

UPDATE OF MASTER PLAN FOR URBAN TRANSPORT IN THE METROPOLITAN AREA OF BELEM

UPDATE OF MASTER PLAN FOR URBAN TRANSPORT

FINAL REPORT

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**UPDATE OF MASTER PLAN FOR
URBAN TRANSPORT IN THE
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PRESENTATION

This document elaborated by COHAB/PA, SEDURB and JICA constitutes the Final Report of the Update of Master Plan for Urban Transport in the Metropolitan Area of Belém – PDTU/2001.

Brazilian consultants hired by JICA and a counterpart team composed of technicians of related metropolitan counties and state offices conducted the PDTU/2001 Study in cooperation with Japanese consultants dispatched by JICA. The Japanese consultants, who participated in the PDTU/1990 done by JICA from November 1989 to June 1991, conducted technical advice in the Study.

The Study was commenced from May 2000 and completed in March 2001. The Study contains a great number of field surveys to understand the situations of transport system in Belém Metropolitan Area. The following aspects were analyzed from the survey data: the social economic structure and tendencies of the development in the study area, and elements of diagnosis and prognosis in this issue, including the formulation of alternatives for roads and transport system.

The development of the travel demand model and evaluation of its alternatives for roads and transport system were also conducted. Based on the those analyses, "Implementation Program for the PDTU/2001" is recommended by each stage: short-term, medium-term and long term, aiming at an adequate development of the metropolitan transport system which includes road network system, public transport system, and traffic management system.

Belém, March/2001

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LIST OF SIGLAS AND ABBREVIATIONS

- ABC – Brazilian Agency of Cooperation (Agência Brasileira de Cooperação)
- ABNT – Brazilian Association of Technical Rules (Associação Brasileira de Norma Técnica)
- AMBEL – Belem Metropolitan Area Municipalities Associations (Associação dos Municípios da Região Metropolitana de Belém)
- BPR – Bureau of Public Roads
- CEFTRU – Formation Center of Transports in Human Resources (Centro de Formação de Recursos Humanos em Transportes)
- COHAB/PA – State of Para Habitation Company (Companhia de Habitação do Estado do Pará)
- CONAMA – National Concierge of Environment (Conselho Nacional de Meio Ambiente)
- CTA – Traffic Control in Area (Controle de Tráfego por Área)
- CTBel – Transports Company of Belem Municipality (Companhia de Transportes do Município de Belém)
- DEMUTRAN/PMA – Ananindeua Prefecture Department of Transports Municipality (Departamento Municipal de Transportes da Prefeitura de Ananindeua)
- DETRAN – State of Para Department of Transit (Departamento de Trânsito do Estado do Pará)
- EBTU – Urban Transports Brazilian Enterprise (Empresa Brasileira dos Transportes Urbanos)
- EIRR – Economic Internal Rate of Return
- Eletronorte – Electrical Centrals of North Brazil S.A. (Centrais Elétricas do Norte do Brasil S.A.)
- EMTU – Urban Transports Metropolitan Enterprise (Empresa Metropolitana de Transportes Urbanos)
- FINATEC – Enterprise Foundation Cientific and Technologic (Fundação de Empreendimento Científico e Tecnológico)
- FNO – Constitutional Found of North Finance (Fundo Constitucional de Financiamento do Norte)
- GNP – Gross National Product
- GRDP – Gross Regional Development Product
- IBGE – Institute of Brazilian of Geography (Instituto Brasileiro de Geografia e Estatística)
- JICA – Japan International Cooperation Agency
- LCCU – Urbanistic Control Complementary Land (Lei Complementar de Controle Urbanístico)
- MACROPLAN – Macroplan – Planning, Prospection and Survey (Macroplan – Planejamento, Prospecção e Pesquisa)
- NPV – Net Present Value
- O/D – Origen and Destination
- ONG – Organization not Governmental (Organização não Governamental)
- PD – Person Trip Survey (Pesquisa de Entrevistas Domiciliares)
- PDTU – The Masterplan Study on Urban Transport in Belém Metropolitan Area (Plano Diretor de Transportes Urbanos da Região Metropolitana de Belém)
- PDU – Masterplan Study on Urban Belem Municipality (Plano Diretor Urbano do Município de

Belém)

PIB – Gross Internal Product (Produto Interno Bruto)

PMB – Belem Prefecture Municipality (Prefeitura Municipal de Belém)

PNAD –National Survey per Household Sample (Pesquisa Nacional por Amostra de Domicílios)

RMB – Belem Metropolitan Area (Região Metropolitana de Belém)

SEDURB – Executive Secretary of Urban and Regional Development (Secretaria Executiva de Desenvolvimento Urbano e Regional)

SEGEP – Secretary Municipality of General Coordination of Planning and Administration (Secretaria Municipal de Coordenação Geral do Planejamento e Gestão)

SEPLAN/PA – Executive Secretary of Planning General Coordination (Secretaria Executiva de Planejamento e Coordenação Geral)

SETRAN – Executive Secretary of Transports (Secretaria Executiva de Transportes)

SINDICARPA – Enterprise Syndicates of Cargo Transport of Para State (Sindicato das Empresas de Transportes de Cargas no Estado do Pará)

TZ – Traffic Zone (Zona de Tráfego)

UFPA – University Federal of Para (Universidade Federal do Pará)

US EPA – USA Agency of Protection and Development (Agência de Proteção e Desenvolvimento dos Estados Unidos)

UNAMA – University of Amazonia (Universidade da Amazônia)

V/C – Vehicle / Capacity



Proposed Busway – Almirante Barroso Ave.

SUMMARY

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1. Background and Objectives of the Study

In 1988, the Para State and the Federal Government through the Brazilian Cooperation Agency – ABC, signed a technical cooperation program with JICA – Japan International Cooperation Agency to conduct the Masterplan Study on Urban Transport in Belem Metropolitan Area – PDTU. The study was conducted from November 1989 to June 1991.

The next stage of the PDTU Study would be the realization of Feasibility Studies for the implementation of projects identified as high priority projects. Therefore, the economic cooperation would be requested to the Government of Japan, aiming at the implementation of high priority projects. The Feasibility Study, however, was not conducted due to the facts below:

- a) Discontinuance and great administrative reorganization in the Federal Government led to the extinction of the Urban Transport Brazilian Enterprise – EBTU; which was responsible for making the urban transport plan under the federal government assistance. At the time, there was no other agency to accompany or implement the PDTU Study; and
- b) The same situation happened in the state administration, culminating with the extinction of the Urban Transport Metropolitan Enterprise – EMTU, which was responsible for executing the plan. Also the management of the Metropolitan Public Transport System was transferred to the Municipality of Belem, which was named Transport Company of Belem Municipality – CTBel. At that time CTBel did not incorporate the plan - PDTU with the CTBel's transport plan.

During nine years after the PDTU was completed, the RMB - Belem Metropolitan Area, which includes the municipalities of Belem and Ananindeua, have been expanded due to expansion of urbanized area. Since 1996 the municipalities of Marituba, Benevides and Santa Barbara do Para were incorporated into RMB (FIGURE A).

The population in RMB was estimated at 1,332,840 in 1991 (IBGE, Demographic Census 1991) and 1,574,487 in 1996 (IBGE, Counting 1996) which means a population growth ratio of 18.0%. This population growth is caused not only by the population growth of Belem and Ananindeua Municipalities, but also by the incorporation of Marituba and Benevides Municipalities to the metropolitan area. These two municipalities: Marituba and Benevides, show a significant population growth in the last few years due to a high population growth of the peripheral area in those areas. In addition to these municipalities, Santa Barbara in Para State has also been incorporated to the RMB. Santa Barbara has contributed to the population growth in RMB, even though the effect of population growth of the peripheral area in the area is low.

The large population growth of the peripheral municipalities in the RMB directly influenced in the public transport system, which keeps the traditional operational system with predominance of radial lines, which come from several peripheral areas and head to the center. The bus loading conditions are severe on the main radial roads where traffic jam occurs due to heavy bus frequencies. In the peripheral area the accessibility to bus stops is low because of the inadequate road network. This forces the bus users to walk a long distance to access to the nearest bus stop. Although in the last seven years the public transport system in RMB has been improved in the bus supply, it is not reflected in improvement of the service level.

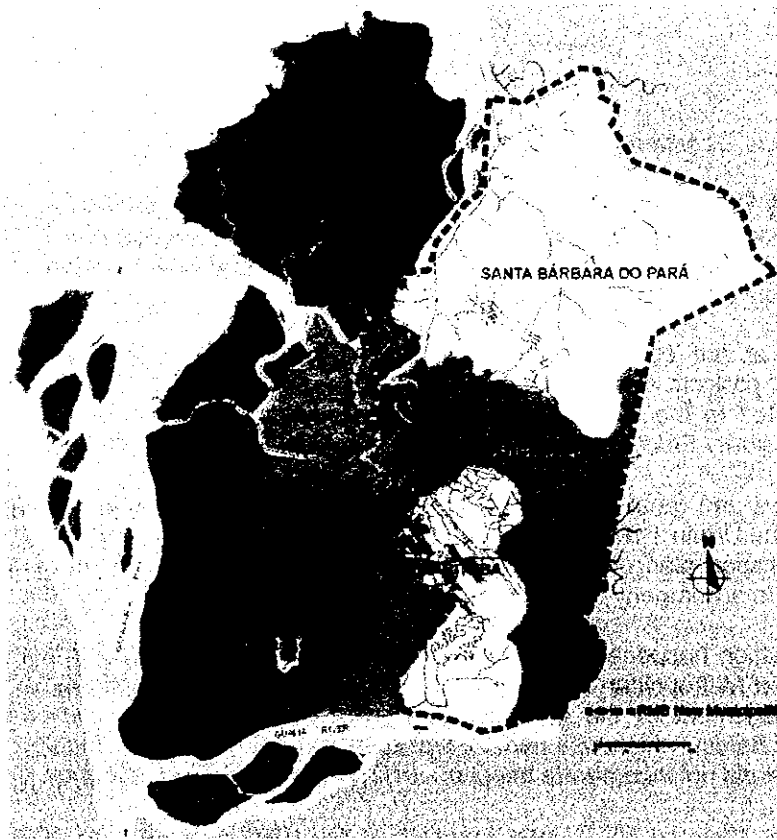


FIGURE A – Location of the Study Area

Source: COHAB/PA

The objectives of the Update of Master Plan for Urban Transport in the Metropolitan Area of Belem – PDTU/2001 are as follows:

(1) General Objective:

The urban transport plan in PDTU/1991 is reevaluated for the road system, traffic management system, and public transport system, to cope with the expansion of the Study Area and population growth in RMB. The impact of projects implemented or under construction for last decade is evaluated. The possibility of introduction of the public transport system with new technology is also examined.

(2) Specific Objectives:

- a) To survey the present conditions of road, public transport and traffic management systems
- b) To study the possibility of new public transport system introduced in RMB in the short-term period
- c) To get environment indicators for the particle materials on main metropolitan corridors
- d) To forecast the future travel demand in RMB
- e) To recommend the short-term projects in road and traffic management systems in RMB
- f) To recommend the further study for the high priority projects as feasibility study
- g) To recommend transport systems, considering the travel demand and physical supply conditions on the main transport corridors in RMB
- h) To qualify and provide tools, equipment and software programs used in the Study for the counterpart local team in the course of the Study

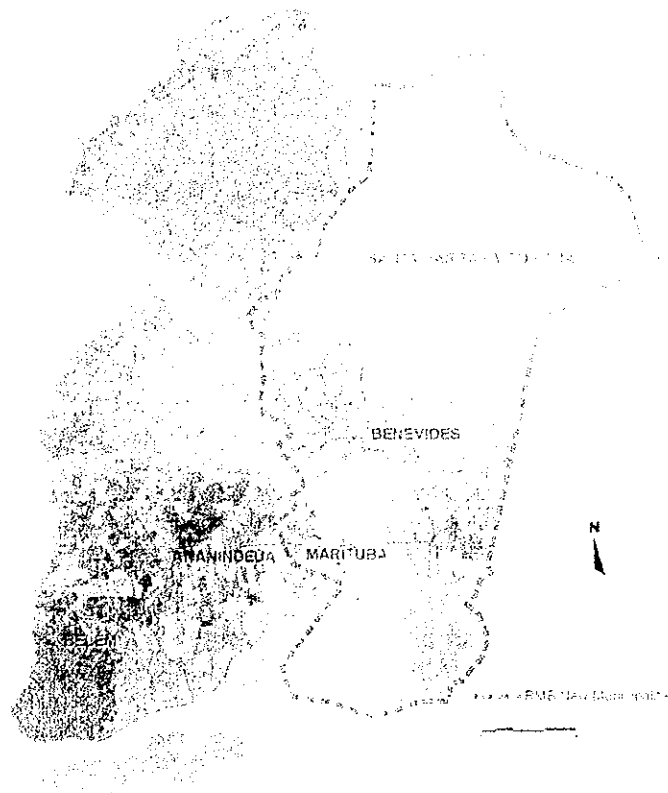


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2. Present Traffic and Transport Conditions

(1) Trip Characteristics

In the PDTU/2001, in order to understand the present traffic and transport conditions, many types of traffic surveys were carried out such as Person Trip Survey, Cordon Line Survey, Screen Line Survey, traffic volume count survey, intersection traffic volume count survey, public transport survey, environment impact survey, etc. The Person Trip Survey was conducted through home interviews with 7,000 households in the Study Area to collect the socioeconomic data and traffic movement in the RMB which is expanded due to expansion of urbanized area. Those collected data was analyzed and compared to those in the PDTU/1991 to grasp the change of socioeconomic and traffic conditions during the last decade.

The total number of trips per day in the Study Area in 2000 is approximately 4.08 million, of which 4.04 million trips are made within the Study Area, equivalent to 99% of the total. On the other hand, 39 thousand trips (1.0%) travel through the boundary of the Study Area. The trip increase ratio of the total trips in 2000 to that in 1991 is approximately 1.41, in contrast to 1.18 in population (TABLE A). FIGURE B shows the trips according to internal and external trips. As for the motorized trips exclusive of boat, bicycle and walking modes, the total number of trips is approximately 2.56 million in which the increase ratio to that in 1998 is approximately 1.25, in contrast to 1.41 in all modes (TABLE B).

TABLE A – Number of Trips in All Modes in the Study Area

Trip Type	1990		2000		2000/1990
	Trip Number	%	Trip Number	%	
Internal – Internal	2,852,700	98.8%	4,043,183	99.0%	1.42
Internal – External	33,800	1.2%	39,046	1.0%	1.16
External – External	770	0.0%	876	0.0%	1.14
Total	2,887,270	100.0%	4,083,105	100.0%	1.41

TABLE B – Number of Trips exclusive of Boat, Bicycle and Walking in the Study Area

Trip Type	1990		2000		2000/1990
	Trip Number	%	Trip Number	%	
Internal – Internal	2,011,245	98.3%	2,525,108	98.5%	1.26
Internal – External	33,329	1.6%	37,171	1.5%	1.12
External – External	717	0.0%	827	0.0%	1.15
Total	2,045,291	100.0%	2,563,106	100.0%	1.25

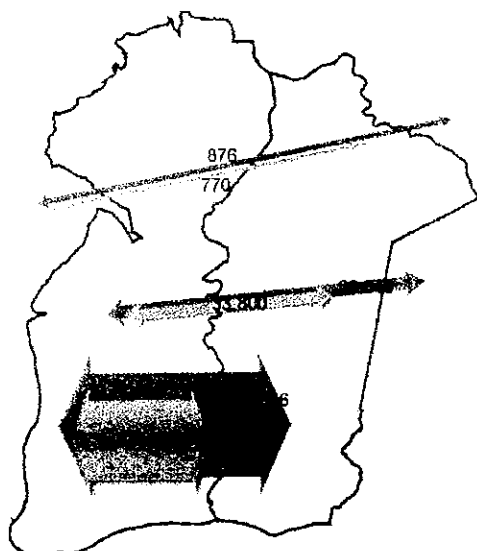


FIGURE B – Total Number of trips in the Study Area

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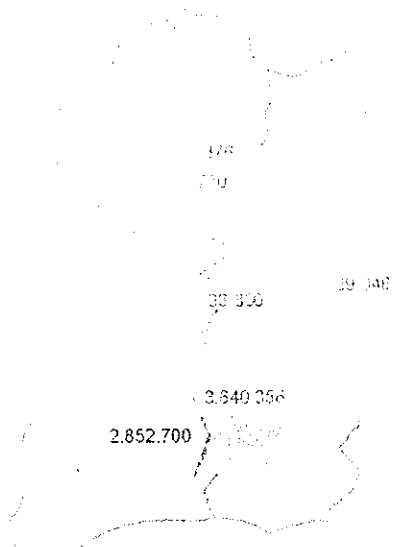


FIGURE B – Total Number of trips in the Study Area

FIGURE C shows the composition ratio of trip purposes by all modes. As can be seen, the highest ratio of trip purposes is "to home" purpose (45.0%), which is return to residence, followed by "work" (16.0%) and "study" (15.0%) purposes. "Others" (23.0%) are the aggregate of trips of "shopping's", "leisure", "health", "personal matter", "transfer" and "others. As for the motorized modes excluding "bicycle", "walking" and "boat" modes (FIGURE D), the "bus" mode accounts for 75.77% of total trips. The trips added to "car" (20.52%) reach almost 97.0%.

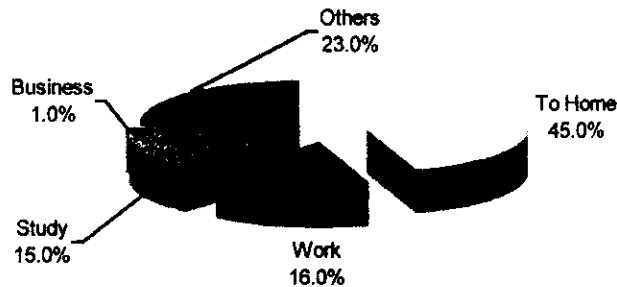


FIGURE C – Composition of Trip Purposes by All modes

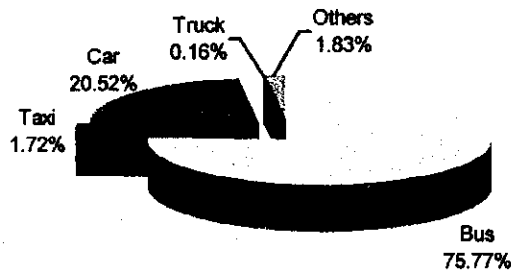


FIGURE D Composition of Trip Modes (Exclusive of Boat, Bicycle and Walking)

In comparison of the PDTU/1991 and PDTU/2001 data, the trip composition by purpose does not present significant difference. FIGURE E shows the composition ratio of motorized modes. "Bus" trips show similar percentage around 75%, and "car" increase ratio is from 18.0% to 20.52%.



FIGURE E – Comparing to Composition Ratio of Motorized Modes between PDTU/1991 and PDTU/2001

FIGURES F, and G show the trip distribution patters by bus and car modes (all modes except bus and walking) from the origin and destination data in the Person Trip Survey in manner of the desire line charts which are based on the macro zones. These lines show the similar trip patterns to concentrate to macro zones 1, 2, 3, and 4, on 1.^a Legua from among peripheral districts. The bus passenger trips cover a wide area, while car trips mainly cover within 1.^a Legua.

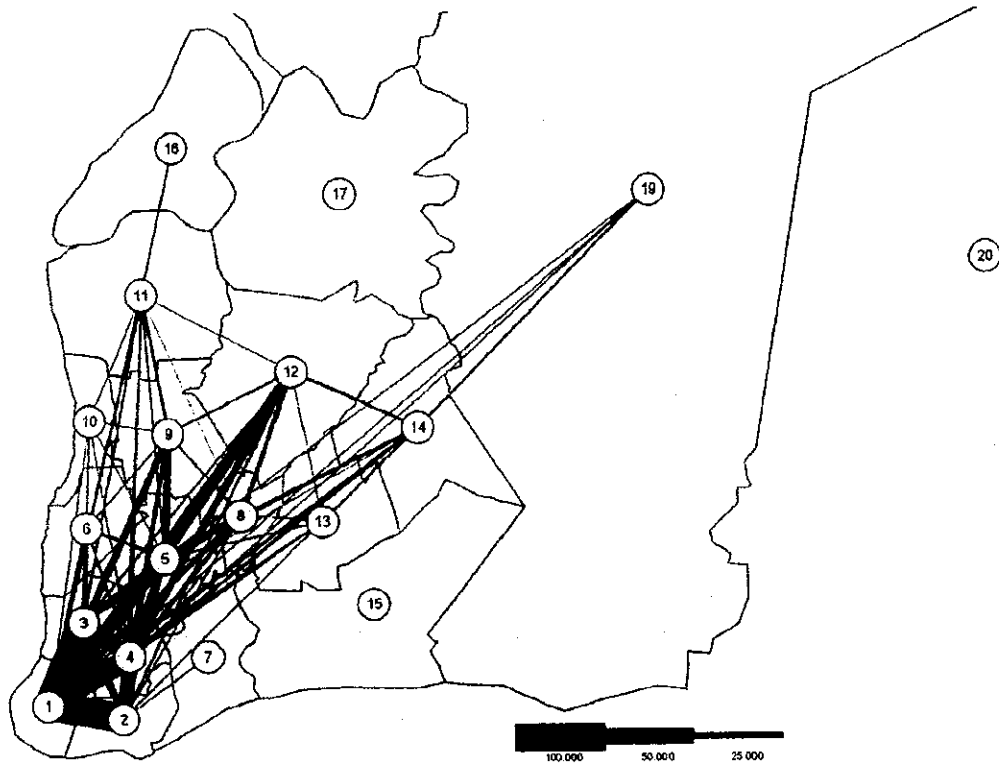


FIGURE F – Trip Distribution by Bus (All purposes)

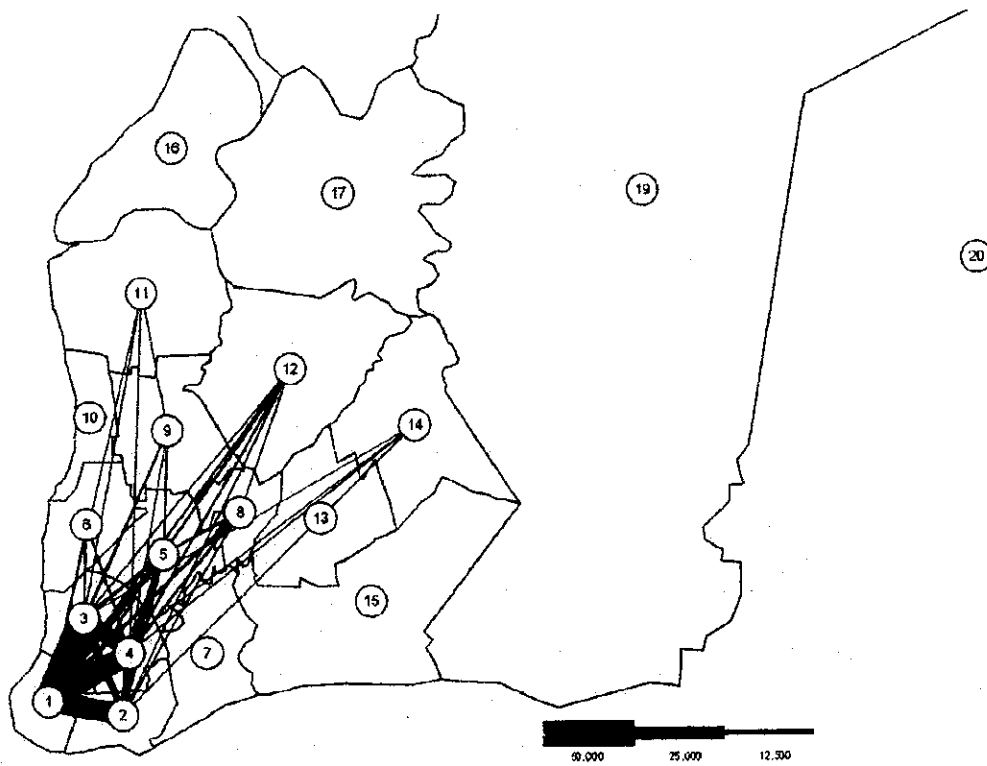


FIGURE G – Trip Distribution by Cars (All Modes except Bus and Walking; All Purposes)

(2) Traffic Volume on Roads

BR-316 road records the largest volumes with approximately 6,500 vehicles/hr in the dual-ways in the peak hours from 8:30 a.m to 9:30 a.m in the morning and 6:15 p.m to 7:15 p.m in the evening peak hours. Augusto Montenegro ranks the second highest with average volumes between 4,000 and 5,000 vehicles/hr. Bernardo Sayo, Perimetral and Arthur Bernardes Avenues present lower volumes between 500 and 1,000 vehicles/hr during the same period.

Traffic volumes in the morning and afternoon peak hours at intersections between Almirante Barroso Ave reach 4,000 pcu/hour. At the intersections in the Central Area, the traffic volumes are approximately 4,000 pcu/hour. Those intersections have homogeneous traffic movements except for intersection between Boulevard Castilhos França and Presidente Vargas Avenue, where traffic flow on the Boulevard Castilhos França reaches 2,000 pcu/hour in the morning peak hour.

(3) Public Transport Conditions

The public transport system in the RMB - Belem Metropolitan Area has 147 conventional bus lines with 81 terminals and 27 minibus selective lines. There are approximately 1,800 bus stops. 12,723 trips/day are operated with 1,750 conventional bus fleets. Approximately 1,450,000 passengers/day are transported. The bus network converges into the central of 1ª Legua and its surroundings and in addition, the bus routes converge into BR-316 and Augusto Montenegro corridors due to road discontinuity (FIGURES H and I).

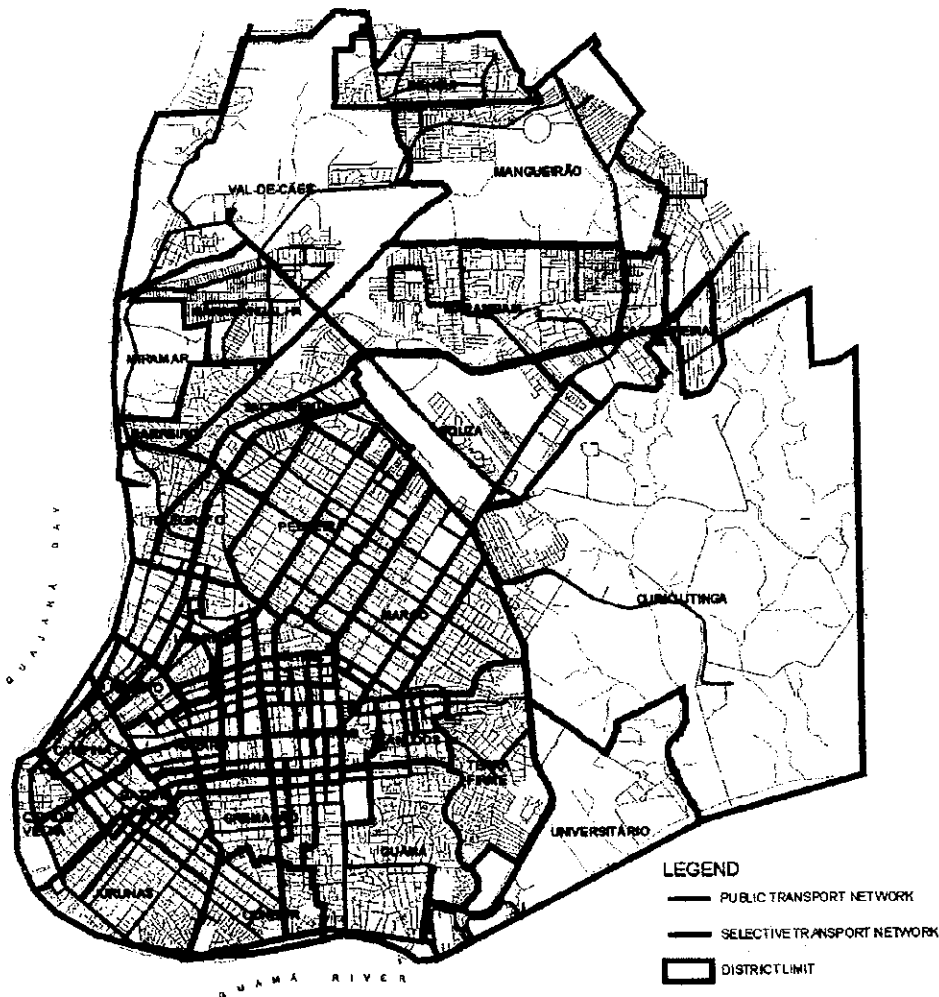


FIGURE H – Public Transport Network in 1ª Legua and Surrounding Area

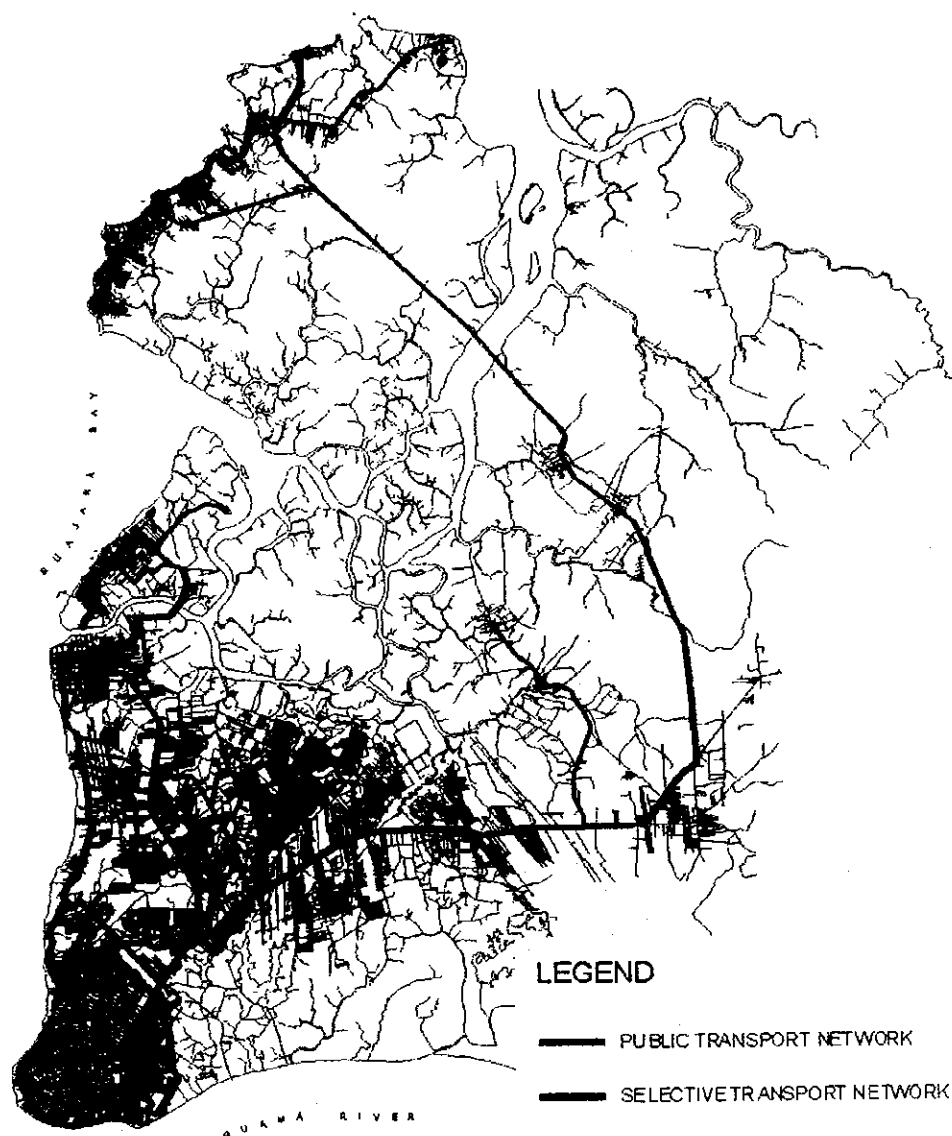


FIGURE I – Public Transport Network in RMB

The total number of daily passengers based on the boarding and alighting survey is 1,448,301 passengers. FIGURE J shows the number of daily passengers on board by link in main corridors and the boarding and alighting volume at bus stops with greater demand. On the way to the district-center, the number of boarding passengers continuously rises until the Entroncamento bus terminal, and it reaches the peak at Tavares Bastos and Julio Cesar on Almirante Barroso Avenue. The highest number is approximately 200,000 passengers/day.

The amount of boarding and alighting shows that the Central Area is the highest at 40,000 passengers in each direction, followed by the area of Sao Braz (range from 25,000 to 30,000 passengers), and Entroncamento (ranges from 10,000 to 14,000 passengers/way).

The number of passengers on board in the morning peak hour during from 6:15a.m to 7:15a.m is the similar as in the daily volume. The highest flow rate is approximately 38,000 passengers/hour on Almirante Barroso Avenue. In the Central Area it is recorded with 7,000 passengers/hour.

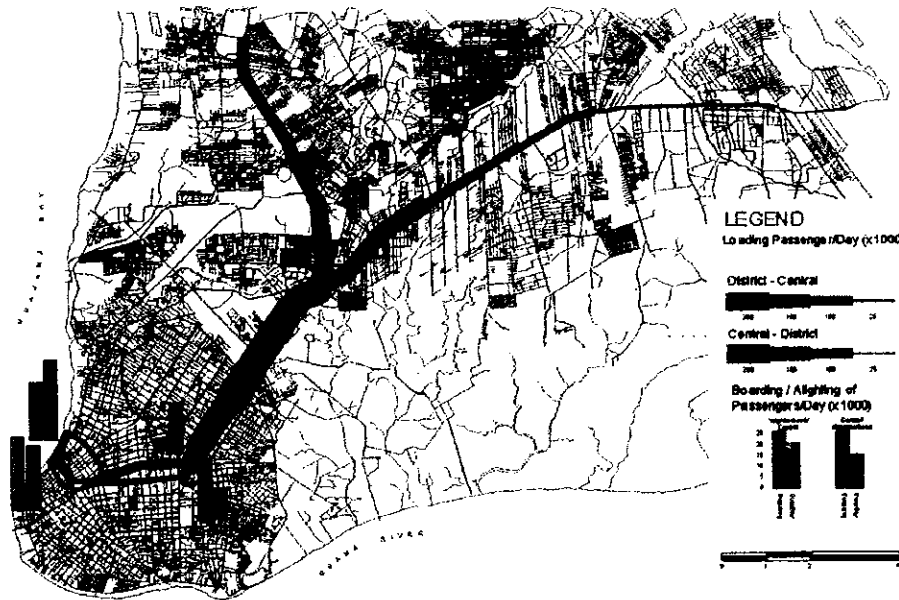


FIGURE J – Number of Bus Passengers on Board and of Boarding/Alighting Passengers by Direction for 24 Hours

(4) Travel Time

The vehicle speed on BR-316 (FIGURE K) gradually decreases according as access to Entroncamento, and then reach the lowest velocity in Central Area. The lowest figure is approximately 20km/h. The velocity increases as it get far from Entroncamento in direction of Pirelli Road. The highest figure is approximately 60km/h or more.

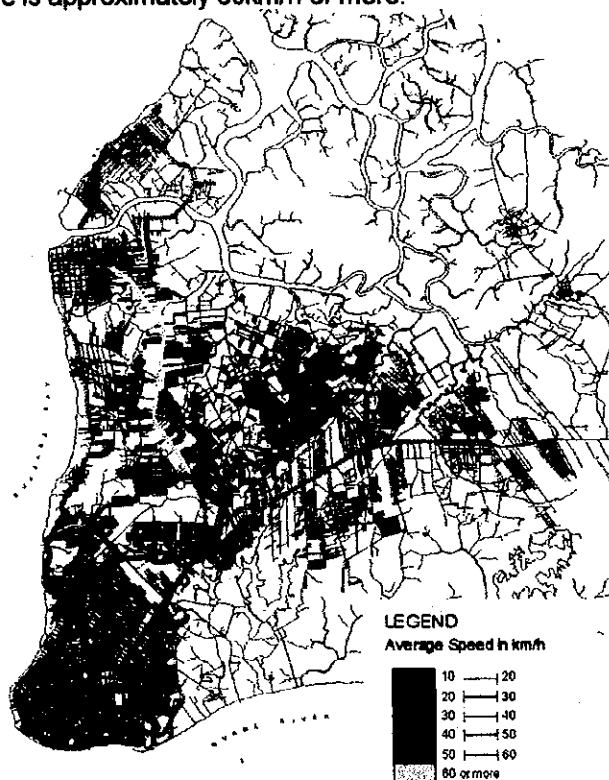


FIGURE K – Average Velocity by Segment

(5) Road Maintenance Conditions

Fifty five (55.0%) percent of total surveyed roads present bad pavement conditions in the Expansion Area, while 45.0% are regular quality in 1ª Legua. No roads with excellent pavement conditions are identified. There are few roads without sidewalks. The roads with only two lines are predominant.

The dissatisfactory conditions in the current road system come from several factors, such as lack of management on pavement, inadequate drainage system, lack of construction technology standard, lack of road hierarchy system, and lack of traffic regulation, especially cargo transport in RMB - Belem Metropolitan Region. FIGURES L and M show the results of road assessment.

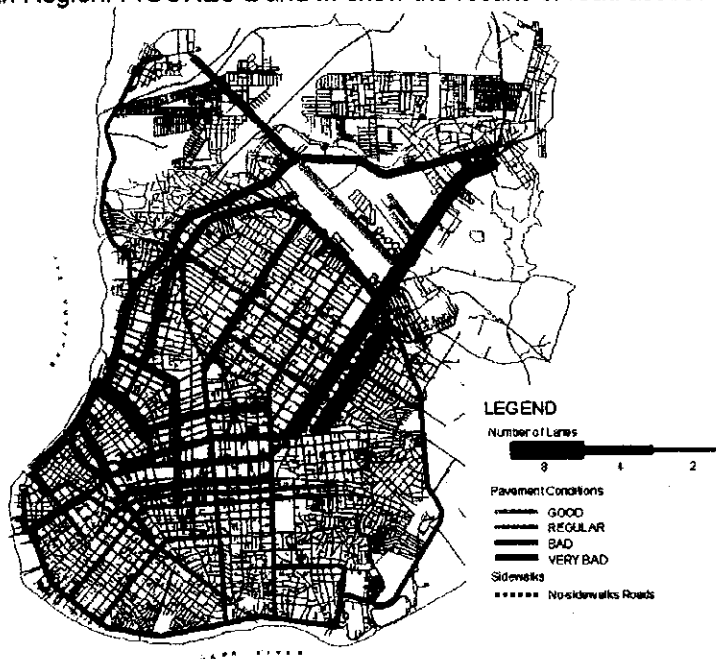


FIGURE L – Road Pavement Conditions in 1ª Legua and Surrounding Area

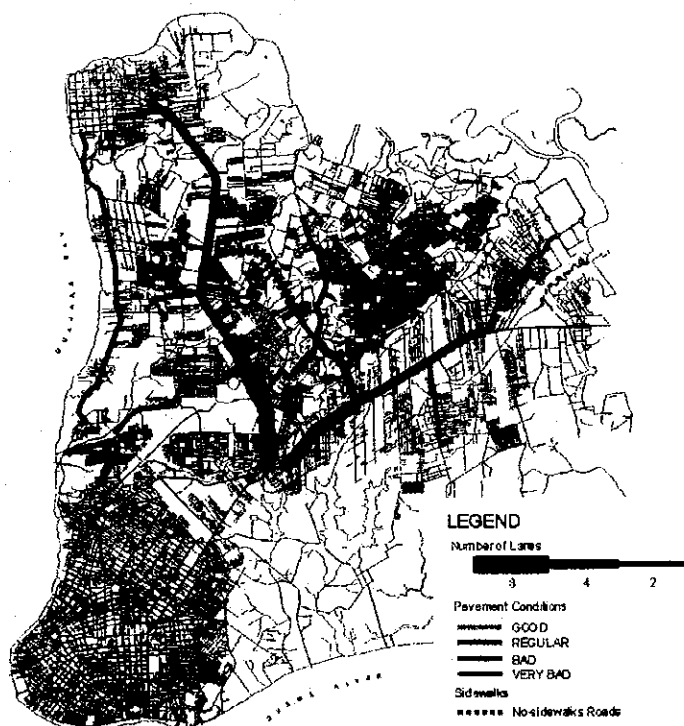


FIGURE M – Road Pavement Conditions in Expansion Area

(6) Transport Users' Opinion

This survey was carried out together with Person Trip Survey in order to collect data for the quality of movement from pedestrians, bus users, private vehicle drivers, and bicycle riders. The questionnaire sheet with only a transport opinion was filled out. The number of collected questionnaires is 6,841 sheets, equivalent to 0.4% of total population.

In bus users' opinion for bus loading condition, the "overcrowded" on board is predominant with 40.1% of all the opinion. The ratio of "overcrowded" and "crowd" totals up to 65.1%. The data reveals that most of the users are dissatisfied with the bus loading condition. Approximately 65 % of users regard the number of operated bus frequencies as small or very small.

The reasons for not taking these travels are distributed equally between 19.9% and 18.7% of the answers as follows:

- Necessity to transfer more than one bus (19.9%)
- Long walking distance (19.2%)
- No security (19.0%)
- No comfort (18.7%)
- Expensive ticket (10.7%)

The restrictive factor of the bus fare rate is lower than that of current operation conditions such as transfer of bus, long walk distance, no security.

As for the priority of the public transport improvement, the betterment of "bus security" is the highest priority at 33.8%, followed by "operation speed" (30.1%), "adequate frequency" (18.8%) and "comfort" (17.2%). Except for "bus security", the highest priority opinions concentrate on the improvement of bus operation system.

(7) Present Environment Conditions

The noise and vibration levels as well as the emitted particle material level generated by motorized traffic in Belem were measured in the Study to evaluate those levels and to compare to the Brazilian standard. The measurements were carried out at 9 locations where residential and commercial, educational areas and hospitals along major roads were selected for the noise and vibration. As for the particle material, three locations were selected for the measures, taking into account the traffic volume and its composition.

TABLE C shows the noise level in the collected locations. Comparing all the Leq to the maximum levels employed by Brazilian Rule, all the Leq in all collect points reaches to the maximum levels. These major roads with heavy vehicle volume also presents the heavy traffic composition (buses and trucks) where the composition ratio reaches to 30% of traffic volume. On point 1 (e.g. Gentil Bittencourt Avenue) with three lanes in dualway, the measured noise level is $Leq=79.7$ with 19 vehicles per minute with the average heavy vehicle composition ratio of 29.0%. Comparing to the maximum level 65 dB (A) in the commercial zone, the noise level in this point exceeds by 14.7 dB(A).

As for the vibration, there are situations where the vibration level is up to the limit fixed by the Japanese rule at intersection between Doca Souza Franco and Antonio Barreto Ave. In this case the maximum level in axle Z is 71.3dB, whose figure means no problem. The L10 level shows that in 10.0% of the measuring time duration, the vibration level is up to 55.4 dB.

TABLE C – Noise Level Measured in the Survey Locations

January/2001

Points	Location	Date	Time	L _{eq} dB-A	L _{max} dB-A	L ₁₀ dB-A	L ₉₀ dB-A	Q _T	C (%)
1	Gentil Bittencourt Avenue (between Dr. Moraes Street and Serzedelo Correa Avenue)	16	10:38	79.7	103.2	82.8	66.6	280	29
		17	11:25	79.5	97.7	83.0	64.1	293	33
2	Quintino Bocaiuva Street / Nazare Avenue	16	11:17	77.3	91.2	80.9	67.9	596	14
		18	08:30	77.8	92.5	81.9	64.8	586	15
3	Generalíssimo Deodoro Avenue / Bernal do Couto Street	17	08:20	73.9	89.5	77.3	65.4	542	7
		18	12:00	75.0	87.4	78.5	68.2	659	5
4	Gov. Jose Malcher / Almirante Barroso Avenues	17	09:10	79.0	90.6	82.3	73.1	603	23
		18	11:20	78.0	89.4	80.7	71.4	577	23
5	Visconde Souza Franco Avenue / Antônio Barreto Street	17	10:00	77.0	93.3	81.0	65.3	482	8
		17	18:15	76.4	97.1	80.1	64.6	554	11
6	Castilhos França Boulevard	17	10:35	76.0	97.9	79.4	66.8	327	32
		18	07:30	75.6	88.9	79.4	65.9	239	46
7	Nazare/ Generalíssimo Deodoro Avenues	17	16:10	75.9	95.3	78.7	69.0	796	13
		18	08:00	74.8	90.5	78.2	66.5	583	15
8	BR - 316 Road/ Parabor Street	18	09:10	78.7	93.2	81.8	72.3	557	25
		19	08:25	79.0	91.9	82.1	72.2	660	20
9	Augusto Montenegro Avenue/ WE2 Street	18	09:45	77.3	96.1	80.4	67.2	308	24
		19	07:50	79.2	92.5	82.9	64.4	402	20

Q_T – total vehicles volume in 15 minutes;

C – traffic composition, per percentage of heavy vehicles;

The particle material is one of the elements emitted from vehicles. It presents with three indicators: Total Dust in Suspension (PTS), Inhalant Particles (PI), and Smoke. These particles can be carried by air through the long distance between the pollution origin and residences or areas. In the Study, the concentration level of the emitted particle material beside roads in Belem Metropolitan Area was measured at three locations in which TABLE D shows the concentration level.

The pollutant concentration levels varied between 20.38 (COHAB/PA) and 56.39 µg/m³ (Sao Braz). This means that the concentration does not exceed the permitted maximum limits. TABLE D shows that the concentration of the pollutant material is larger in areas with heavy traffic volume. The traffic volume at the intersection between Almirante Barroso and Governador Jose Malcher Ave. (Sao Braz) stands out at 11,000 vehicle/day. Traffic jam causing a great volume of pollutants occurs in this area.

The results show the necessity of management of the inhalant particles together with a vehicle inspection program. It would be possible to obtain information for the cycle and temporal pollution structure to evaluate all air quality parameters for the annual average concentration. This analysis would be used to support the environmental conservation management.

TABLE D – Pollutant Concentration Levels of Particle Material

Local	Date	Rain (min)	P(initial) (g)	P(final) (g)	P(sample) (g)	Qp (m ³ /min)	Vp (m ³)	Concentration (µg/m ³)
COHAB	24/01/01	0	2.6711	2.7045	0.0334	1.134	1638.5	20.38
COHAB	26/01/01	0	2.7154	2.7518	0.0364	1.131	1626.1	22.39
COHAB	25/01/01	0	2.6707	2.7130	0.0423	1.131	1670.1	25.33
COHAB	23/01/01	20	2.6973	2.7396	0.0423	1.133	1630.9	25.94
COHAB	29/01/01	0	2.7263	2.7713	0.0450	1.131	1628.1	27.64
COHAB	13/12/00	120	2.7866	2.8375	0.0489	1.126	1621.0	30.17
COHAB	11/12/00	35	2.7824	2.8380	0.0556	1.128	1623.8	34.24
COHAB	* 27/01/01	0	2.7400	2.8001	0.0601	1.131	1626.7	36.95
COHAB	* 28/01/01	0	2.7141	2.7828	0.0687	1.130	1626.7	42.23
P. Estiv.	* 20/01/01	445	2.7326	2.7658	0.0332	1.129	1614.4	20.56
P. Estiv.	* 21/01/01	20	2.7475	2.7951	0.0476	1.116	1606.0	29.64
P. Estiv.	* 17/12/00	50	2.6783	2.7391	0.0608	1.115	1604.6	37.89
P. Estiv.	18/12/00	475	2.7458	2.8078	0.0620	1.115	1605.3	38.62
P. Estiv.	19/01/01	105	2.7244	2.7913	0.0669	1.123	1617.4	41.36
P. Estiv.	19/12/00	45	2.7799	2.8463	0.0664	1.111	1599.6	41.51
P. Estiv.	22/01/01	0	2.7284	2.8018	0.0734	1.113	1602.4	45.81
P. Estiv.	18/01/01	80	2.7186	2.8008	0.0822	1.120	1612.4	50.98
Sao Braz	* 16/12/00	340	2.7192	2.7931	0.0739	1.124	1618.1	45.67
Sao Braz	* 14/01/01	55	2.7753	2.8509	0.0756	1.113	1602.4	47.18
Sao Braz	15/01/01	35	2.7713	2.8522	0.0809	1.111	1598.9	50.60
Sao Braz	15/12/00	330	2.6748	2.7575	0.0827	1.108	1595.3	51.84
Sao Braz	14/12/00	130	2.7660	2.8503	0.0843	1.106	1592.4	52.94
Sao Braz	16/01/01	70	2.7633	2.8509	0.0876	1.103	1580.9	55.41
Sao Braz	17/01/01	10	2.7134	2.8032	0.0898	1.106	1592.4	56.39

(*) : Collect done on weekends;

P(initial): Gross initial weight of dry filter (g);

P(final): Gross final weight of dry filter (g), after the collect;

P(sample): Weight of collected sample (g);

Qp: Average air outflow sample in normal conditions of temperature and pressure (m³/min);

Vp: Total volume of sample air in normal conditions of temperature and pressure (m³);

Concentration: Concentration of pollutant material per cubic meter of sample air (µg/m³).

3. Identification of Transport Problems in the Belem Metropolitan Area

(1) General Issues

The issues to prepare the future alternative plans for the road system, the public transport system and traffic management in the Belem Metropolitan Area are presented by identification of existing and future problems in the transport system. The seminar for discussion on the problems in RMB transport system was held and transport problems were identified.

Although transport policies are influenced by land use, only the Belem Municipality among RMB has prepared the urban master plan, which is based on the recommendations of PDTU/1991 by Para State Government and JICA. As for other municipalities that do not have the urban master plan yet, the importance of these urban policy and these actual plans is not recognized.

The poor administration for the public transport system was mentioned on seminar as big problem which should be solved with high priority. The mutual cooperation with Para State and all prefectures for administration of the public transport system is essential.

(2) Road Network

The current road system is inadequate to motorized vehicle demand, especially in the area of the center-periphery-center area, where the road network between 1^o Legua and Expansion Area is discontinuous. This missing-link of arterial roads causes traffic congestion near this area.

There is no road functional hierarchy to cope with land use policy in the Metropolitan Belem Area where a few arterial roads and minor roads are served at present. Only two major arterial roads, which are BR-316 and Augusto Montenegro, run through the Expansion Area where these two roads cross. The configuration of road network in the Expansion Area is ineffective. Another part of the problems is the road configuration with only one transport axis in metropolitan municipalities, states and federal road network.

At present, major circulation / ring roads are insufficient in the Study Area. In future, it is necessary to plan major ring roads in the Study Area.

(3) Public Transport System

At present, the current bus operational system is inadequate and incompatible with the RMB passenger volume such as extension of physical operational area, bus operation system, and fare system. The bus passenger and opinion surveys show the unbalance of public transport demand and supply. The infrastructure in the public transport such as terminals, bus stops, busway is inadequate. The administration support for the infrastructure is also inadequate. Urban Bus routes concentrate to only one road on main radial corridors. On the other hand, inter-municipal bus routes also lack.

The bus terminal facility is poor in the number of terminals, parked lots, and passenger facility. Many terminals have an inadequate space with on-street parking in the Expansion Area. Bus passengers face traffic safety problems against other buses and vehicles near these bus terminals. In order to strengthen the facility of urban bus terminals, the transfer of Inter-Municipal Bus Terminal to place near Alça Viária on BR-316 in the Marituba Municipality is proposed now.

The opinion survey disclosed that public transport does not satisfy bus passengers for the current bus system such as transfer times, long walking to bus stops, security, bus comfort, fare level.

From investigation of pollutants of emission gas, especially the particle materials from buses, the bus transport contributes for the major part of urban air pollution. It will be urgently necessary to control the current bus emission gas.

(4) Traffic Management System

Traffic signs and signals are inadequate and insufficient and do not cope with road hierarchy in the urban area. The parking policy in the central area is absent. Since the on-street parking on curb, exclusive of arterial roads, is predominant, the road capacity is limited.

4. Proposed Projects in the Master Plan Study

(1) Future Socioeconomic Frame

The future population of the Study Area will reach 2.97 million in 2020 (TABLE E). The growth ratio of population in 2020 to that in 2000 is approximately 1.7 which is equivalent to 2.6% per annum. As for the employment, the growth ratio of tertiary sector is higher at 1.67, while the primary sector is low at 0.94.

The distribution of population in the future is shown in FIGURE.N, which shows in manner of population density. As can be seen, the highest population density locates in 1^o Legua. The second highest locations are in Umarizal, Telegrafo Districts, Icoaraci, Cidade Nova and Entroncamento, which are mainly along Almirante Barroso Avenue. The medium range of the density of 60 to 120 persons/ha is in the surrounding areas of Cidade Nova, Bengui and Icoaraci.

In 2010, the population density is increases slightly on 1^o Legua and Telegrafo district, while the areas along BR-316 and Augusto Montenegro Roads, and Icoaraci, Cidade Nova and PAAR are considerably increase.

By the completion of several projects until 2020, the progress of the density stabilizes in 1ª Legua which indicates the intensification of employment. Coqueiro, Cidade Nova (along BR-316) and Icoaraci reach to the highest. The remained continental portions of Belem, Ananindeua and a part of Marituba Municipalities will increase up to 60 persons/ha, excluding the institutional areas.

TABLE E – Future Socioeconomic Frame in the Study Area

Indices	2000	2010	2020	2010/2000	2020/2000
Population	1,782,394	2,315,225	2,969,472	1.30	1.67
Employment					
Primary	6,798	6,278	6,405	0.92	0.94
Secondary	36,318	46,305	59,389	1.27	1.64
Tertiary	464,499	604,274	775,032	1.30	1.67
Student	548,727	713,089	914,597	1.30	1.67

FIGURE O shows the density of employment for the tertiary sector in Comercio, Reduto, and Batista Campos district. The density stratum in those areas are 100 or more employment/ha. These values decrease to second stratum in these surrounding areas which are 1ª Legua at Sacramento, Telegrafo and some dispersed areas such as Icoaraci and Administration Center in Expansion Area.

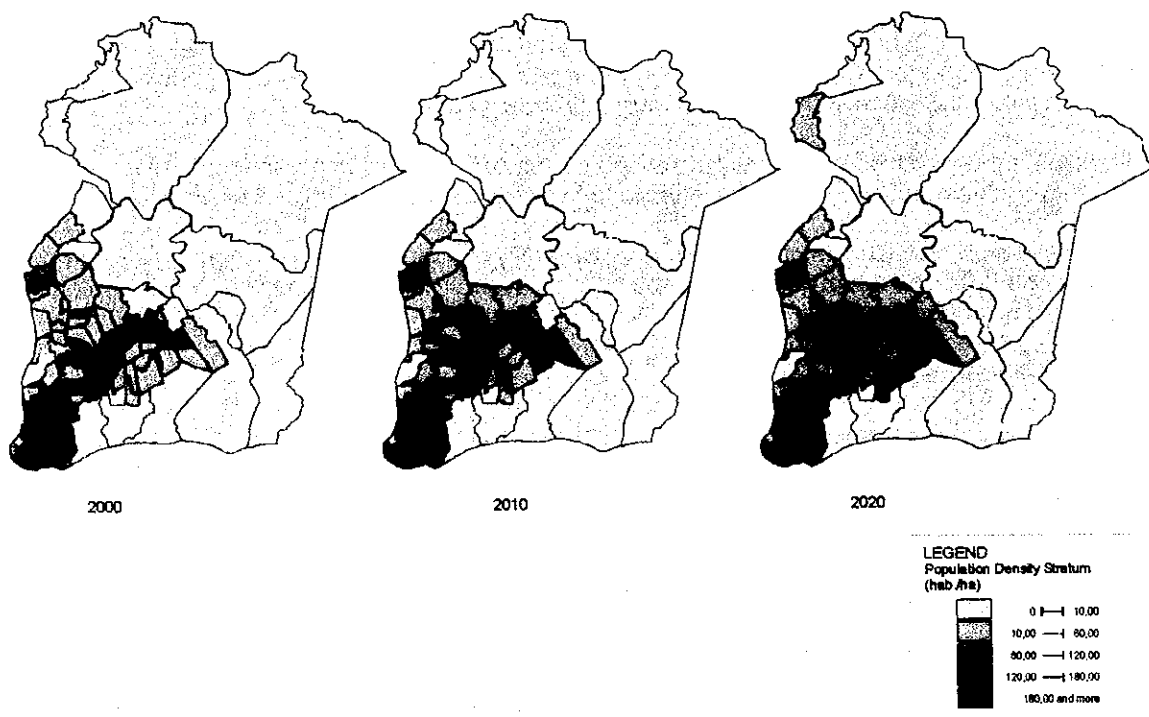


FIGURE N – Population Density in 2000, 2010 and 2020

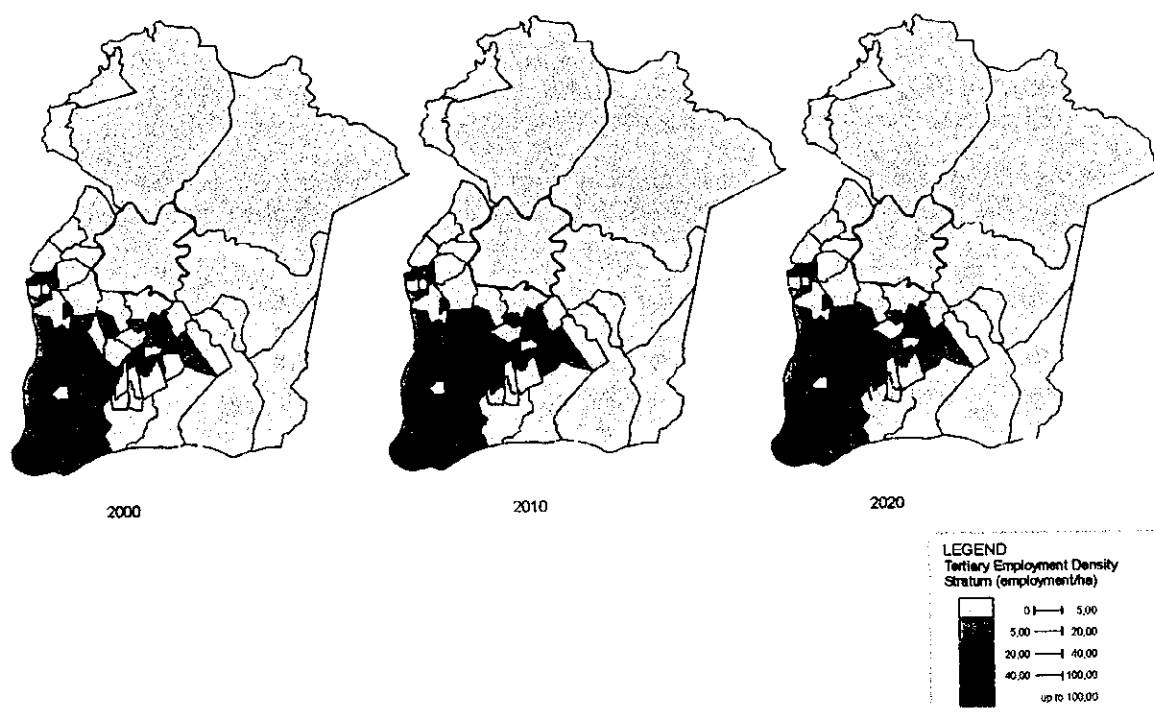


FIGURE O – Employment in Tertiary Sector in 2000, 2010 and 2020

(2) Road Network

In order to solve the previously identified traffic and transport problems, alternative plans of the road network system were formulated, which propose future roads on the present road network in the RMB. These roads are proposed on new traffic corridors to have a new traffic potential. The road hierarchy by road function from the point of view of both the spatial structure and the population mobility was formulated as shown in FIGURE P.

Based on this basic concept, the main roads were planned as a hierarchic main axis. The secondary roads were planned for linking to these main axes. In the economic evaluation, the set of main and secondary roads was grouped into seven (7) corridors (FIGURE Q).

Group 1– Set of roads that has the Independencia Avenue as main axis that is in stage of implementation in the some segments by the Para Government. It creates the alternative route for accessing from the areas of Cidade Nova, PAAR and Curuçamba to the 1^o Legua Patrimonial. This group includes the extension of the Marinha Street linking the BR-316 Road, and next to the Castanheira Shopping

Group 2 – Set of roads that has the 1^o de Dezembro Avenue as main axis. The segment between Dr. Freitas Avenue and Alça Viária is in stage of partial implementation by the Belem Municipality. It creates alternative route of the BR-316 Road. In this group there is a set of secondary roads that makes the link between 1^o de Dezembro Avenue and the areas of Cidade Nova, PAAR, Curuçamba and Augusto Montenegro Road

Group 3 – Set of roads that has the Liberdade Avenue as main axis planned by the State Government. This road forms alternative route to link the Alça Viária to Perimetral Avenue. In this group there are also other secondary axis to access 1^o de Dezembro Avenue

Group 4 – Set of roads that has the extension of Pedro Miranda Avenue as main axis crossing the Yamada Street and Arthur Bernardes Road until Icoaraci. This forms the alternative to link Icoaraci with 1^o Legua Patrimonial. The main roads to link with those areas are Arthur Bernardes Road and Augusto Montenegro Road with the priority to the public transport

Group 5 – Set of roads that has two parallel road: the one parallels BR-316 Road on the north side that passes through the dominion area of a transmission line of energy from Curuçamba in Ananindeua until PA-391 Road. The other on the south side parallels the extension of 1ª de Dezembro Avenue from Alça Viária to the entry of Benevides City Hall

Group 6 – Set of roads that has Lig. Paar/Icoaraci as main axis to link Ananindeua to Icoaraci. Those roads link the areas of Cidade Nova, PAAR, Curuçamba to Icoaraci and reaches Alça Viária, which form the outer ring road in RMB

Group 7 – Set of roads that has the Bernardo Sayao Avenue that consists of the inner ring road of 1ª Legua Patrimonial interconnected to secondary roads. These roads aim the improvement of accessibility to the districts of Terra Firme, Guama, Condor e Jurunas. This group also includes the extension of Generalissimo Deodoro Avenue to Quintino Bocaiuva Street.

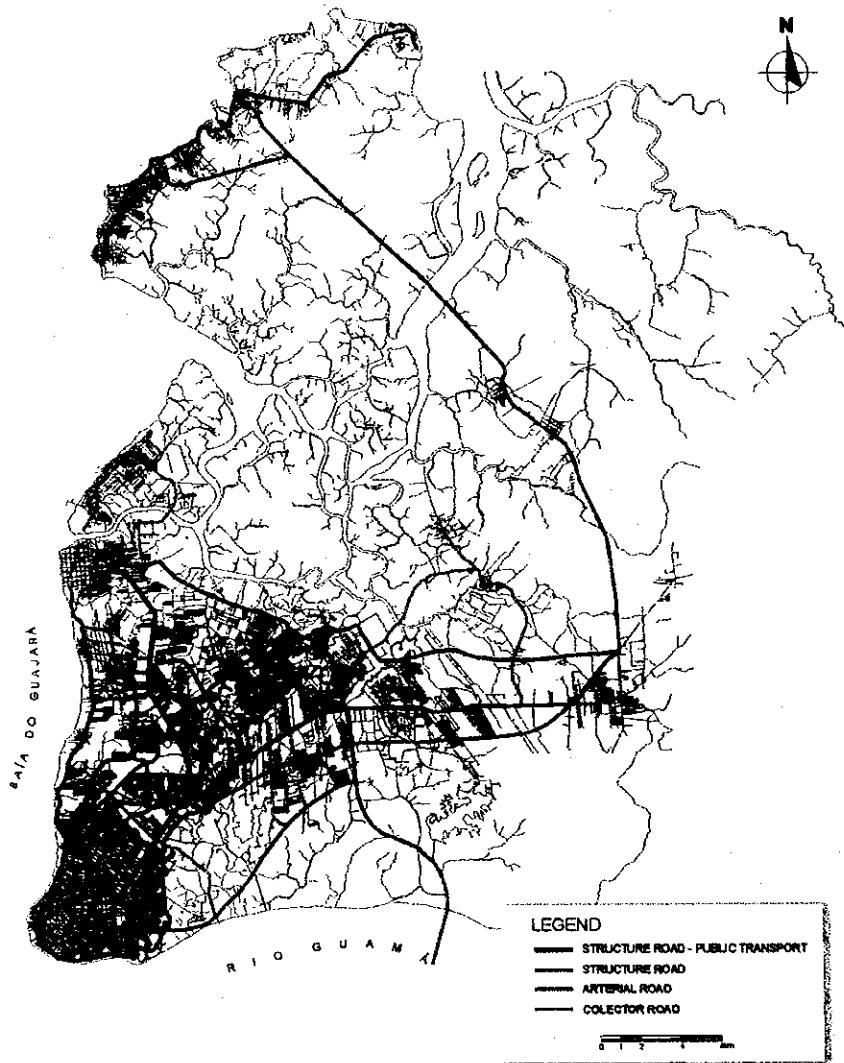


FIGURE P: Future Road Hierarchy in RMB

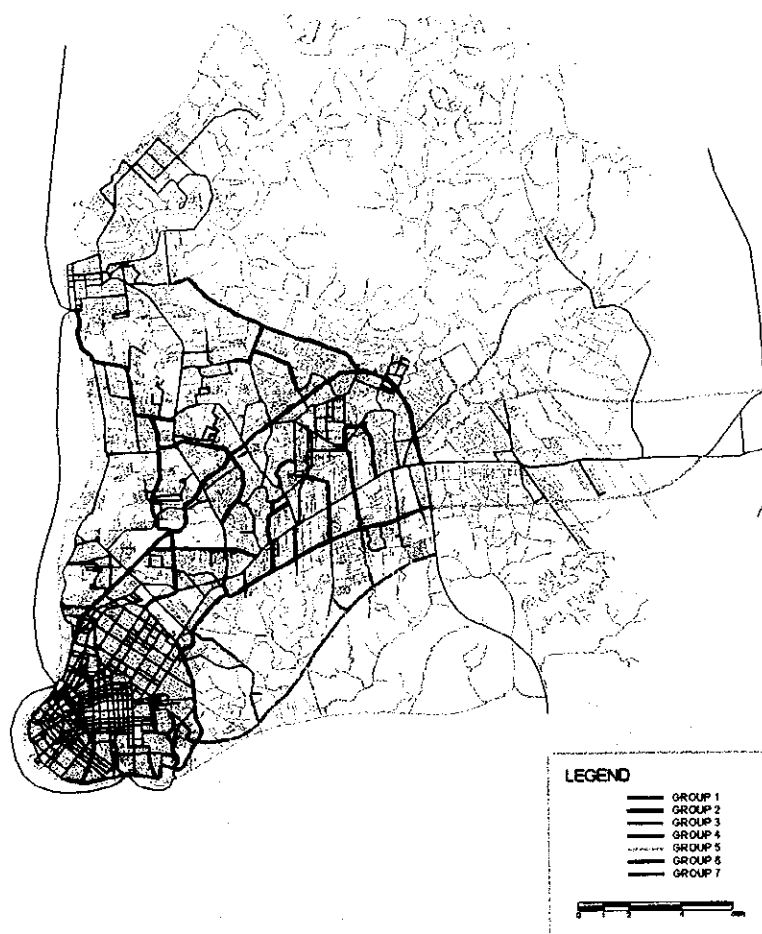


FIGURE Q: Future Road Network Plan Grouped into Seven (7) Corridors

(3) Public Transport Plan

In the public transport system, a trunk-feeder bus system (FIGURE R) was proposed in which buses are operated on the integrated bus network which is composed of trunk, feeder and conventional lines. The buses on the trunk lines are operated with articulated and/or bi-articulated bus in the segregated busway.

Main trunk bus lines – operated by bus fleets with higher capacity on segregated busways in BR-316, Augusto Montenegro Roads and Almirante Barroso Avenue, or exclusive bus lanes on other roads to link Expansion Area/Main Center and Expansion Area / Sub-Center of Sao Braz

Secondary trunk lines – operated by bus fleets with higher capacity on segregated busways, BR-316, Augusto Montenegro Roads, or exclusive bus lanes on other roads between Expansion Area and Main Center without crossing Sao Braz

Feeders lines – operated by conventional buses to link areas outside of main corridors to some transfer points to trunk lines;

Conventional lines– operated by conventional buses to link several peripheral areas to Main Center.

In the collection system of bus fare, intelligent card system was proposed at the strategic bus terminals where many feeder lines converge. The boarding and alighting time at bus stops will be reduced when articulated or bi-articulated buses are operated under this system. Therefore, the bus operation speed will increase.

The proposed public transport system with integrated network and new collection system will be operated until 2005 as well as the terminal construction to cope with the new trunk-feeder bus system. The future bus network will expand all over the RMB due to the increase of future passenger demand and expansion of road network.

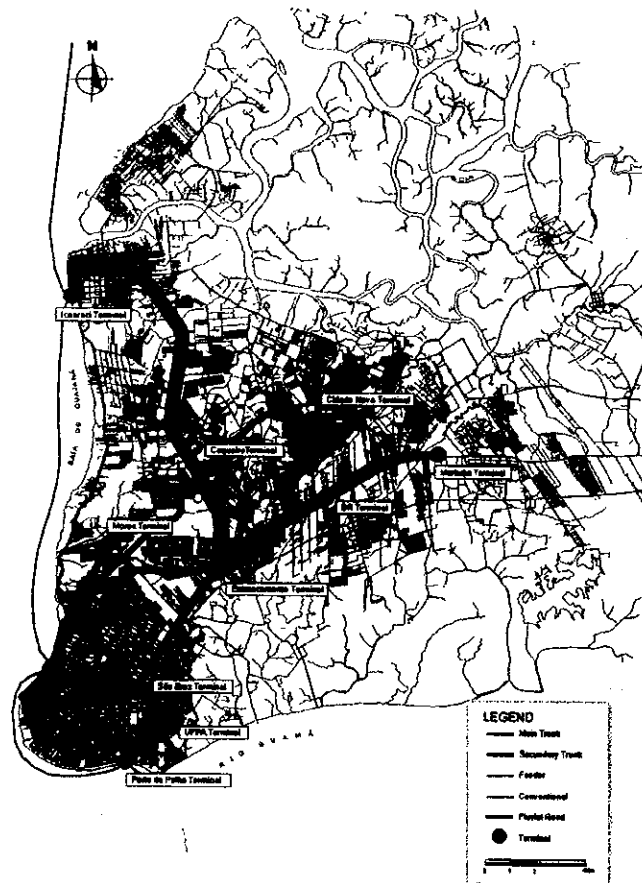


FIGURE R: Future Trunk-Feeder Bus Network Plan

(4) Traffic Management Plan

The traffic management system is proposed as follows.

Reformulation of one-way traffic system to adjust to the future road network and to new operation system in the public transport system

Proposal of bicycle road system to cope with bicycle trip demand

Proposal of measures for "traffic calming" and parking in Marco district. These measures aim to create an "good living environment condition" in the residential areas

Introduction of a modern Traffic Control System in Central Area - CTA such as traffic signal with *on line* monitor to control one-way traffic system in central area.

(5) Demand Forecast

Travel demand forecast was conducted for the estimation of private and public transport demand in Belem Metropolitan Region. The familiar four-step model was developed in PDTU/2001.

TABLE F shows the total number of trips in the morning peak hour in RMB in 2000, 2010 and 2020. The increase ratio of total number of trips between 2000 and 2020 is 1.99, in contrast to 1.67 of the population growth ratio. The ratios of car trips and bus passenger trips are 1.98 and 2.01, respectively.

The trip distribution is graphically shown with "desire lines" charts by car mode/all purposes and public transport mode /all purposes in the morning peak hour in the years of 2020 (see FIGURES S and T). The figure shows the great concentration of car and public transport flows into 1^a Legua zones, which is as much in the year 2020 as in the present. The characteristics of the desire lines indicate the expansion of travel demand between the expansion area and the 1^a Legua. Therefore, the road and transport projects need for strength of the corridor between those area.

TABLE F: Total Number of Trips by Type of Vehicles in RMB in 2000, 2010 and 2020 (without intra-zonal trips) PCU/hour

Year	2000	2010	2020	2010/2000	2020/2000
Car	30,348	44,065	60,075	1.45	1.98
Bus	191,550	276,240	384,274	1.44	2.01
Total	223,898	322,315	446,369	1.44	1.99

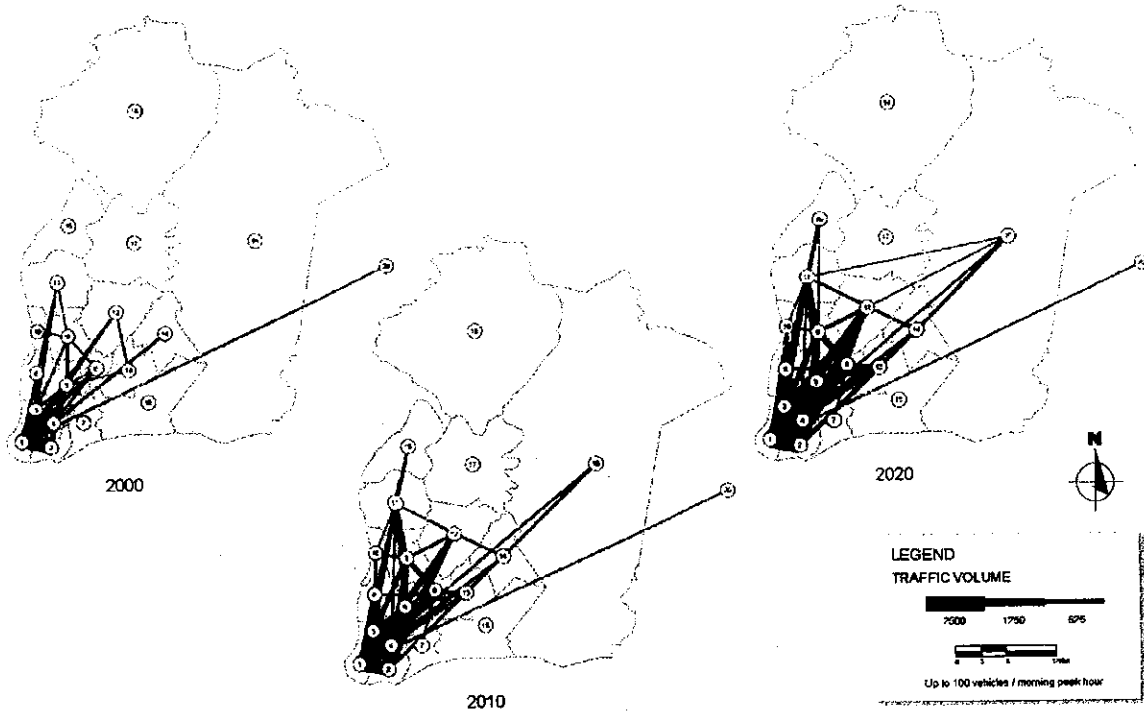


FIGURE S: Trip Desire Lines in 2000, 2010 and 2020 (car mode/all purposes)

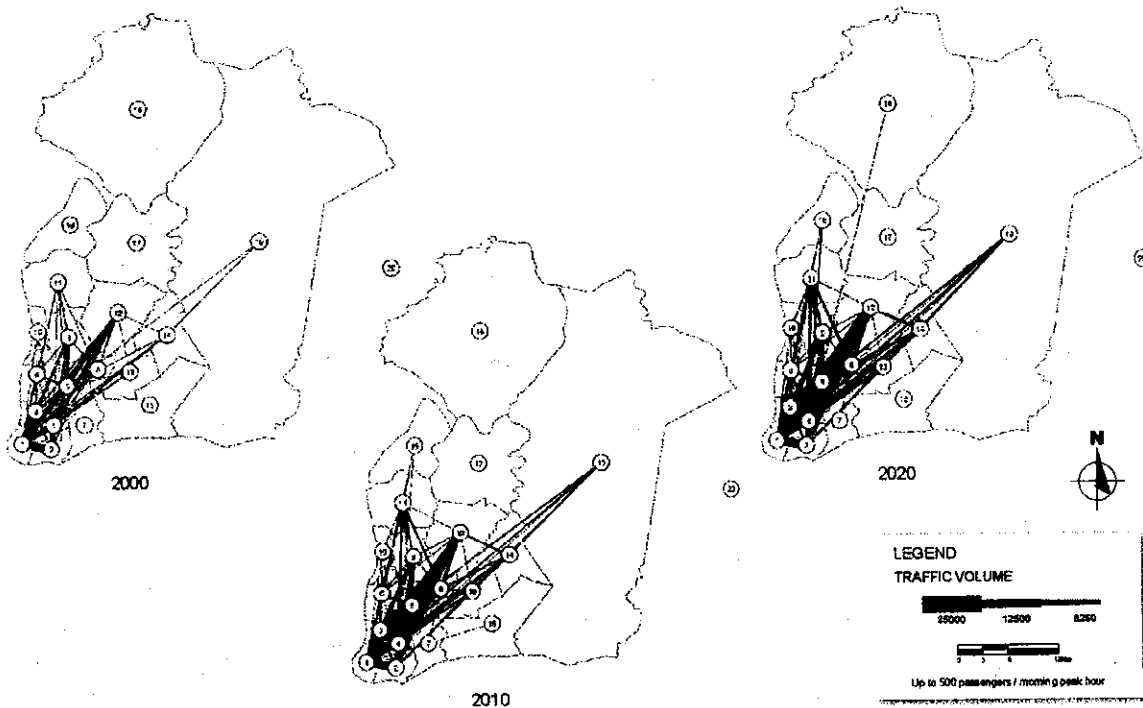


FIGURE T: Trip Desire Lines in 2000, 2010 and 2020 (public transport mode /all purposes)

(6) Summary of the Masterplan

The highest priority is given on the Masterplan in PDTU/2001 for the improvement of traffic and transport conditions in RMB. In the Masterplan, the road, public transport and traffic management system plans were proposed. For the public transport, the trunk –feeder bus system was proposed, in which large capacity buses are operated in the trunk bus lines on the main corridors with segregated busway. For the road system improvement, the network extension was proposed, especially to increase its capacity between the link of 1.ª Legua Patrimonial and the Expansion Area. For the traffic management system, the lower cost measures, which are the introduction of a CTA and the parking system in traffic crowded areas, were proposed. The proposed investment cost for the public transport and road systems reached US\$ 242.8 million.

5. Project Priority

(1) Road Project

The project priority was evaluated for implementation of road projects in the Study Area in terms of the quantifiable benefits of each project group from among the seven project groups shown in Section 4 (2).

The benefit is composed of two items; saving in vehicle operation cost (VOC) and saving in vehicle travel time cost (TTC). The TTC and VOC were calculated by traffic assignment in which future travel demand is assigned on the 7 alternative networks which add the proposed roads in each project group on the present road network. The benefit and cost, which would be brought by the implementation of the proposed project groups, are measured and compared between the "with project" and "without project" cases. The "benefit and cost" analysis was applied for criteria of priority project group.

This process was used only to obtain the relative priority rank by each project groups. The implementation schedule of each proposed project was set up from the viewpoint of economic effects, effect of traffic service level, balance of annual investment, project size, etc.

In order to make the project Implementation schedule, the priority ranking of the seven project groups was defined based on the economic performance analysis as shown in TABLE G.

TABLE.G – Comparative Evaluation of Road Projects

Group of Project	Name	PDTU					
		Financial Cost (US\$ million)	Economic Cost (US\$ million)	Benefit	B-C	B/C	Ranking
Group 1	Independência	24,590	22,967	15.130	-2	0.658794806	1
Group 2	1º de Dezembro	32,641	30,487	17.399	-2	0.570714716	2
Group 3	Liberdade	17,089	15,961	6.692	-1	0.419258978	3
Group 4	Pedro Miranda	18,829	17,586	4.601	-1	0.261633132	4
Group 5	Curuçamba-Benevides	34,216	31,958	-1.860	-2	-0.058204258	6
Group 6	Ananindeua - Icoaraci	15,989	14,933	0.722	-1	0.048318674	5
Group 7	Bernardo Sayao	19,239	17,970	-1.714	-1	-0.09539585	7

The implantation schedule sets up based on the economic performance evaluation of each group of road projects as shown in TABLE J. The characteristics of these groups are as follows.

Extension of 1º de Dezembro Avenue until Alça Viária – The performance of this corridor is the strengthening to link the areas located in the north to BR-316 Road. This project requires a careful study of the environmental impact due to the fact that the location is close to Bolonha and Água Preta lakes.

Independencia Avenue – This project is in progress by the State Government, but it is recommended that number of lanes is extended to three lanes per direction, since at the present the road is planned with two lanes for traffic. This widened lane will be prepared for the use of the trunk bus line in the public transport. In this group, the extension and enlargement of the Marinha Street is planned until the year 2005 as alternative route for traffic diversion. At the present, the Almirante Barroso and Pedro Alvares Cabral Avenues are used.

Liberdade Avenue – Although this project presents the third better performance in the economic evaluation, the project was estimated in this phase term because of low cost investment only for the road work construction. It was not taken into account the costs for the mitigation measures of the environmental impact related to the improper occupation near the lakes.

Extension of the Pedro Miranda Avenue – The Pedro Miranda extension is foreseen in the Urban Plan of Belem Municipality (in this project there is a large difficult segment for execution). The linking between Pedro Miranda Avenue and Rodolfo Chermont Street is of great importance as a structural corridor between Belem and Icoaraci. This segment will enable the connections between Dr. Freitas, Julio Cesar and Pedro Alvares Cabral Avenues. The construction of this new road involves resettlement and large road construction, especially due to the transposition of the Julio Cesar Airport.

(2) Trunk Bus Project

In the public transport system, the following projects are planned as a high priority project.

Construction of Marituba, Cidade Nova, Icoaraci terminals – those are bus terminals at the terminal points of main trunk bus lines to connect to the feeder bus routes, and the reform of Sao Braz terminal is planned. It forms the operational terminal of the trunk bus lines and links between the 1ª Legua and peripheral districts such as Guama, Terra Firme, Canudos, Sacramento, and Pedreira with trunk bus lines

Construction of busway on Almirante Barroso Avenue and BR-316 Road – the trunk bus line network is rerouted, as well as the construction of bus exclusive lane in the roads where the trunk line passes on Augusto Montenegro Road. These measures are important for good operational performance of the trunk lines.

The trunk bus operation between origin in Marituba, Cidade Nova and Icoaraci, and destination in Central Area utilizes the Sao Braz bus terminal.

(3) Project Cost

The construction costs of the project groups are presented in TABLE H. It sum approximately U\$162,5 million of dollars. These costs include the costs with works of dispossession, the road construction and other necessary construction such as bridge, fly over, etc..

TABLE H – Construction Cost by Project Group

Group of Project		Extension (km)	Total Cost (US\$x1.000)
N.º	Name		
Group 1	Independencia	39.52	24,585.52
Group 2	1º de Dezembro	38.57	32,641.14
Group 3	Liberdade	22.30	17,088.63
Group 4	Pedro Miranda	18.42	18,829.06
Group 5	Curuçamba-Benevides	35.63	34,216.48
Group 6	Ananindeua - Icoaraci	14.92	15,988.51
Group 7	Bernardo Sayao	23.98	19,239.32
TOTAL		193.34	162,588.66

The construction costs of the public transport system sum approximately US\$80 million of dollars (TABLE I), including the construction of bus terminals and exclusive busways.

TABLE I – Cost of Public Transport Project

Project	Extension (km)	Total (US\$)x1.000
BR-316 Road	10.29	9,775.00
Almirante Barroso Ave.	6.85	6,275.00
Augusto Montenegro Road	15.88	5,562.20
Road system of Area Central	15.01	6,724.48
Binary Pedro Alvares Cabral-Senador Lemos	13.94	12,318.96
Terminal Marituba (new)		8,234.24
Terminal Cidade Nova (new)		8,323.00
Terminal Icoaraci (new)		6,240.00
Terminal Porto da Palha (new)		7,860.45
Terminal Entroncamento (new)		2,141.44
Terminal Sao Braz		1,344.00
Terminal UFPA		1,344.00
Terminal Marex		1,344.00
Terminal Coqueiro		1,344.00
Terminal BR		1,344.00
TOTAL	61.97	80,174.77

6. Guideline and Recommendations

(1) Road Network

The road hierarchy and its proper management to serve all the transport modes proposed in PDTU/2001 will bring the following benefit.

To assure the smooth traffic flows in the road system composed of structural, arterial, and collector roads through the changes of one-way traffic system, parking system and traffic signal operation decreasing the struggles and increasing the security.

To improve the accessibility in the local road with proper management for parking and delivery.

To improve the traffic flow quality with discrimination and segregation of road use in the arterial road system in the central area.

To implant the bicycle path in the main roads through physical management separated from the motor vehicle traffic, aiming the minimization of traffic accidents as well as stimulating the use of the bicycle.

The whole road projects should be constructed until the year 2020 on the schedule showed in TABLE J.

(2) Public Transport System

The construction of new bus terminals as well as the consolidation of some existent terminals is proposed in this project. There are many convergence of a large number of feeder lines from the peripheral area of secondary commercial nucleus and services. Due to these attractions, these terminals should have commercial facility to earn the maintenance fee from tenants, referring to the example of other Brazilian cities.

There were ten proposed bus terminals with the several characteristics as follows (FIGURE R).

Marituba Terminal – Located near the intersection between Alça Viaria and BR-316 Road. This terminal will function as a connection point between the metropolitan and inter-municipal bus systems, where the future metropolitan bus terminal will transferred to this place.

Cidade Nova Terminal – Located on Arterial 18 between SN17 and SN3; all feeder buses from Cidade Nova and PAAR to surrounding areas concentrate on this bus terminal in which trunk lines connect between this terminal, and Center and Sao Braz.

Icoaraci Terminal– Located in Soledade Street. All feeder bus lines from Icoaraci and Outeiro areas as well as water transport lines between Mosqueiro and Cotijuba concentrate on this terminal.

Entroncamento Terminal – This terminal serves for transfer between Augusto Montenegro and BR-316 Roads, and between some feeder lines of Guanabara and Jaderlandia.

Sao Braz Terminal– Using the current terminal facility, this terminal is located on strategic point to link the districts of 1ª Legua (located outside of trunk lines) with the RMB peripheral areas through the trunk system that cross Sao Braz.

Porto da Palha Terminal– Located in Bernardo Sayao Avenue between Padre Eutiquio Street and José Bonifacio Avenue. This terminal serves conventional and feeder bus lines connecting the water transport system to urban road.

UFPA, Marex, Coqueiro and BR Terminals – These local bus terminals should be connected to the trunk-feeder bus system with improvement of their terminal facilities.

- Almirante Barroso Avenue

The road width of this avenue is between 41.20m and 42.40m with sidewalks, median and four traffic lanes in one direction. Considering the construction of trunk bus lines and future traffic demand, a segregated busway physically separated from the vehicle lanes in the central lane is proposed with total width of 16.50m.

The segregated busway would have one bus lane per direction with bays for boarding and landing with a spacing of 600m.

As for the pedestrian crossing over the segregated busways, a physical separator from bus flows is installed for the bus passenger security. The passengers safely reach to the bus stops.

Considering the physical constraint of the Almirante Barroso Avenue, the present four lane road in dualway have to be converted into three traffic lanes without extra lane for bus stop and/or parking. This brings a reduction of the lane width.

- BR-316 Road

A segregated busway physically separated from the vehicle lanes in the central lane with total width of 16.50m is proposed. This segregated lane would have one traffic lane per direction with boarding and landing bays with a spacing of 800m. The present two lane roads in dualway have to be converted into three traffic lanes with additional lane for sideway. Between the parking and the sidewalk, the construction of a bicycle road in both sides is proposed.

- Augusto Montenegro Road

The road width of Augusto Montenegro Road is variable between 35.80m and 52.40m separated by median with median and lateral sidewalks. Due to the difference of road width, the segregated bus lane is located next to the median to serve the trunk bus lines.

This segregated lane would have one bus lane per direction with boarding and landing bays with a spacing of 600m. A bus stop should be installed near the road intersections for better accessibility of passengers to the bus stops, which cross at intersections with the traffic signals.

Although the bus passengers are forced to cross the road at boarding and alighting, the segregated lane is important for the increase of bus operation speed due to stopping, parking and weaving to the traffic lane next to the lateral sidewalk. The bus lane in the left side requires the bus adaptation with left side doors.

PDTU/2001 also recommends the water transport system as public transport that should operate with high-speed boats (cruise speed of 25 knot) and 140 passenger capacity. These lines should be connected to the road system to serve the transfer demand between the two modes such as water and road transports, which does not accepted any type of economic subsidiary to the system.

The public transport system should be provided with other bus facilities such as information system to the passengers, improvement of the bus shelters, bus stop, and special services for handicap.

(3) Traffic Management System

Management of Road Parking

The most serious problem for on-street parking was detected in Central Area, especially the Ver o Peso area in the morning peak hour, 15 de Novembro Street and Presidente Vargas Avenue during all day.

In PDTU/2001 there are problems for parking that causes one-way traffic system in Central Area. The parking problems are the same as those in the big urban centers in Brazil, which are characterized by the high parking demand, and inadequacy and insufficiency of off-street parking facilities.

The permission of on-street parking in central area causes constant traffic jam due to searching parking places. The prohibition of on-street parking is recommended.

Residential Areas - there are not problems for parking in residential areas. In the older streets located near the central area where the houses do not have garage, they use the off-street parking. This causes trouble of one-way traffic system, especially in narrow streets that blocks the vehicle passage. In these areas, there are older community buildings that also do not have garage. In these cases, problem of one-way traffic aggravates the parking problems. The prohibition of on-street parking is recommended.

The solution of these problems is not always possible. The decision of allowing or not the parking is related to the planned service level of the roads. The vision and the solutions of the parking problem in these areas should consider the general aspect of the one-way traffic policy for transport and land use in city.

Centralized Control of Traffic Signals

PDTU/2001 shows the necessity of modernizing the current traffic control system, aiming at minimizing the traffic jams and increasing the operational speed of all system.

The traffic management in real time in CTA should be planned as follows.

- Traffic signal control system only in one control central
- Traffic management through video camera
- Operation of a panel set of variable messages
- Traffic information cover all area
- Vehicle detectors strategically located
- Information processed by computers
- The best signal cycle time processed by computers
- Traffic signal control system by latest technology

7. Economic Evaluation

The economic evaluation of the all projects was conducted with the cost/benefit analysis by each phase plan (short-term, mid-term and long-term) referred to the implementation schedule. The economic evaluation in PDTU/2001 was done from results of traffic assignment, comparing the economic costs of project investment with project benefits in situations "with" and "without" project cases from the reductions of:

- Vehicle operation cost of private vehicles
- Vehicle operation cost of public transport
- Passengers travel time cost of private vehicles
- Passengers travel time cost of public transport

Two distinct technological alternatives for the public transport system are considered: one is operated by bi-articulated bus with diesel engine, and the other is by bi-articulated bus with a hybrid system (electric-diesel engine).

Benefit-Cost Ratio (B/C), Net Present Value (NPV) and Economic Internal Rate of Return (EIRR) show in TABLE K. As can be seen, EIRR is approximately 23%. The economic evaluation indicates that PDTU/2001 is considerably feasible.

TABLE K Summary of Economic Analysis

Bus Types	NPV		
	B/C	Mill US\$	EIRR
Diesel Bus	4.32	51.53	23.4%
Hybrid Bus	4.30	50.94	23.3%

8. General Guideline

(1) Management of Proposed Public Transport System

In Belem Metropolitan Area, there are two public transport systems. One is an operation system within municipality that covers only one municipality, and the other is the operation within inter-municipality. The current bus management system is extremely inefficiency for operation system, tariff system and institution and as a result, it presents low quality services.

The PDTU/2001 shows the Public Transport System Plan in RMB, which presents the trunk- feeder bus system in the short-term plan. Since this public transport system covers the whole RMB including the five metropolitan municipalities, the implementation of this system should carefully consider the participation of the Para State and the five metropolitan municipalities. Those organizations should have the ability to implement and manage the institutional, financial and operational aspects in the public transport system.

(2) Further Studies Needed

The Para State Government has already requested to the Japanese government the realization of the Feasibility Study of this plan as technical cooperation through the Brazilian Cooperation Agency - ABC. This study is important to secure project funds from the international financial agencies. After conducting the Feasibility Study, the high priority projects on the recommendations in the Study will be implemented.

INTRODUCTION

Previous Work

In 1988, the Para State and the Federal Government through the Brazilian Cooperation Agency – ABC, signed a technical cooperation program with JICA – Japan International Cooperation Agency to develop the Masterplan Study on Urban Transport in Belem Metropolitan Area – PDTU that was done from November 1989 to June 1991.

The next stage of the PDTU Study would be the realization of Feasibility Studies for the viability of projects identified as high priority projects. In the stage, the economic cooperation would be requested to the Government of Japan, aiming the implementation of the high priority projects. The Feasibility Study, however, was not conducted due to the facts below:

- a) Discontinuance and great administrative reorganization in the Federal Government lead to the extinction of the Urban Transport Brazilian Enterprise – EBTU; which is responsible for making the plan, under federal assistance. At the time, there is no other agencies to accompany or implement the PDTU Study; and
- b) The same happened in the state administration, culminating with the extinction of the Urban Transport Metropolitan Enterprise – EMTU, which is responsible to execute the plan. Also the management of the Metropolitan Public Transport System was transferred to the Municipality of Belem, which is named Transport Company of Belem Municipality – CTBel. At that time CTBel did not incorporate the plan - PDTU with the CTBel's transport master plan.

Although its recommendations were not put into action, the PDTU was the most complete study of transport done in the last ten years in RMB – Belem Metropolitan Area. Both State and City offices still largely use its data and information.

However, after nine years of the completion of the PDTU, there have been many changes in the territorial composition of the RMB, which includes the municipalities of Belem and Ananindeua, the municipalities of Marituba, Benevides and Santa Barbara do Para since 1996 (FIGURE 01). It is also necessary to emphasize the fact that some road projects impact in the behavior of the transport demand, as well as the technological innovation impacts in the transport systems of medium capacity.

The population in RMB was estimated at 1,332,840 in 1991 (IBGE, Demographic Census 1991) and 1,574,487 in 1996 (IBGE, Counting 1996) which means a population growth ratio of 18.0%. This population growth was estimated considering not only the demographic growth of Belem and Ananindeua Municipalities, but also the incorporation of Marituba and Benevides Municipalities to the metropolitan area. These two municipalities: Marituba and Benevides, show a significant population growth in the last few years, adding to this new geographical configuration there is intense process of formation of peripheral area in the RMB. Besides these municipalities, the Municipality of Santa Barbara of Para has also been incorporated to the RMB. Even though it has not affected to the process of peripheral formation, the municipality has contributed to the growth of the metropolitan population.

The large demographic growth, within the peripheral municipalities of the Area, reflects directly in its public transport system, which keeps the traditional operational system with predominance of radial lines, which come from several peripheral areas and head to the center. This operational structure causes a high rate of bus loading in the main corridors where traffic jam caused by heavy bus operation frequently occurs. In the peripheral area the accessibility of bus system is low due to the inadequate road system. This forces the users who walk a long distance to access to the nearest bus stop. Although in the last seven years the public transport system of RMB has presented great increase of the supply, it is not reflected to increase of quality in the offered service level.

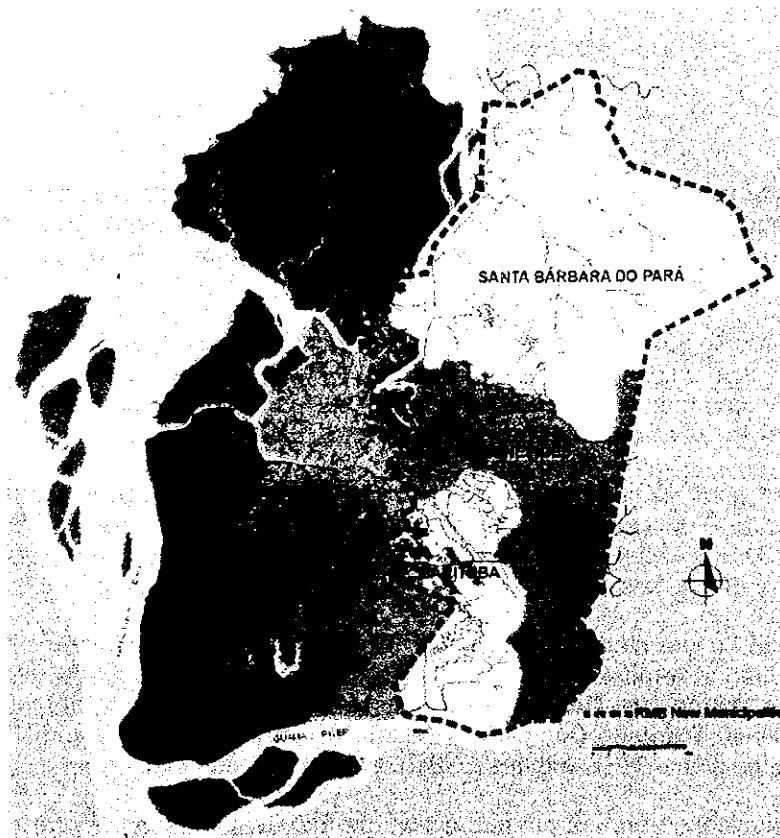


FIGURE 01: Belem Metropolitan Area – RMB
Source: COHAB/PA

The changes of above present socioeconomic and traffic conditions urge the review of the projects in PDTU. It will not only make the improvement/development plan and the immediate actions in the existing transport system, but also contribute to the further study in the high priority projects identified by PDTU.

The purpose of PDTU/2001 is as follows:

General Objective:

The urban transport plan for the road system, traffic management system, and mainly public transport system proposed in PDTU/1991, is reevaluated to cope with the expansion of the Study area and population growth in RMB. The impact of projects implemented or under construction for last decade is evaluated, as well as the possibility of introduction for the public transport system with new technology is also examined.

Specific Objectives:

- a) To survey the present conditions of road, public transport and traffic management systems;
- b) To study the possibility of new public transport system introduced in RMB in the short-term period;
- c) To get environment indicators for the particle materials on main metropolitan corridors;
- d) To forecast the future travel demand in RMB;
- e) To recommend the short-term projects in road and traffic management systems in RMB;
- f) To recommend the further study for the high priority projects as a feasibility study;
- g) To recommend transport systems, considering the travel demand and physical supply conditions on the main transport corridors in RMB;
- h) To qualify and provide tools, equipment and software programs used in the Study to the counterpart local team in the course of the Study.

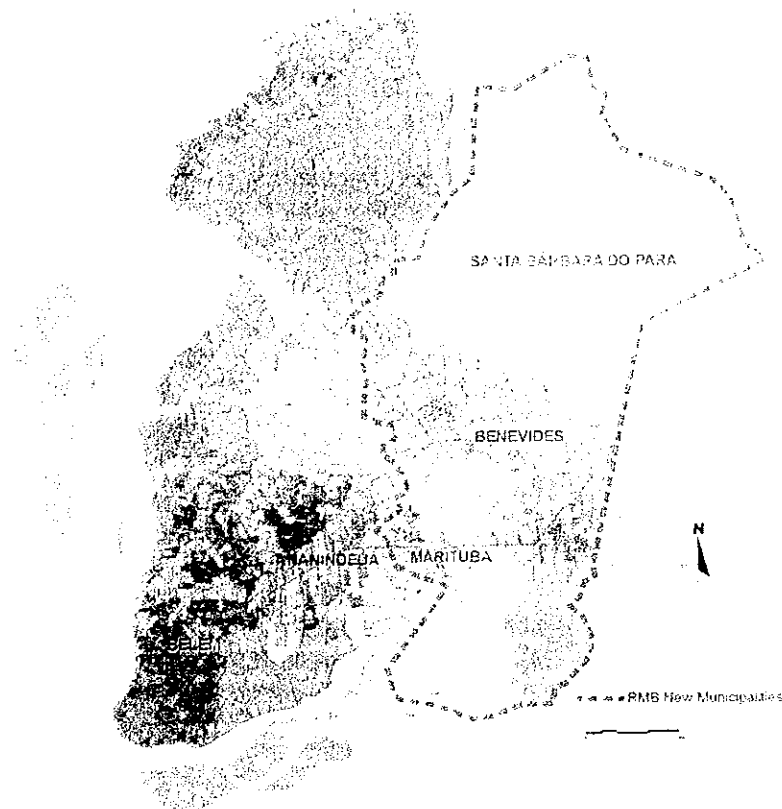


FIGURE 01. Belem Metropolitan Area – RMB

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The Update of Master Plan for Urban Transport in the Metropolitan Area of Belem – PDTU/2001 aims to review the present traffic and transport conditions in the Metropolitan Area. It developed and conducted the many types of surveys for traffic, transport and road system, including a Person Trip Survey. The purposes of the surveys are to know the characteristics of the present traffic conditions and to identify the traffic and transport problems in the Study area for formulation of Master Plan in the RMB.

The Inception Report that includes scope of work, its detailed description and its working schedule was submitted by JICA at that time.

Considering the lack of land use masterplan for the municipalities in RMB (excluding Belem Municipality), a seminar was held on August, 29 with government organizations, associations, unions, ONG and the academic community aiming qualitative discussions about the tendencies of RMB development.

Later, another seminar was held involving even a great number of community representation, in November. The problems and possible solutions to the transport system were discussed.

The Interim Report submitted in December 2000, presented the result done from May to November 2000. The tendencies of future development in RMB and the first planning approach in the transport system were presented.

The Final Report is divided into four parts. The first contains the traffic and transport survey results and analyses, highlighting the Person Trip Survey whose purpose is to collect the trip data and socioeconomic data. The environment impact survey for transport systems was also conducted at first time.

In the second, the present socioeconomic structure and the tendency in the RMB were identified. Through the future limits of the Study Area, the future socioeconomic frame was planned.

The formulation of the future transport system in the RMB is the third part in which alternatives are made to solve the present traffic and transport problems.

The Final Report also contains the social-economic evaluation. The fourth part includes the most significant recommendation of the development projects for the road network system, public transport system, and traffic management system for the next twenty years as well as general recommendations of the program suggestion and the implantation program.

