersection Traffic Volume Diagram at Morning Peak Hour (7:00-8:00)

4.2. TRIP CHARACTERISTICS

Two transport master plans, PDTU1991 and PDTU2001, have studied the Belem Metropolitan Area (BMA). PDTU2001 estimated the present OD trip tables from the data obtained by the Person Trip Survey on approximately 7,000 families (about a 2% sampling) and forecast the future travel demand. This study updated the OD trip tables to 2002 OD tables, using data from the Screen Line Survey that was carried out in the study. The trip characteristics during the decade since 1990 were analyzed in terms of total trips in the study area, trip generation/attraction, and trip distribution.

4.2.1. UPDATE OF 2002 OD TRIPS

The 2000 Person Trip data from interviews in PDTU2001 was updated based on traffic volumes and passenger volumes passing through on two (2) screen lines. To update the 2000 OD trips, the 2000 OD trips supposed to cross the screen lines were compared to the passenger volume by mode counted in 2002 on the lines. The 2002 trip OD tables by mode adjusted the 2000 trip data to the 2002 passenger volumes on the screen lines.

Table 4.2-1 shows the updated trip OD tables in 2002 by mode in the table's row No. (2): Updated 2002 Trip OD Tables. As can be seen, the average increase ratios of passenger volumes per annum from 1990 to 2002 on the updated 2002 OD trips are 2.2% for all modes, 7.5% for the passenger cars and 0.8% for the buses. Those trips by mode show increase ratios similar to those in screen line-1. This is because the 2002 trip OD tables adjust to the 2002 passenger volumes on the screen lines. Total trips in the BMA are estimated at approximately 3.8 million trips.

In Table 4.2-1, trip OD tables in 2000 per day are not shown because those tables are not estimated in PDTU2001.

Types of Vehicles	1990 (PDTU1990)	2002 (F/S Study)	2002/1990 per Year
(1) Screen Line-1 (Counting)			
All Modes	709,467	919,368	2.2%
Passenger Car	114,059	239,501	6.4%
Bus	544,665	629,090	1.2%
(2) Updated 2002 Trip OD Table			
All Modes	2,888,003	3,765,799	2.2%
P. Car	366,190	876,514	7.5%
Bus	1,544,975	1,700,332	0.8%

Table 4.2-1 2002 OD Trips by Mode (trips /day)

4.2.2. TOTAL NUMBER OF TRIPS

Table 4.2-2 shows trips, population and motorized households in the years 1990 and 2002 in the study area. The increase ratio of motorized households, which own a passenger car, during the decade is higher than that in population. The increase ratio of passenger car trips is approximately 7.5% per annum. This figure shows the higher ratio, compared to the figures estimated in PDTU1991. During the decade, bus trips are almost same volume.

Table 4.2-2 Trips, Population and Motorized Households in 1990 and 2002 in the Study Area

Item	1990	2002	2002/1990 Ratio	2002/1990 /year
Population	1,419,224	1,782,394	1.26	2.3%
Motorized Households	56,044	78,029	1.39	3.4%
All Trip Modes	2,888,003	3,765,799	1.30	2.2%
Passenger Cars	366,190	876,514	2.39	7.5%
Buses	1,544,975	1,700,332	1.10	0.8%

Note: Figures in the column of population and motorized households in 2002 are for 2000.

4.2.3. TRIP GENERATION AND ATTRACTION

Estimated trip generation and attraction in the year 2002 according to the integrated zone are shown in Figure 4.2-1 for passenger cars and Figure 4.2-2 for buses, which show a comparison between the figures in 1990 and 2002. As can be seen, the increase ratios of trip generation and attraction for passenger cars in the Centro area are considerably higher (1.7-2.3), while in suburban area (Icoaraci and Ananindeua) they are somewhat lower (see Figure 4.2-1).

As seen in the trip generation and attraction of the bus mode in 1990 and 2002, the increase ratios in suburban areas are higher than those in the Centro area. Its figures are approximately 1.2-1.8, in contrast to 0.9–1.1 in the Centro area.

4.2.4. TRIP DISTRIBUTION

Figure 4.2-3 and Figure 4.2-4 illustrate the desire lines by passenger car for inter-zonal trips in 1990 and 2002. In 2002, the desire lines by car strongly cover entire Central area and also invade into Zones No. 8 (Guanabara), No.9 (Bengui) and No.12 (Cidade Nova), while in 1990 they cover only the area within the Central area with narrow desire lines.

On the other hand, the bus mode in 1990 links the Central area and surrounding residential areas with strong desire lines and those characteristics of the desire lines in 2002 are similar to those in 1990 (see Figure 4.2-5 and Figure 4.2-6).

The desire lines by car and bus are different in the covered area. The strong desire lines by bus mode cover the whole study area, while the car desire lines cover within the Central area with strong lines.

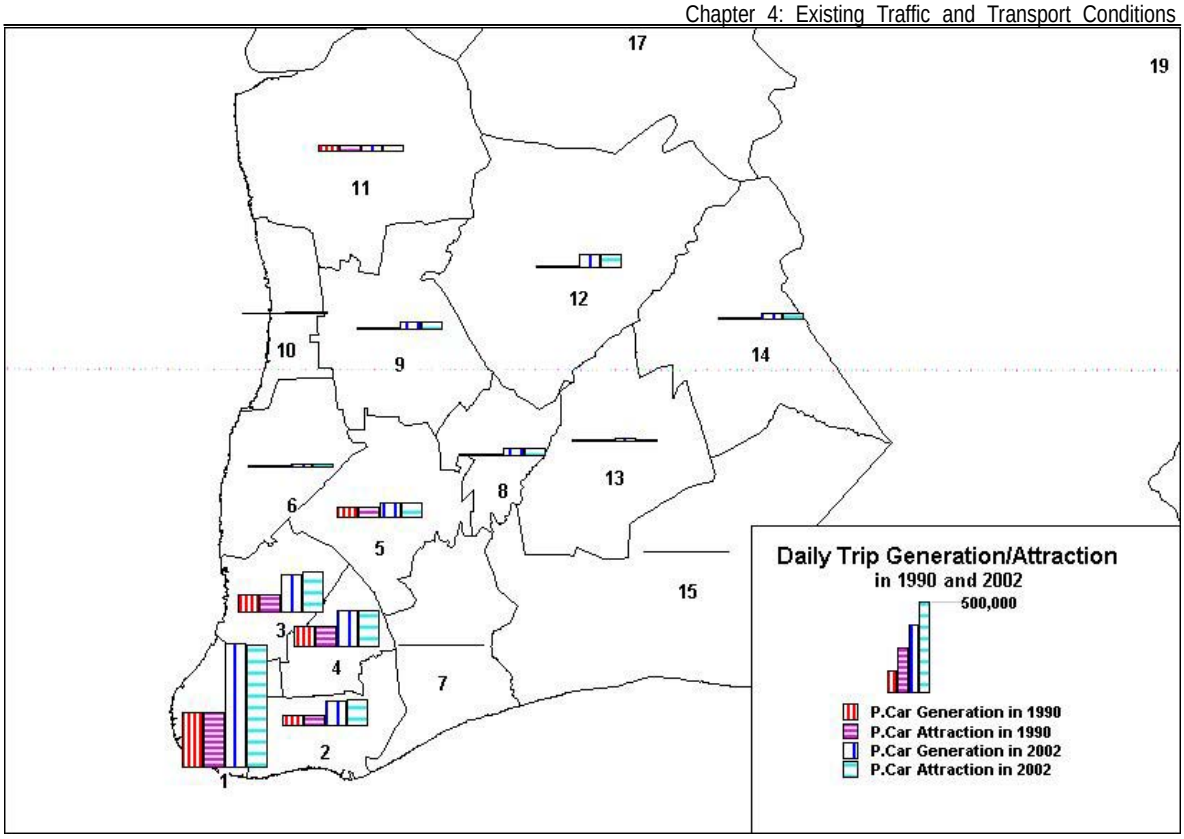

Figure 4.2-1 Trip Generation and Attraction in 1990 and 2002 by Passenger Car

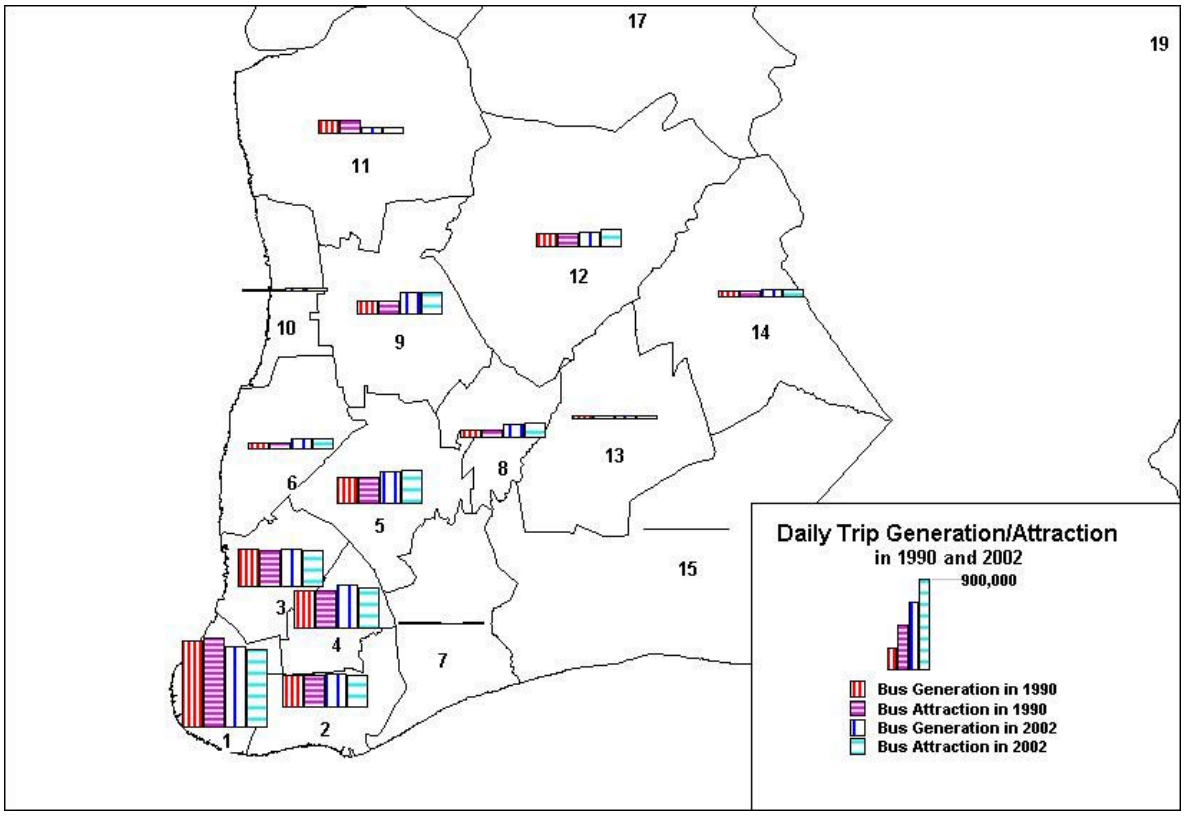

Figure 4.2-2 Trip Generation and Attraction in 1990 and 2002 by Bus

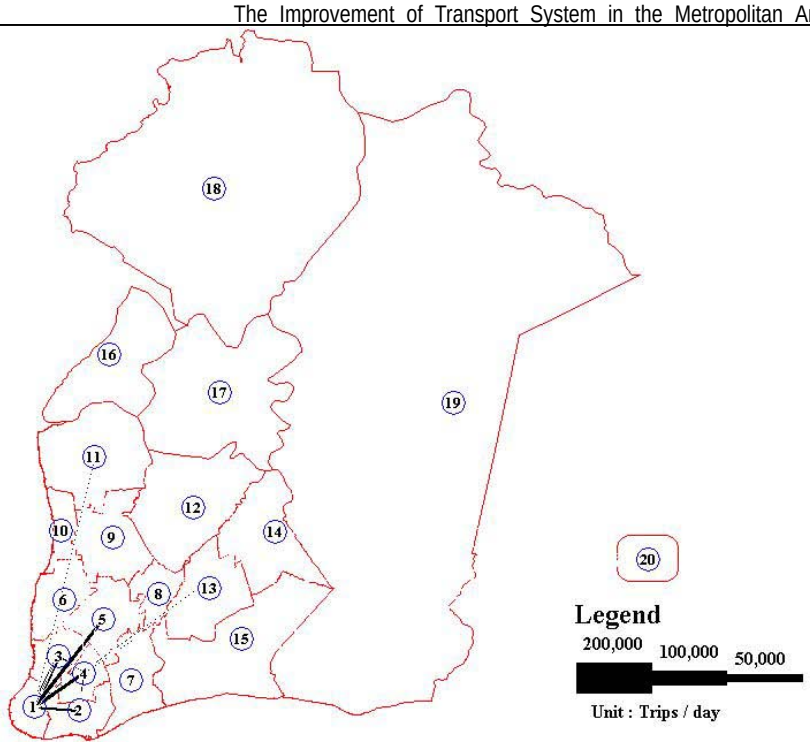

Figure 4.2-3 Trip Desire Lines in 1990 by Car

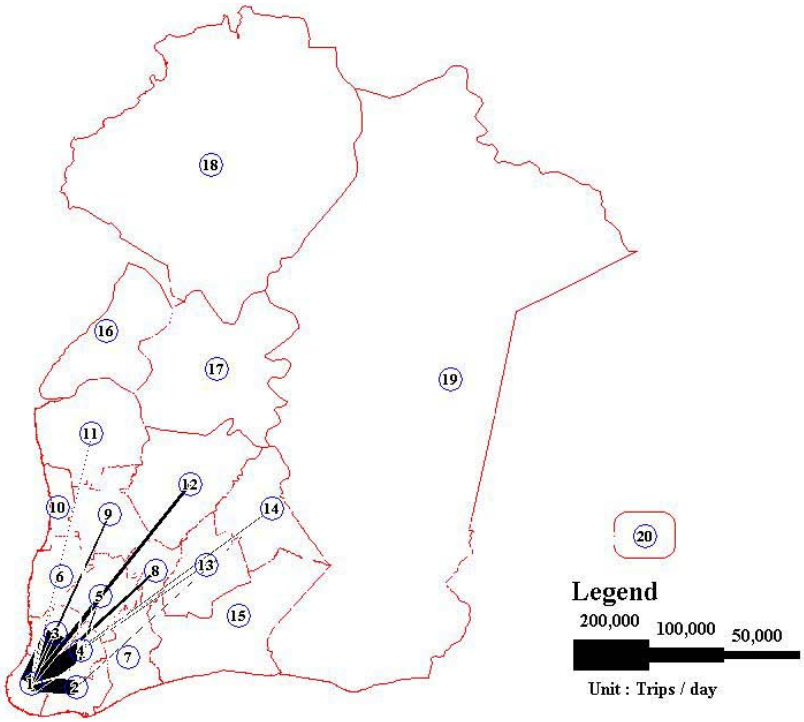

Figure 4.2-4 Trip Desire Lines in 2002 by Car

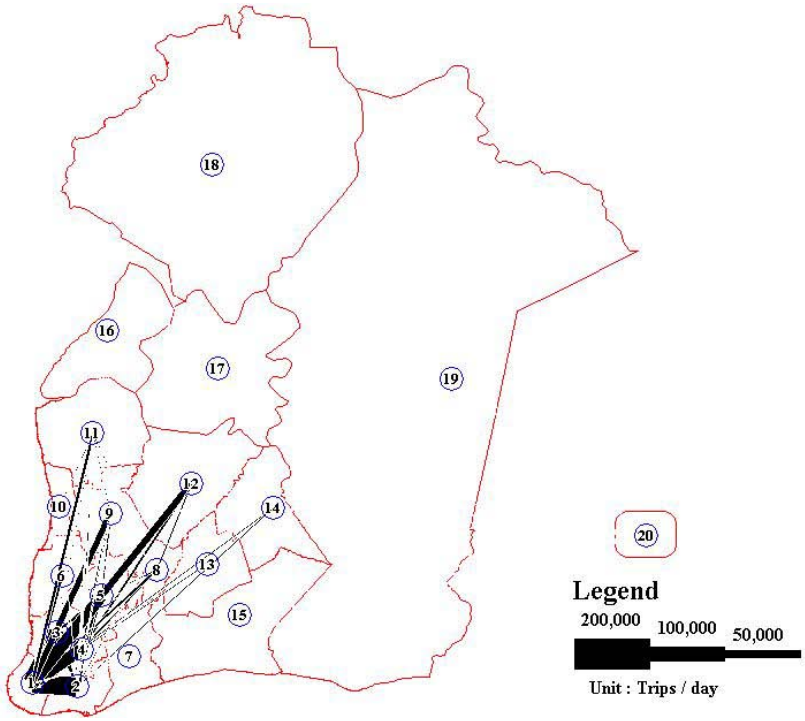

Figure 4.2-5 Trip Desire Lines in 1990 by Bus

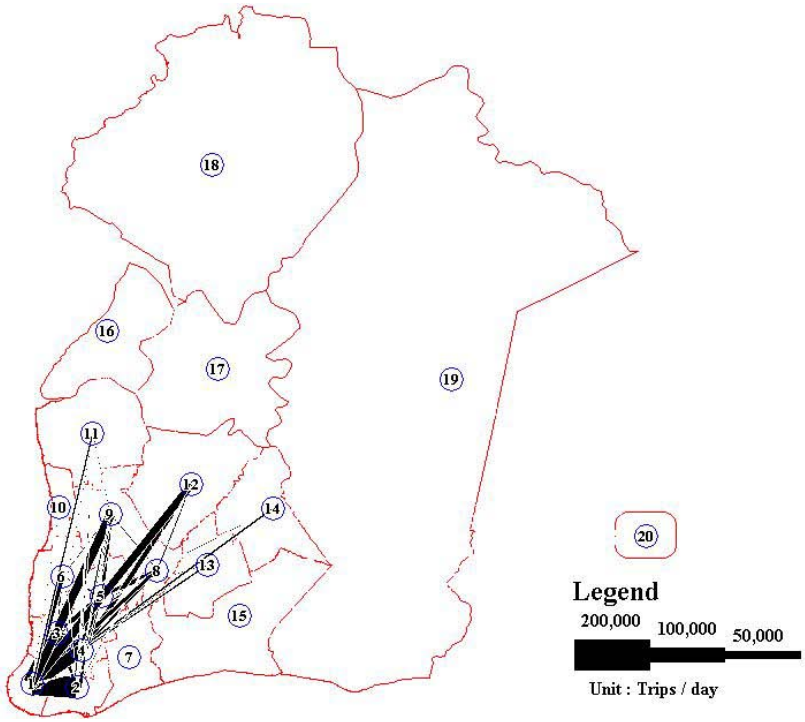

Figure 4.2-6 Trip Desire Lines in 2002 by Bus

4.3. PEAK HOUR TRIP CHARACTERISTICS

4.3.1. PROCEDURE

The estimation of the trunk bus system is based on the travel demand in the peak hour. The bus operation plan such as bus service frequency on bus routes, bus fleet operational needs, busway lanes, bus stop facilities, etc. is conducted on the basis of demand in the peak hour, exclusive of economic evaluation of the daily base demand.

Therefore, the peak hour OD trip table is estimated based on the Person Trip survey data, which has departure and arrival time in each trip data. The peak hour trips are for a period of 7:00 a.m. to 8:00 a.m. in the morning. Only trip data of travel during the peak hours are selected from Trip Master data and the peak hour OD trip table is made from these trip data. The OD trips are finally adjusted to the traffic volume in the same peak hour on the screen lines. The peak hour OD trips are estimated on the unit of person trip by mode.

4.3.2. NUMBER OF TRIPS AT PEAK HOUR

The total number of person trips exclusive of walking, bicycle and motorcycle modes in the morning peak hour in the study area in 2002 is forecast at 410,000. The peak hour trip ratio is 15.6%. A summary of travel demand is shown in Table 4.3-1. As for the trips by mode, private and public modes, and numbers of trips by mode (private and public) in the year 2002 are 298,000 for public mode and 113,000 for private. Ratios of peak hour trips to daily trips by mode are 17.5% for public mode and 12.2% for private, respectively.

As for the composition of trip modes, the share of public transport is approximately 73% in the morning peak hour, in contrast to 65% for daily unit. In the peak hour, the ratio of public transport is higher than that of daily trips.

Table 4.3-1 Travel Demand in Peak Hour in 2002

Types	Peak Period	Day	Peak Ratio
Private	112,668	924,719	12.2%
Public	297,825	1,700,332	17.5%
Total	410,493	2,625,051	15.6%
Private	27.4%	35.2%	
Public	72.6%	64.8%	
Total	100.0%	100.0%	

4.3.3. TRIP GENERATION AND ATTRACTION AT PEAK HOUR

Figure 4.3-1 and Figure 4.3-2 show the trip generation and attraction in the morning peak hour in 2002 by public and private mode, respectively. The trip generation and attraction are considerably different in trip volume. The trip attraction by public and private mode in the central commercial areas—Zone No. 1—is dramatically higher than the generation in the same zones, while other zones surrounding those zones—residential areas—show that the trip generation is considerably higher than the attraction. The trip ratios of attraction to generation in Zone No. 1 by the private and public modes are approximately 2.1 and 4.4 times in the morning peak. This indicates that almost all the passengers concentrate into the central commercial areas, by means of public transportation and private vehicles.

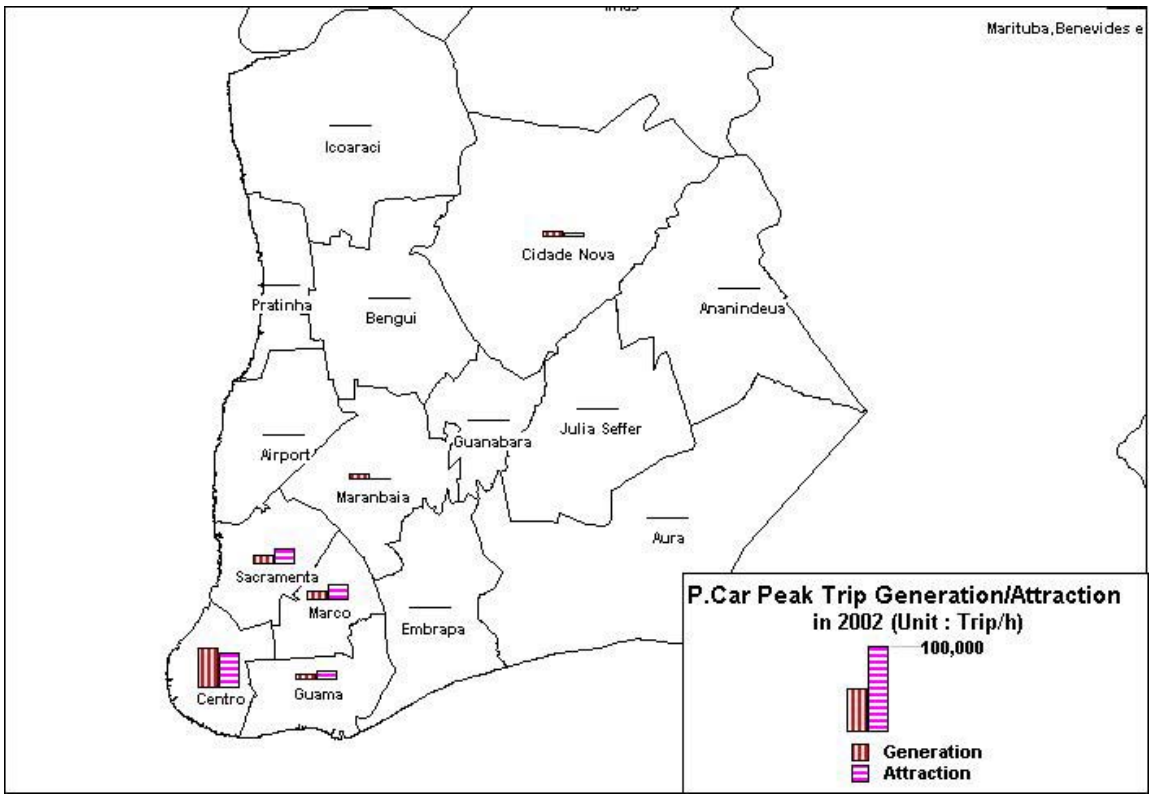

Figure 4.3-1 Peak Hour Trip Generation and Attraction by Private Mode in 2002

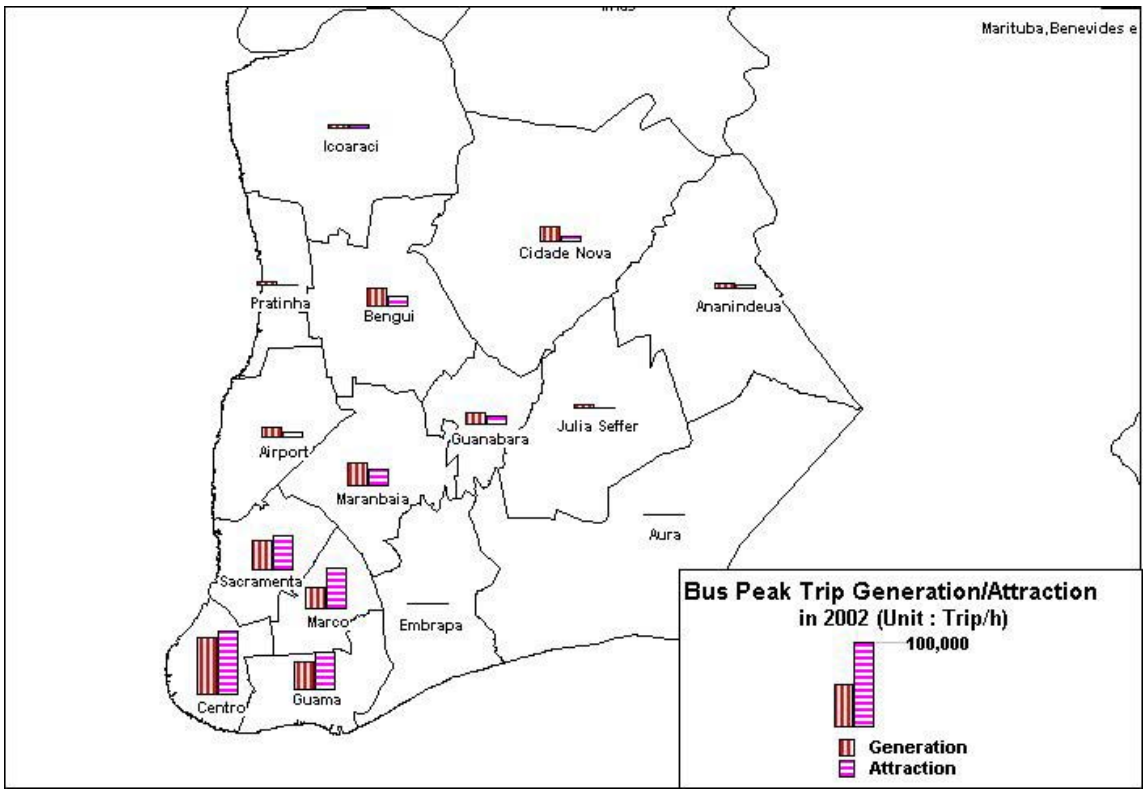

Figure 4.3-2 Peak Hour Trip Generation and Attraction by Public Mode in 2002

4.3.4. TRIP DISTRIBUTION AT PEAK HOUR

Trip distributions in the morning peak hour in 2002 by the public and private modes are shown in Figure 4.3-3 and Figure 4.3-4 by desire line charts. In these figures, the directional movements to the zone block where trip attraction is predominant—Zone No. 1—from the others surrounding that zone block—mainly residential areas—are shown according to the characteristics of the trip generation and attraction. The width is proportional to the number of trips between zone blocks.

As can be seen in those figures, large inbound movements by the public and private modes from every residential area located in suburban areas to the central commercial areas can be seen in the morning peak hour. This indicates that people living in surrounding areas travel into the central areas by means of private vehicles and commuter buses.

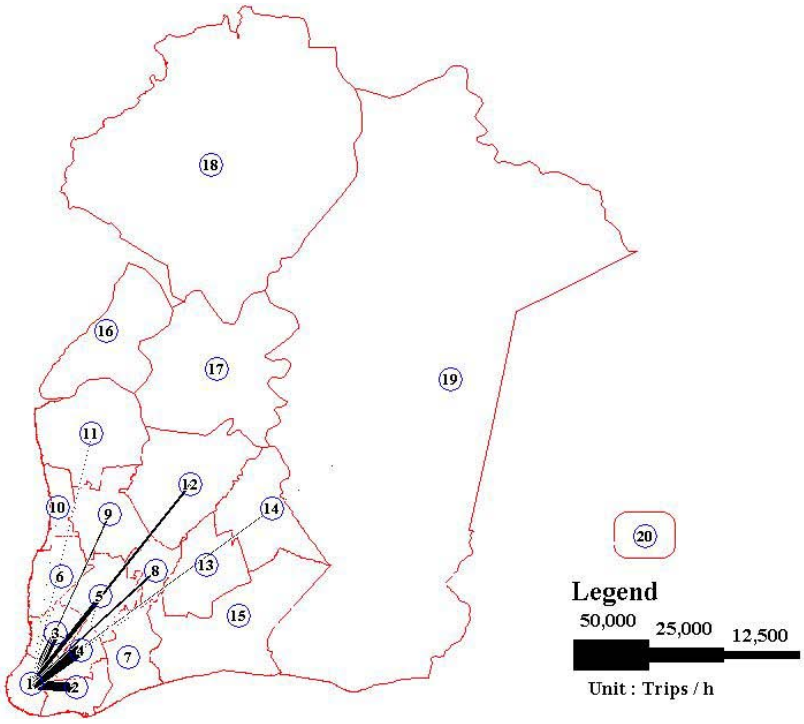

Figure 4.3-3 Peak Hour Trip Desire Lines by Private Mode in 2002

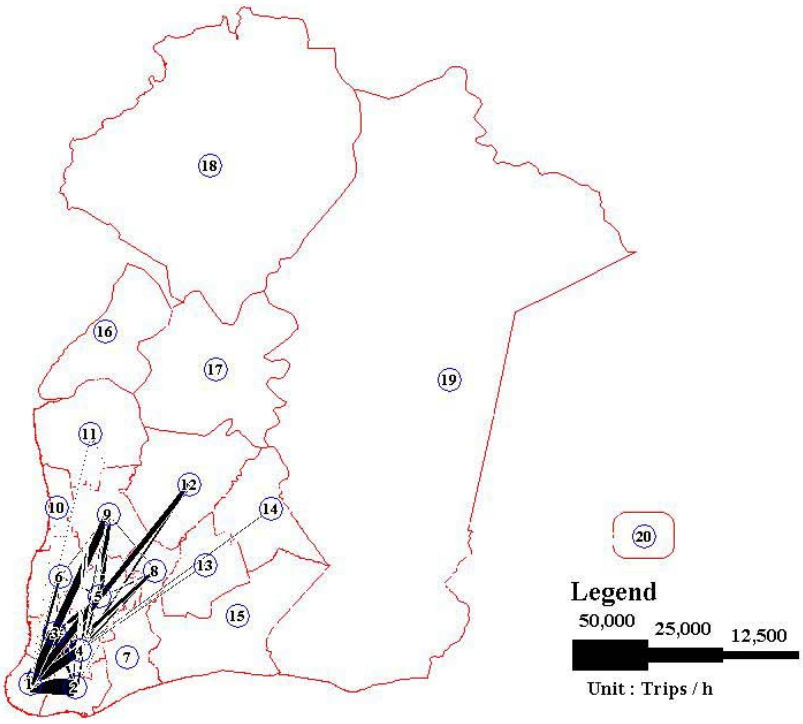

Figure 4.3-4 Peak Hour Trip Desire Lines by Public Mode in 2002

CHAPTER 5
Traffic Management Conditions

5. TRAFFIC MANAGEMENT CONDITIONS

5.1. PURPOSE OF THE STUDY

The purpose of this study is to allow smooth, efficient and safe operation of public transport, especially the bus system from the viewpoint of traffic management. Working toward this purpose, the current situation of traffic management and traffic safety is analyzed and discussed in this chapter.

5.2. PRESENT TRAFFIC MANAGEMENT CONDITIONS

5.2.1. HOW TO PROCEED WITH THE ANALYSIS OF PRESENT TRAFFIC MANAGEMENT CONDITIONS

Based on zoning, which considers land use, major facilities and traffic characteristics such as traffic volume and road conditions along public transport corridors, problems and issues concerning the traffic management are analyzed.

Zoning (area/corridor) is summarized below and is illustrated in Figure 5.2-1.

- Belem Central Area (Primeira Légua Patrimonial): Surrounding the Av. Gov. Jose Malcher-Av. Magalhaes Barata/Nazare corridor
- Icoaraci Area: Surrounded area along Trav. Cristovao Colombo -Rua Manoel Barata corridor
- Av. Almirante Barroso/BR-316 Corridor: Between Sao Braz terminal and Marituba terminal including Avenida Mario Covas and Cidade Nova terminal
- Rodovia Augusto Montenegro Corridor: Between Entroncamento and the entrance of Icoaraci

5.2.2. PRESENT TRAFFIC MANAGEMENT CONDITIONS

Based on the above procedure, major findings are as follows, and the outline of area/corridor and identified problems are summarized in Table 5.2-1.

- The Belem Central Area has a dense road network with narrow streets. This is the result of the development in Belem that preserves the historical buildings and facilities. The road system is relatively well managed, using the one-way system as shown in Figure 5.2-2. The on-street parking must be controlled.
- The Icoaraci Area is developed as the resort beach town for Belem citizens. A well-maintained residential area with a small town center occupies most of the area. Bicycle traffic in the town is heavy.
- Avenida Almirante Barroso/BR-316 Corridor is the busiest transport corridor including interstate through-traffic.
- Rodovia Augusto Montenegro Corridor is one of the most important transport corridors in the Municipality of Belem.

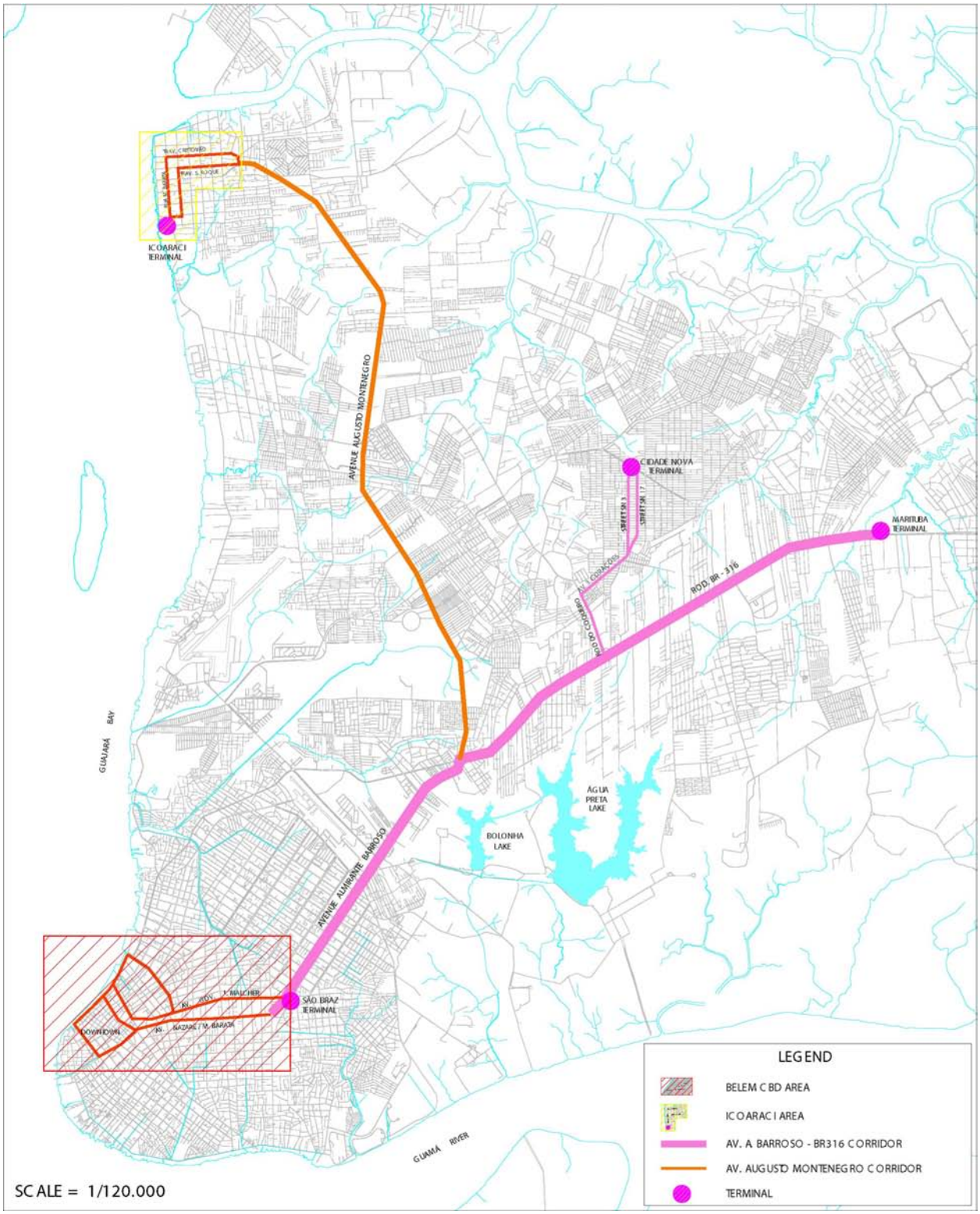

Figure 5.2-1 Location of the Study Area and Corridor of the Traffic Management Condition

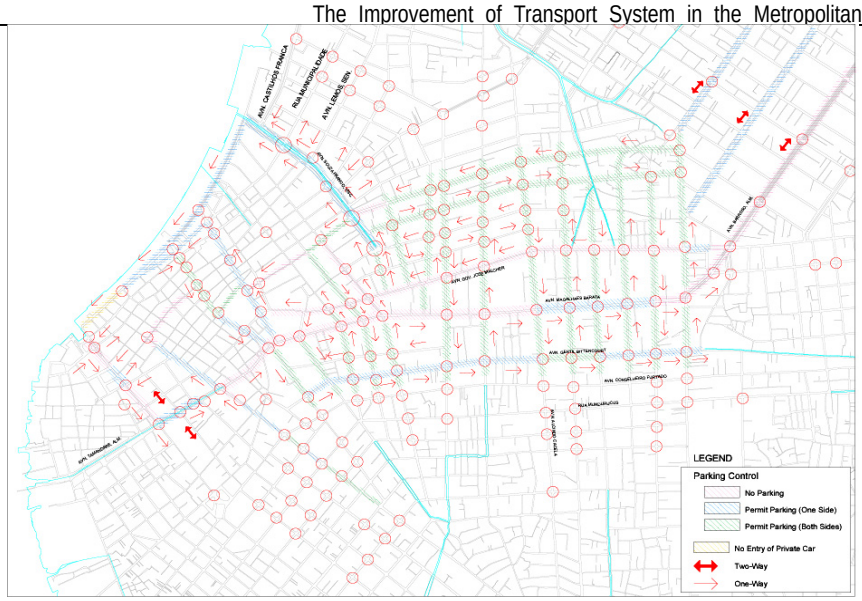

Figure 5.2-2 Existing Traffic Management System in the Belem CBD

Table 5.2-1 Identified Problems of Traffic Management in the Study Area

Items	Whole study area Belem, Ananindeua, Marituba, Benevides and Santa Barbara	Belem CBD Area surrounded of Av. Gov. Jose Malcher-Av. Nazare corridor	Icoaraci Area surrounded of Trav. Cristovao Colombo and Rua Manoel Barata	Av. Almirante Barroso/BR 316 Between Sao Braz terminal and Marituba terminal including Rod. Mario Covas (Rod. do Coqueiro) and Cidade Nova terminal		Rod. Augusto Montenegro Between Entroncamento and entrance of Icoaraci
				Av. Almirante Barroso	BR 316	
Outline of the zone/ corridor	・Center for urban activities, such as business and commerce in the northern region in Brasil and its surrounding area.	・Well-managed road utilization based on the one-way system because of historically developed narrow streets.	・Beach resort for Belem citizens with a small town center and well-maintained residential area.	・National trunk road connects Belem CBD, the other cities of the Belem Metropolitan Area, northern region of Para and Brasilia.		・Trunk road in the municipality of Belem connects the Belem CBD and Icoaraci and serves the suburban area in Belem.
Identified problems	Wh-1 Many bus passengers wait for the bus on the carriageway due to the occupation of the sidewalk by vendors and illegal on-street parking.	Be-1 Intersection between Av. Pres. Vargas and Av. Nazare/Av. Magalhas Barata is one of the busiest intersections in the CBD because many bus routes traverse the area.	Ic-1 Many on-road parking vehicles parked on the road at town center of Icoaraci along Trav. Cristovao Colombo interrupt through-traffic.	Ab-1 This road is most prone to traffic accidents because it is the busiest transport corridor in the study area, catering not only to private cars and commercial vehicles but also to public transport.	Br-1 Many pedestrians cross the heavy-traffic BR316 without using a pedestrian crossing/pedestrian overpass due to the long distance between pedestrian facilities.	Am-1 Even though there are three vehicle speed detectors, overspeeding is still rampant because of the road's straight alignment and few traffic signals. Therefore, this is one of the most accident-prone roads.
	Wh-2 The bus is the only public transport mode in the study area. However, no bus route information and three types of bus stop cause inconvenience to the bus users.	Be-2 Lane marking along Av. Nazare is unclear so that drivers totally ignore it. This causes the decrease of this road's capacity.	Ic-2 An on-road bus terminal in Icoaraci located at Rua Manoel Barata/Trav. Soledade interrupts the through traffic along Rua Manoel Barata.	Ab-2 The flyover exit at Av. Almirante Barroso from Av. Dr. Freitas is located middle of the carriageway. This could cause a serious accident.	Br-2 Many humps along Rod. Mario Covas (Rod. do Coqueiro) cause uncomfortable rides to the vehicle users and damage to the cargo carried by trucks.	Am-2 Many pedestrians cross the heavy traffic Av. A. Montenegro without using the pedestrian crossing due to the long distance between pedestrian facilities.
	Wh-3 Rough driving by bus drivers interrupts through-traffic along the trunk road in the study area, especially in the CBD.		Ic-3 Much bicycle traffic mixed with vehicular traffic especially along Trav. Cristovao Colombo.		Br-3 Cyclists use not only the sidewalk side but also the dangerous median side along BR 316.	Am-3 There are many median openings for U-turn traffic along this road with no accelerator lane.
	Wh-4 Despite the decrease of fatalities, the number of accidents and victims are increasing.				Br-4 There are many median openings for u-turn traffic along this road with no accelerator lane.	

Beautiful mango trees along Av. Pres. Vargas

Bus stop and shelter along Av. Gov. Jose Malcher

Rough driving of bus along Av. Magalhaes Barata

Town center along Trv. Cristovao Colombo in Icoaraci

Pedestrian crosses the busy BR-316 without pedestrian facilities.

Median side bike lane along Rod. Augusto Montenegro

Photo 5.2-1 Areas/Corridors and Identified Problems

5.3. TRAFFIC LAWS AND REGULATIONS

Law No. 9503 – September 23, 1997 and Law 9602 – January 21, 1998, established and implemented respectively as a new Brazilian traffic law. The Law No. 9503 is composed of 341 articles and cover such important items as the national traffic system, traffic education, traffic signage, vehicle registration, driver's licenses, traffic violations and traffic crimes, the pedestrian and drives and others.

The main purpose of the traffic law was to transfer the authority to the municipal agencies such as CTBel and DEMUTRAN in the Belém and Ananindeua municipalities, respectively. The revision contained stricter rules such as higher penalties for speeding and drunken driving, and seat belt requirements. Thus, the drastic decrease of the annual number of traffic accidents in 1998 was greatly attributed to these new measures.

5.4. ADMINISTRATION OF TRAFFIC MANAGEMENT

Basically, the transport related sections in municipalities are responsible for the administration of traffic management. For the municipalities of Belem and Ananindeua these are CTBel and DEMUTRAN, respectively. A part of the traffic management, such as the part of traffic safety education, is responsibility of all organizations including DETRAN in Para State, CTBel and DEMUTRAN in the Belém and Ananindeua municipality. The outline of these organizations is summarized below and the organizational charts are shown in Figure 5.4-1, Figure 5.4-2 and Figure 5.4-3. The outline of agencies that it is responsible for the maintenance and management of the traffic management facilities, among other things, is shown in Table 5.4-1.

DETRAN (Traffic Department of Para): is responsible for vehicle register and driver competences, statistics accidents and traffic safety education in Pará State. DETRAN belongs to the Special Secretariat of Social Defense of Para, which is one of seven special secretariats under the governor and vice governor. DETRAN is composed of eight units under the Superintendent Director, and under these units, 143 municipalities are divided into three areas for supervision. The total budget and number of staff of DETRAN in 2001 were 31,000,000 real and 695, respectively.

CTBel (Transport Company of Belem): CTBel is responsible for the traffic and the public transport system management in the Municipality of Belem. CTBel is one of 15 organizations under the mayor and vice mayor in the Municipality of Belem. Basically, CTBel is composed of five departments under the Fiscal and, the Administrative Council and the president. The total budget and number of staff of CTBel in 2001 were 4,015,000 real and 409, respectively.

DEMUTRAN (Municipal Department of Transport and Traffic of Ananindeua): is responsible for transport and traffic in Ananindeua under Infrastructure Secretary of Ananindeua. Five divisions comprise DEMUTRAN. DEMTRAN is also responsible for traffic management along BR-316 into Ananindeua under authority of DNIT, which is the National Department of Road Transport Infrastructure under the Ministry of Transport in the federal government. The number of staff in DEMUTRAN is 91.

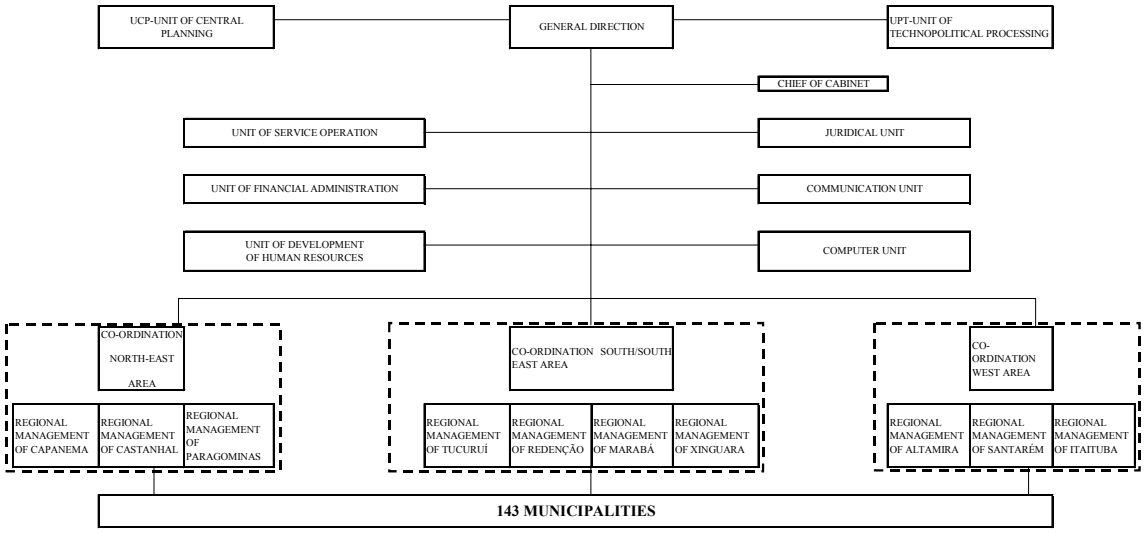

Figure 5.4-1 Organizational Chart of DETRAN

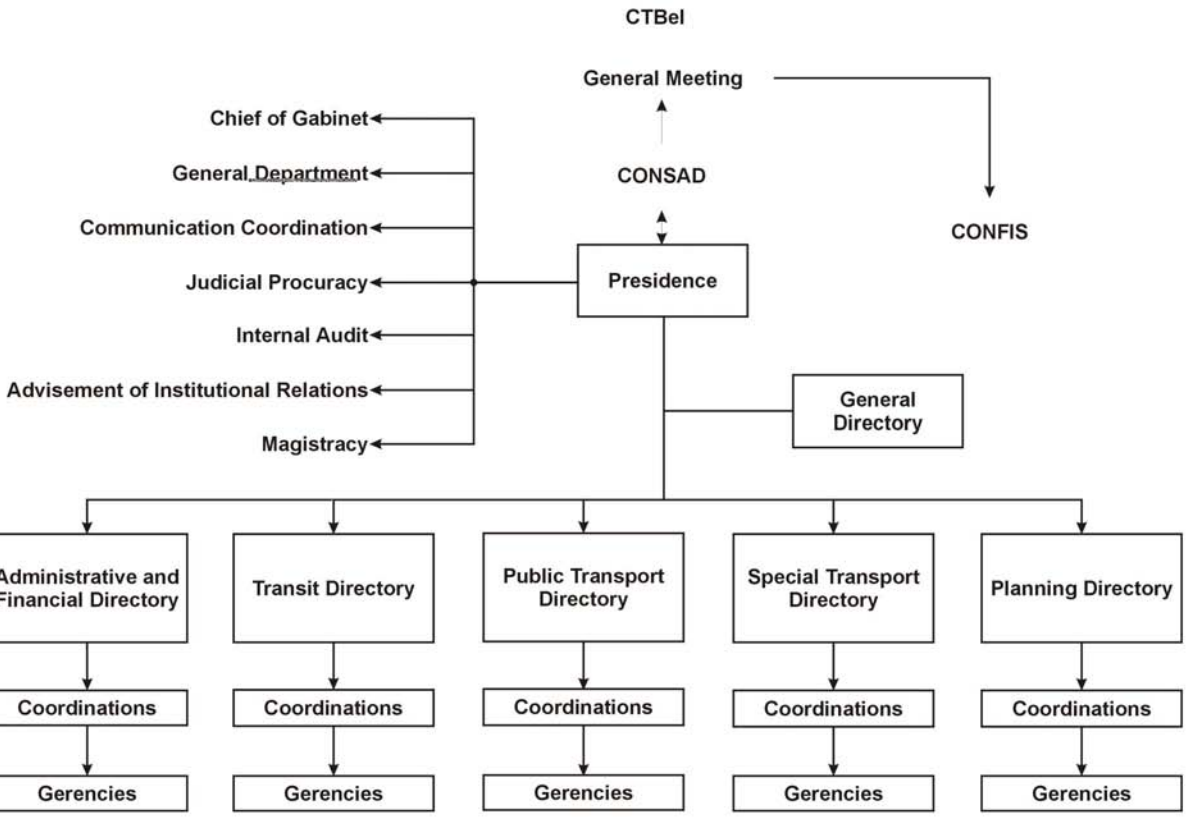

Figure 5.4-2 Organizational Chart of CTBel

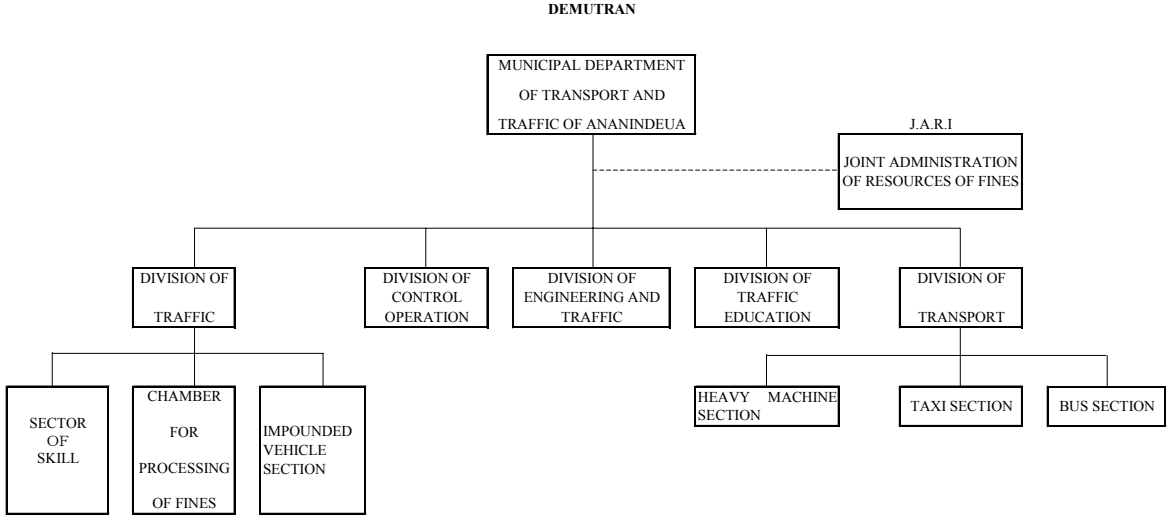

Figure 5.4-3 Organizational Chart of DEMUTRAN

Table 5.4-1 Outline of Agencies responsible for the Maintenance and Management of Traffic Management Facilities and Other Related Tasks

Items	Belem CBD	Icoaraci	Av. Almirante Barroso/ BR 316		Rod. Augusto Montenegro	Study Area
			Av. Almirante Barroso	BR 316		
	PMB/CTBel	PMB/CTBEL	PMB/CTBEL	DNIT/DEMUTRAN	PMB/CTBel	DETRAN
Traffic signal	Section of Luminous Signalization	Section of Luminous Signalization	Section of Luminous Signalization	Division of Engineering and Traffic	Section of Luminous Signalization	
Traffic signage One-way road No parking No entry of private car	Section of Graphic Signalization	Section of Graphic Signalization	Section of Graphic Signalization	Division of Engineering and Traffic	Section of Graphic Signalization	
Road Marking Pedestrian crossing Lane marking Bus stop marking	Section of Graphic Signalization	Section of Graphic Signalization	Section of Graphic Signalization	Division of Engineering and Traffic	Section of Graphic Signalization	
Bus stop Bus stop sign Bus stop shelter	Section of Shelter and Terminal	Section of Shelter and Terminal	Section of Shelter and Terminal	Coordination of Transport (Bus)	Section of Shelter and Terminal	
Others Pedestrian overpass Guardrail Bike lane	Technical Division	Technical Division	Technical Division	Division of Transport	Technical Division	
Traffic safety education	Section of Education for Traffic	Section of Education for Traffic	Section of Education for Traffic	Division of Education for Traffic	Section of Education for Traffic	Unit of Central Planning

Source: DETRAN, CTBEL and DEMUTRAN