2.3. EXISTING AND FUTURE SOCIOECONOMIC FRAME

Based on the socioeconomic tendency discussed in the Seminar, the quality tendency of each socioeconomic indices by 100 traffic zones (TZ) is identified, considering several factors such as the TZ location near the main traffic corridors, project impacts and the legal conditions. This work has been worried to maintain the general tendency of the integrated zones in the Seminar when those are divided into the TZ.

On the next step, actual figures of the socioeconomics are forecasted based on the future tendencies of each TZ taking into account the future projects. For this, the procedures in each variable are taken as follows:

a) Average geometric rate of annual evolution in several TZs between 1990[7] and 2000 (1991[8] and 2000 population). To reduce occurrence of excessively high value of rate or impossibility of calculation (cases in which the initial variable value is zero), the values of TZs in 2000 which were divided from TZs in 1990 were regrouped respectively;

b) Normalization of calculated rate referring to a general average of the group of TZs. On variables presented great inconsistency with the standard deviation between the positive value and negatives value, it was necessary to divide the normal curve into two segments;

c) Expurgation of values over 10.0% higher and lower than the normal curve in order to eliminate the highest values and to have results more consistence;

d) Division of rest of normal curve (80.0% of original area) into five segments of 16.0% area, each corresponding to a qualitative tendency defined on Seminar whose limit values are: (-) 40.0% to (-)24.0% for "accentuated reduction"; (-)24.0% to (-)8.0% for "moderate reduction"; (-)8.0% to 8.0% for "maintaining present tendency"; 8.0% to 24.0% for "moderate increasing"; and 24.0% to 40.0% for "accentuated increasing";

e) Definition of a single value to correspond to each one of qualitative tendencies. Considered the average point of each five links defined before; and

f) Transformation of normalized five values, which were defined at previous item into a original TZ (annual rate). There are five annual rate values that represent the five tendency points on seminar.

The next step is to estimate the increase rates of 2010 to 2000 in each TZ, based on the one of the five rate values calculated above according to the integrated zone tendency indicated in the Seminar. The estimated decennial rate of each TZ is multiplied by the value on 2000 and then, findings are an estimated value in 2010.

The estimated values are still provisional value. The sum of estimated values in 2010 in each TZ does not coincide with the global value of the tendential rates. Therefore, the global value is reflected as the total sum of estimated values in each zone. Finally, the estimated values in each TZ are adjusted by using the total sum. For example, suppose the population-increasing rate from 2000 to 2010 is less than the last decade, considering a set of socioeconomic factors, the same tendency will occur on 2010-2020 comparatively to anterior decade.

[7] JICA. Masterplan Study Urban Transports Belem Metropolitan Area – PDTU. Belém, 1991.
[8] IBGE. *Demographic Census 1991*: special tabulations. Rio de Janeiro, 1991.

For 2000-2010 period, the procedure was as follow;

a) Calculation of percentage of provisional absolute variation for any TZ (this is defined by estimate provisional value to 2010 deducted from 2000 value observed on Person Trip Survey) in the total provisional absolute variation of variable on 2000-2010 (defined by the sum of provisional absolute variations of some TZs);

b) Definitive absolute variation estimate of each TZ on 2000-2010 obtained by application of calculated percentage of previous item to total absolute variation of variable expected for the period; and

c) Variable value estimate on 2010, derived from the sum of the result of previous item and the value of TZ value on 2000.

In this step, it is most important to adjust the estimated TZ's values to the estimated global evolution; the final rates calculated to TZs are different from the tendencies in the Seminar.

On period 2010-2020 the way was similar to the anterior, the difference is the rate adopted to calculate TZ provisional value in 2020 were the rate estimated for the anterior period, resulting from evolution between variable value observed in 2000 and the estimated definitive value to 2010.

Relating to a global variable behavior expected on projection (2001-2020), it is necessary that:

a) In population variable, the estimated annual rates to periods of 2000-2010 and 2010-2020 are 2.65% and 2.54% respectively showing a tendency of reduction of increase in demographic rates on the last twenty years (2.92% in 1980-1991 and 2.78% in 1991-2000).It had been adopted, therefore, the same tendency of decreasing rate observed between the two periods;

b) For occupation variables of secondary and tertiary industry, the estimate to 2010 and 2020 years were figured out based on populations percentage observed in 2000. This procedure is explained by considering that there is a historical tendency to tertiaries increasing occupations not only on Belem Metropolitan Area but also in several others local and it can be considered an strong capitalism tendency on last hundred years. According to the scenarios elaborated for the RMB on Seminar, it is expected the same regression crisis on secondary sector as affected on 90´s, with the beginning of a cycle of increase in industrial activities which may supply the increase of occupations in this sector. Explain the same percentage level in 2000 in both sectors;

c) For primaries occupations, it was adopted the average annual increasing rate observed on 1990-2000;

d) For admission student's variable, it is also maintained the same population percentage reported on 2000. The reason is that if exist an increasing tendency of school admission, there is also a tendency of young age stratum reduction – whose go to school – to others; and

e) For income variable it was adopted the intermediate increasing rates between verified tendency on 1990 – 2000 and the Brazilian estimate by Eletronorte scenarios[9] for the period of 2000-2020. The selection of this rate was based on estimate (undirect) of GRDP-Gross Regional Development Product elaborated by the study team, the figure was close to the country's than to Para State's.

[9] ELETRONORTE. (1998) Socioenergetics Scenarios to Amazon – 1998-2000.

The population, employment's and income projections to 2010 and 2020 are presented in the items followed.

After results of quantification obtained on Seminar "Belem Metropolitan Area Tendencies of Development", the population, school admission, income and tertiaries employment dates, were systematized in graphics for accurate analysis; primary and secondary employment's do not have been analyzed in this item because the small percentage (near 9.0%), however they are considered on molding process to get futures demands.

The population and employment percentage related to the total in 2000, 2010 and 2020 are shown in FIGURE 2.3-1 divided into two parts: 1.ª Legua and others areas of RMB:

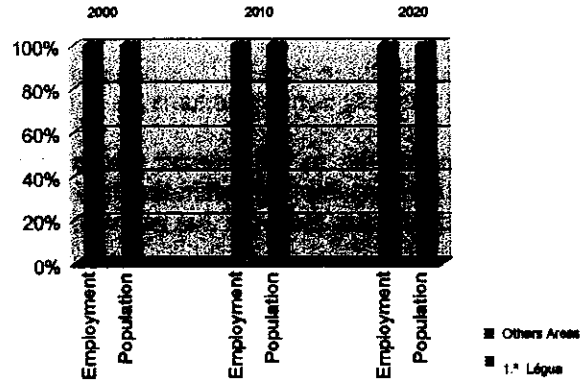

FIGURE 2.3-1 – Balance of Population and Labor between 2000, 2010 e 2020

Through this figure it could be noted that in the period from 2000 to 2020. There is a small percentage of employment increase in the 1.a Legua total from 56.0% to 58.0 %, meanwhile population in others areas increase from 62.0% to 75.0% to the total. These numbers show an expressive increase on next 20 years of transport demands between 1.ª Legua and others areas.

To analyze the population development, tertiaries employment's and admission schools tendencies, density graphics were made per traffic zone – TZ, in 2000, 2010 and 2020 (FIGURES 2.3-2, 2.3-3 and 2.3-4). Although traffic zone was to small to analyze in this study, on peripheral zones, it was also difficult to make precise comparisons and evaluations about densities because its dimensions. The household income is expressed in average values per TZ for the same years (FIGURE 2.3-5).

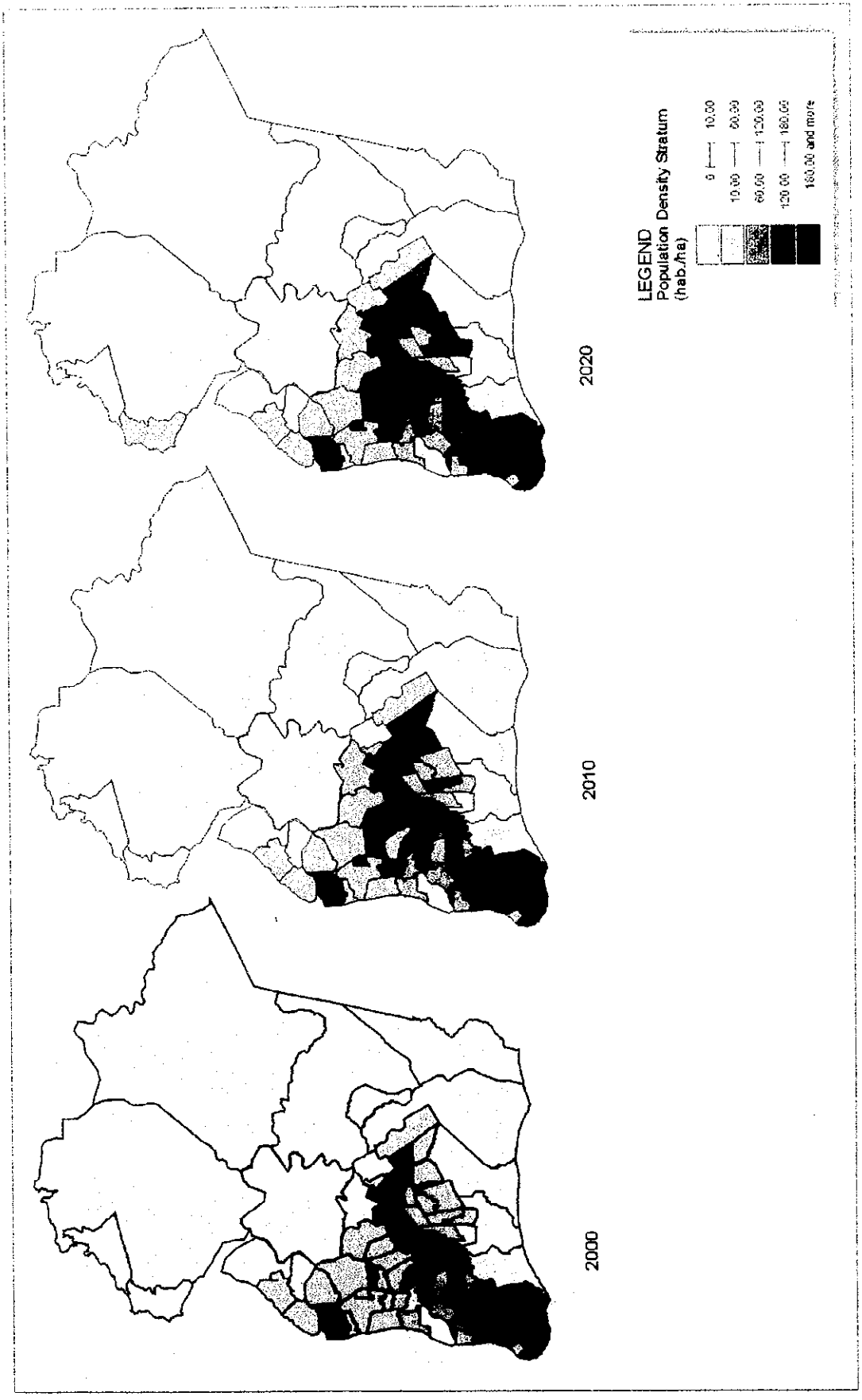

FIGURE 2.3-2 - Populational Density (hab./ha) 2000/ 2010 / 2020

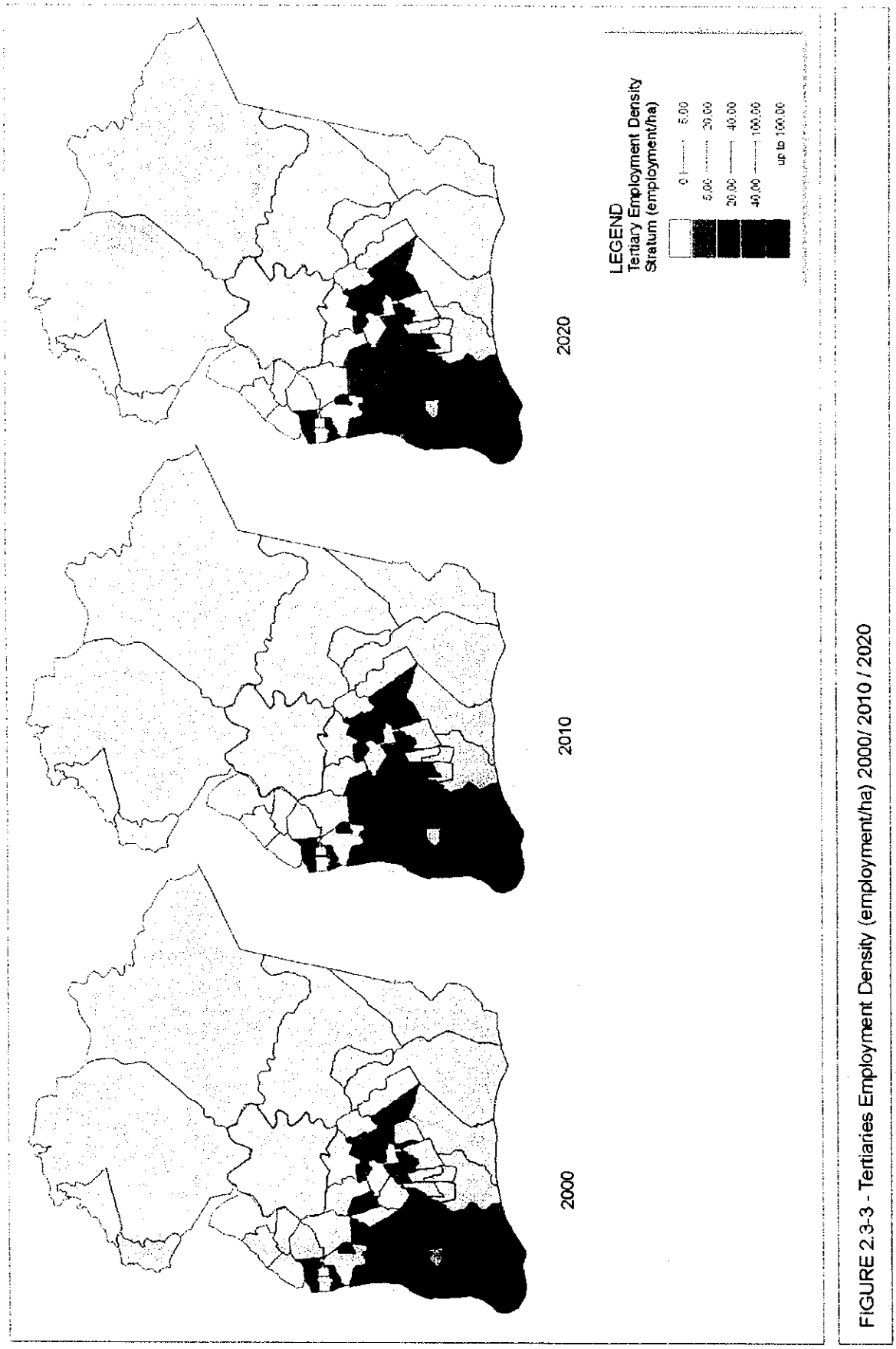

FIGURE 2.3-3 - Tertiaries Employment Density (employment/ha) 2000/ 2010 / 2020

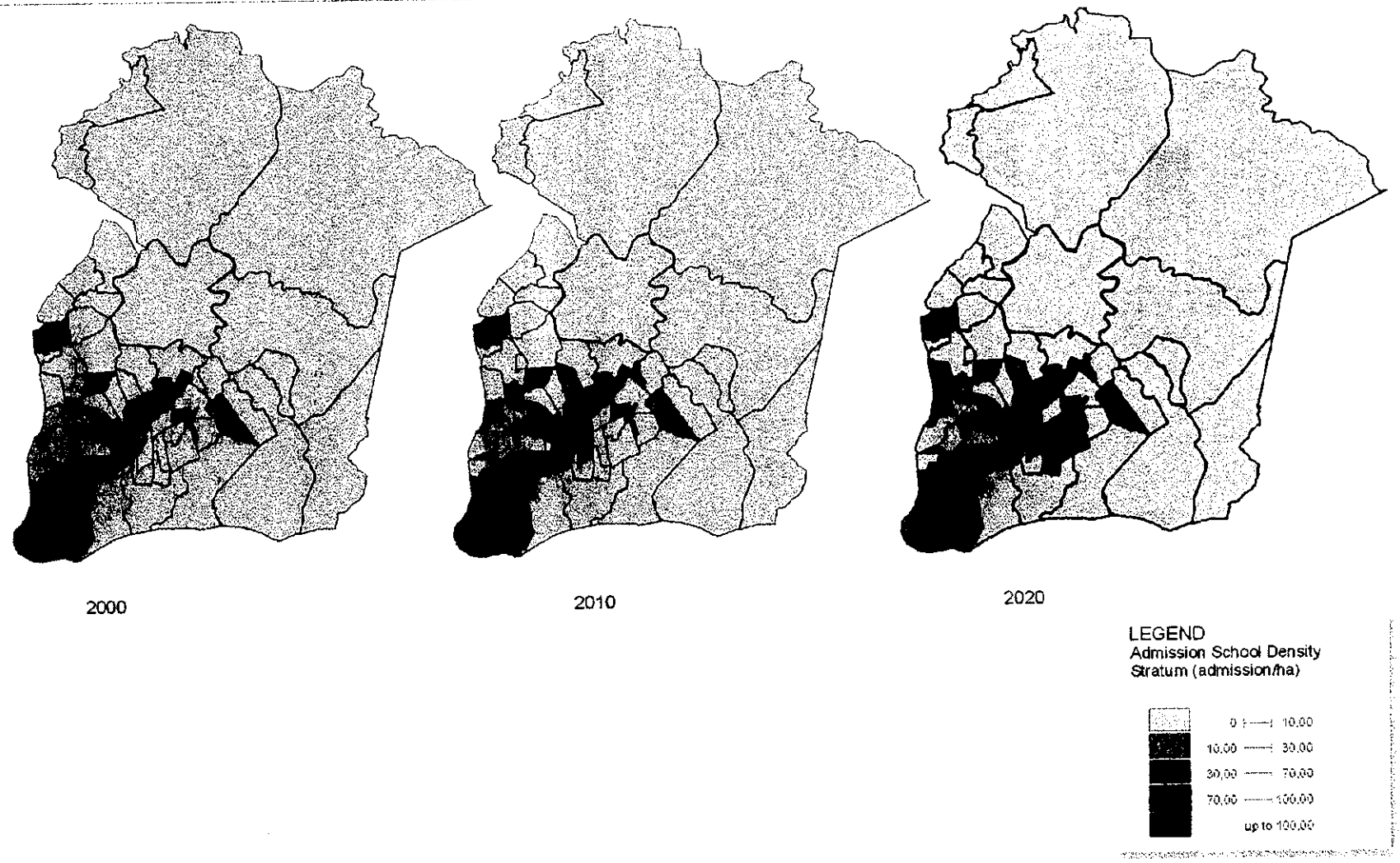

FIGURE 2.3-4 - Admission School Density (admission/ha) 2000/ 2010 / 2020

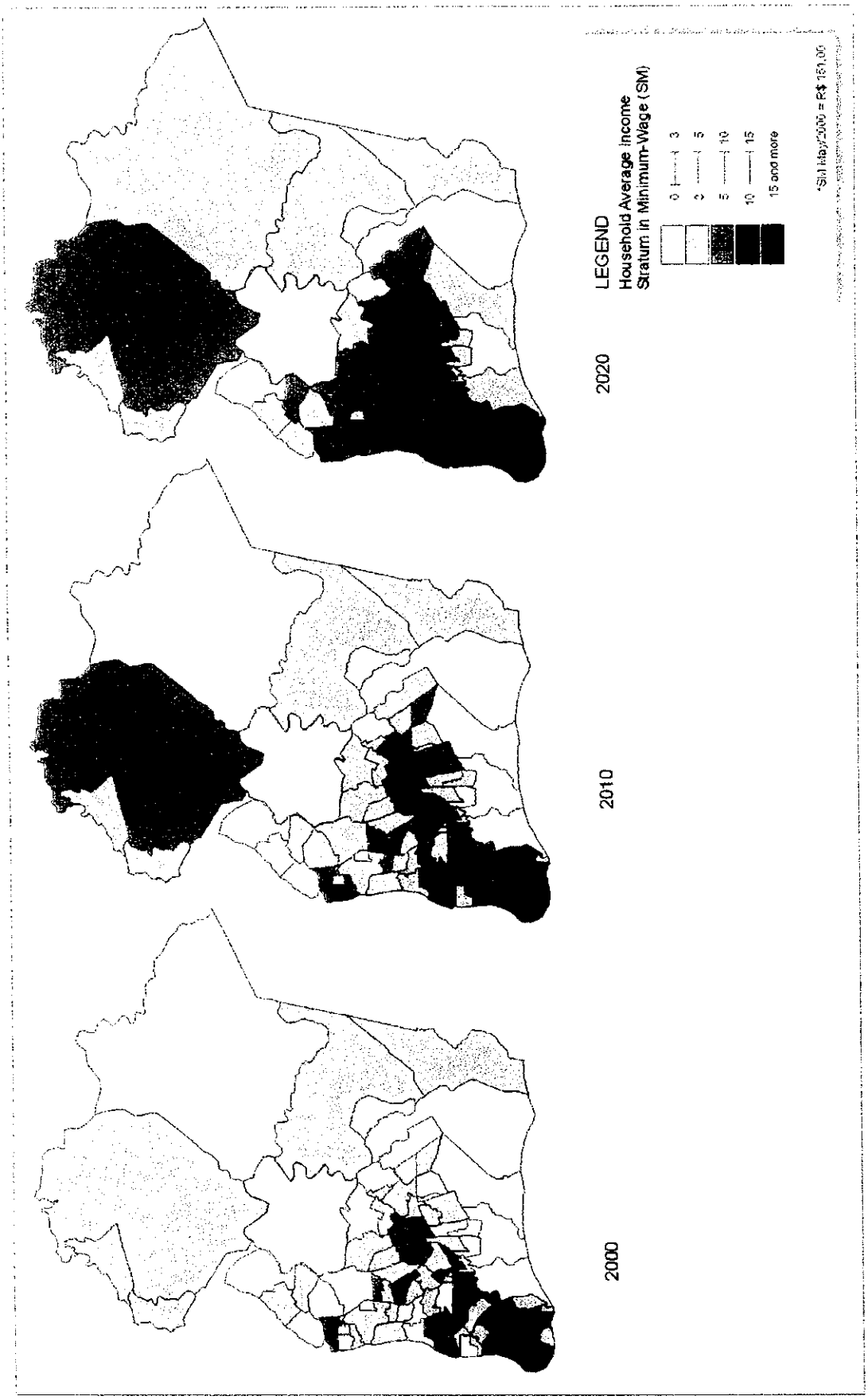

FIGURE 2.3-5 - Household Average Income - 2000/ 2010 / 2020

2.3.1 POPULATION

Referring to population density maps (FIGURE.2.3-2), the highest population density locates in 1.ª Legua. The second higher locations are in the central large peak[10], Umarizal, Telegrafo Districts, Icoaraci, Cidade Nova and Entroncamento. The medium range of the density of 60 to 120 persons/ha is in the surrounding areas of Cidade Nova, Benguí and Icoaraci.

In 2010, the population density is slightly increase on 1.a Légua and Telegrafo district, while a condensation is more expressive on other areas, especially the areas along BR-316 and Augusto Montenegro Roads, and Icoaraci, Cidade Nova and PAAR.

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

2.3.2. TERTIARY EMPLOYMENT

FIGURE 2.3-3 shows the density of employment for the tertiary sector in 2000 on Comercio, Reduto, and Batista Campos district which expand to Padre Eutiquio axis until Condor, São Braz, UFPA Campus and part of Nazare districts. The density stratums in those areas are 100 or more employment/ha. These values decrease to second stratum in these surrounding areas which are 1.a Legua at Sacramenta, Telegrafo and some dispersed areas such as Icoaraci and Administration Center in Expansion Area.

As second rank, some 1.ª Legua peripheral areas, the Entroncamento surrounding, one TZ in Icoaraci, in Administration Center and Ananindeua. The next stratum are Cidade Nova, Augusto Montenegro, and Arthur Bernardes area.

On 2010 year (FIGURE 2.3-3), the main nucleus reach Umarizal, São Braz and Entroncamento. The second stratum expands to almost total area of the 1.ª Legua and to Entroncamento and Ananindeua. While the third stratum increases in Icoaraci and expands to Cidade Nova and Marituba, the others areas stay same densities.

The last map (FIGURE 2.3-3) shows the first stratum expansion from 1.ª Legua, to along the Almirante Barroso Avenue. The second stratums occupy total area of the 1.ª Legua and increase in surrounding of Entroncamento. The third one increases in Cidade Nova, Icoaraci and at the beginning of Augusto Montenegro Road.

2.3.3. ADMISSION SCHOOLS

The admission schools density map in 2000 (FIGURE 2.3-4), emphasizes the major admission density on 1.ª Legua in Batista Campos, Nazare and São Braz districts, besides traffic zones of UFPA and UNAMA campus. The second stratum is located only in Marco district. The third one has the predominance in 1.ª Legua, Marambaia, Entroncamento, Cidade Nova, and Icoaraci areas. The stratum from 10 to 30 admissions/ha shows large concentration along BR 316 Road until Marituba and Augusto Montenegro Road zones.

In 2010 (FIGURE 2.3-4), the first stratum remain unaltered in 1.ª Legua, while the second stratum shows an intensification in Marco, Terra Firme, Guama and Comercio district besides traffic zones in Bengui and Entroncamento. The third stratums is almost totally in 1.a Legua and intensify in Marambaia, Cidade Nova, Ananindeua and Icoaraci. The last two stratums remain unaltered.

In 2020 (FIGURE 2.3-4) , there is an increase of the first stratum in 1.ª Legua along Almirante Barroso Avenue and Terra Firme district. The second stratums predominate in others areas of the 1.ª Legua, in Marambaia, and in some Icoaraci zones. The others stratum do not show any any change.

[10] Highest area in Belem that has as central axis the corridor formed by Nazare, Magalhães Barata, and Almirante Barroso Avenues

2.3.4. INCOME

The average household income would increase in future, since the estimated increase rate of future GRDP adopted the medium rate between the tendency during 1990-2000, and that of favorite estimation during 2000-2020- referred to the Study on Eletronorte Macroeconomics Scenery.

The stratums of the average household income are presented at the minimum salary stratum (FIGURE 2.3-5). In 2000, the highest income stratum which is 10 times more than the minimum salary is in surrounding traditional center areas and the central peak of 1.ª Legua. The third stratum (5 to 10 salaries) occupies the area along Almirante Barroso Avenue in the 1.ª Legua, in Entroncamento, Cidade Nova and part of Icoaraci. The fourth stratum (3 to 5 salaries) in 1.ª Legua shows only on Condor, Terra Firme and Sacramenta. The areas on the fourth stratum are along BR- 316 and Augusto Montenegro Roads and surrounding Cidade Nova. The stratum is observed in traffic zones located on the Benevides Prefecture City Hall, Benfica District and Mosqueiro Island.

In 2010 (FIGURE 2.3-5), the first and second stratum occupy almost the same areas of 1.ª Legua, that were verified in 2000 and emerge discretely on Expansion Area. The third (5 to 10 salaries) extends along BR-316 Road, surrounding Cidade Nova, Icoaraci, Marambaia and some links on Augusto Montenegro Road, besides appear in major traffic zone of Mosqueiro. The stratum from 0 to 5 salaries is in surrounding areas of Belem and Ananindeua Municipalities, in major part of Marituba Municipality and in total area of Benevides and Santa Barbara do Para Municipalities.

The increase rate in 2020 (FIGURE 2.3-5) indicates an expansion of high stratum in Central Peak surrounding, next to Entroncamento, and Cidade Nova residential. The second stratum occupies almost total area of 1.ª Legua, Marambaia, and some TZs along BR-316. The stratum from 5 to 10 salaries is located around the first two stratums priory mentioned and comes mainly in direction to Icoaraci and north of Cidade Nova residential. The fourth stratum shows the zones of Benevides, Santa Barbara do Para and Ville of Benfica.

Besides the absolute increase of household average income, these maps indicate the permanence of highest stratum on 1.ª Legua and its expansion along BR-316 Road, decreasing to low stratum as they are away from these areas.

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CHAPTER 3
DIAGNOSTIC AND PROGNOSTIC

3.1. IDENTIFICATION OF TRANSPORT PROBLEMS ON BELEM METROPOLITAN AREA

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 as follow. In Section 3.2, it is presented in more detail. The plans are made by identification of existing and future problems in the transport system in the Study Area. This section is also included recommendation for its solution.
This general scenario is the result of the "Seminar on Diagnostic and Directive Formulation of RMB Transport System" held in November 14th, 2000 (FIGURE 3.1-1). The 61 people representatives of government and non-government institutions as well as specialists and technicians related with urban development and transport on RMB - Belem Metropolitan Area participated in the seminar.

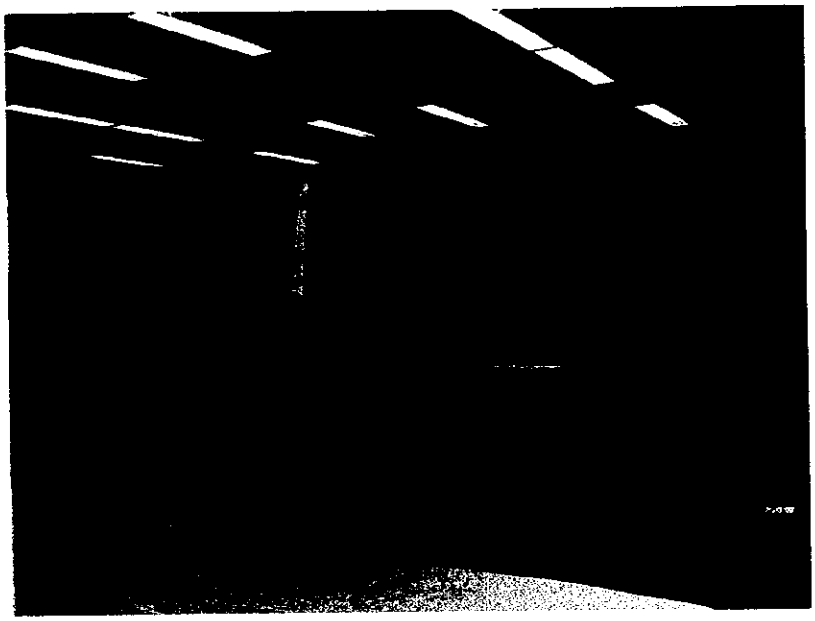


FIGURE 3.1-1 – Scene the Seminar for Diagnostic and Directive Formulation of RMB Transport System

3.1.1. GENERAL PROBLEMS

In the seminar, the problems of urban transport, road and management systems are discussed. As for other aspects, the measures of solutions are shown in the seminar.

3.1.1.1 Land Use

Only the Belem Municipality among RMB-Belem Metropolitan Area has prepared the Urban Masterplan - PDU which is based on the recommendations of PDTU/1991 by Para State Government and JICA. Several institutions and searches present influence for the mutual relationship between land use and transport policies in seminar. Especially referring to the analysis of land use tendency, the increase of traffic generation along new corridors foreces to implemente the projects of "Macrodrenagem da Bacia do Una" and "Independencia Avenue".

As for other RMB municipalities that do not have yet Urban Masterplans, the importance of these urban policy and these actual plans to propose on PDTU/2001 had been detached, specially the road hierarchyzation and the new integration terminal localization.
The working groups suggested specific actions for the land use and occupation planning in the seminar.

- Reevaluation of Historic Center Area as for current function and new role

- Promotion and consolidation of schools and others attraction poles outside of Central Area by introducing legal land use rules
- Traffic impact studies on construction of UNAMA on BR-316
- Recommendation for elaboration of Urban Masterplan in others cities

3.1.1.2 Management

The poor administration for the metropolitan public transport system was mentioned on seminar as big problem which should be solved in high priority. The administration for the public transport system in cooperation with Para State and all prefectures is extreamly important.
Working groups in the seminar had mentioned these recommendations.

- To propose the definition of metropolitan transport administration with equal participation.
- To propose the definition of metropolitan transport regulation.
- To recommend the special legislation regulation of land use for traffic poles.

3.1.1.3 Environment

Environment problems had been focused on as matters related to the public transport system and the road system as well as the compatibility between the land use and environmental management. The problmes of the current uncontrolled bus emission gas from the bus fleets are discussed, though these particles from buses are periodically emitted on the regulated bus operation. The pollution control by future new technologies which is less pollution, will be indicated as the way to solve these problems.

The investigation of pollutants of emission gas from buses is also recommended, since the bus transport contributes to the responsibility for the major part of urban air pollution.

As for the proposed road system, there are the several contrary manifestations to Liberdade Road project (FIGURE 3.1-2), because the alignment of this road project crosses the protection lake area that is the source of water supply in Belem. The road project in this area needs a further study of environmental impacts to avoide serious contamination of lakes. The necessity of the environment assessment in the economic feasibility study had been detached as fundamental importance.

The strong relationship between transport system and land use recommends the realization of environmental protective zoning in the RMB to create territorial spaces..

3.1.1.4. Security

Another important aspect is the security problem demonstrated in the user opinion survey as well as for in the seminar. Such problems, though their origins are not related to the transport systems, deserve special attention, as long as they couse retraction of passengers demand, provoking serious consequences to the selective transport system. It has been recommended studies on security system as way a to change it more attractive.

3.1.2. ROAD SYSTEM

The road alternatives are made taking into account the current RMB road network, the road projects in progress and the present traffic conditions surveyed in the Study. FIGURE 3.1-2 shows the road alternatives which are discussed in the seminar and will further be evaluated by the traffic assignment method which assigns future traffic volumes on the road network.

On basic network suggests:
- To implement a binary system among Senador Lemos and Pedro Alvares Cabral avenues, on section Dr. Freitas / Arthur Bernardes, as a way to improve the traffic flow and as well the circulation conditions of sidewalk pedestrians; and
- To consolidate the binary system, Alcindo Cacela / 9 da Janeiro with the implementation of section on 9 de Janeiro between São Miguel and Padre Eutiquio streets.

Among the road projects in progress, it is remarked the importance of the Independencia Avenue that is been constructed (section Augusto Montenegro - BR-316 Roads), the extension of 1º de Dezembro as well as Alça Viaria.

In order to improve traffic flow conditions and accessibility, the road network alternatives are made to cope with the expansion of urban area and increase of future travel demand in the Metropolitan Area. The alternatives promote the effective relation between the present network and future road plans.

The problems and suggestions in the road network system discussed in the seminar are presented as follows:

Problem 1:

The current road system is not adequated to motorized vehicle demand, especially on the section of the center-periphery-center area, where the road network between 1.a Legua and Expansion Area in the Metropolitan Area discontinuously exists. This missing-link of trunk roads causes traffic congestion near this area.

Only two major structural axes, which are BR-316 and Augusto Montenegro, exist in the Expansion Area on which these two axes converge with ineffevtive road network system. Another part of the problems is the configulation of only one transport axis among metropolitan municipalities, states and federal road network.

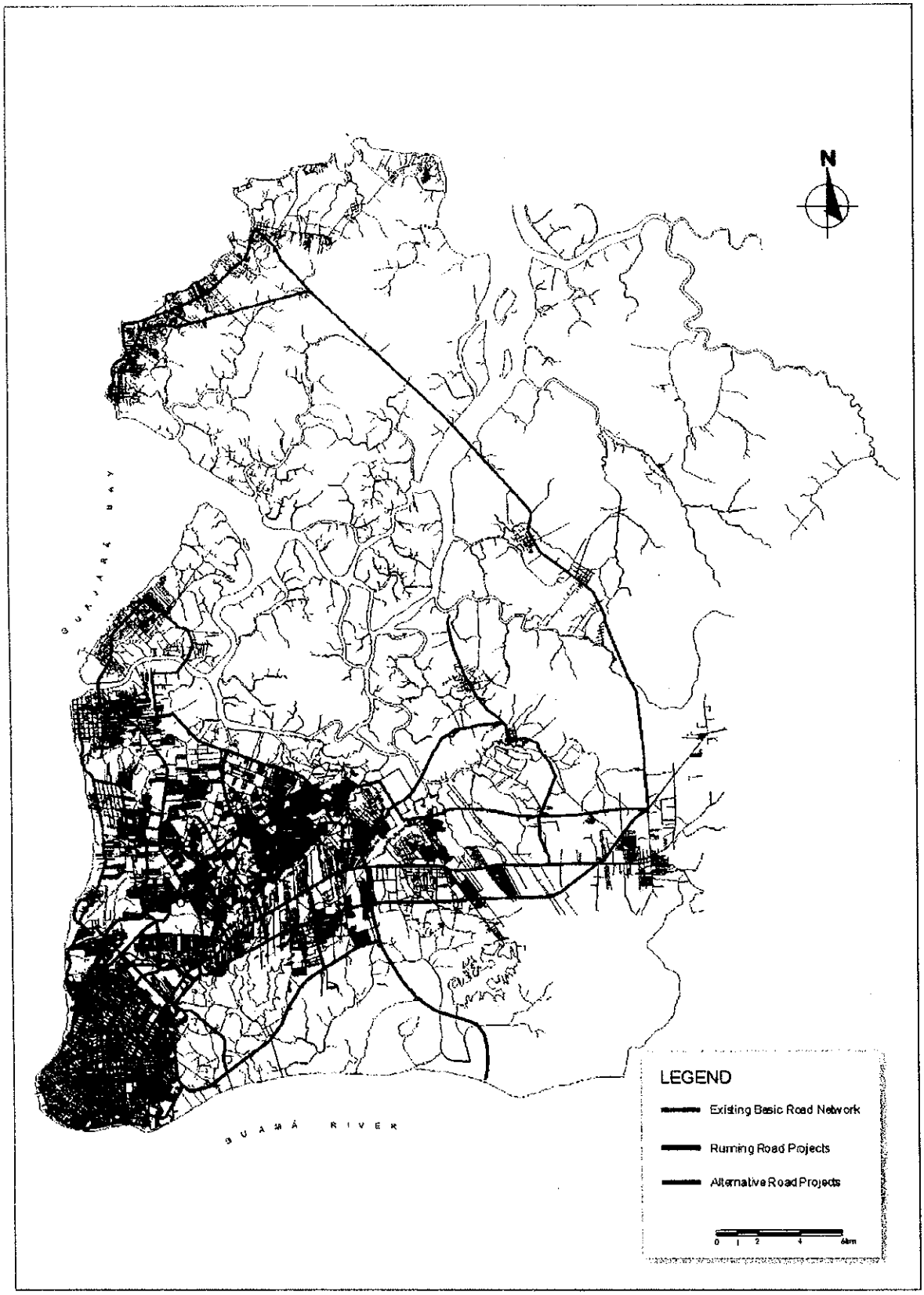


FIGURE 3.1-2 - Existing Road Network and Alternative Network utilized for Discussion

Suggestions from the Seminar:

The following suggestions by the Seminar participants have been formulated, based on the future road network alternatives and RMB future travel demand.

- Implementation of road segments:
  - Alça Viaria
  - Extension of Pedro Miranda Ave.
  - Extension of 1.o de Dezembro Ave. in consideration of alternatives of road alignment due to passing through a lake protection area.
  - To conduct the feasibility study on Liberdade Ave. on which cost estimate by measurement related to environmental impacts in the lake areas is further studied.
  - To study the impacts of land aquisition and resettlement for necessity of the land use to the Independencia Ave. project.
  - To improve the section among Industrial Districts of Ananindeua and Icoaraci.
  - To improve sections inside districts.
- Connection of road network in the 1.a Legua and Expansion Area:
  - Extension of Pedro Miranda and Duque de Caxias Ave.
  - Interconnection of the Yamada Street through Bengui and Pedro Álvares Cabral Ave.
  - Integration between roads related to Macro Drainage Project and the present road network system.

- Connection between 1o de Dezembro / BR-316 / Independencia Ave., Augusto Montenegro and Arthur Bernardes / Alça Rodoviaria axis
- Integration of water transport and road transport

Problem 2:

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.

Seminar Suggestions:

- To propose a metropolitan road hierarchy – considering the physical and geometric characteristics - connected with municipal roads.
- To propose routes that divert a heavy cargo transport flow from urban area.
- To propose revision and implementation of urban legislation in the municipalities and to implement of road maintenance plans.
- To propose support system that encourage the construction of sidewalks by residents themselves.
- To propose a segregated busway for the public transport on the major bus routes.
- To propose bus exclusive lane on several streets.

Problem 3:

Although there is a little bicycle trips in the RMB, there is little concern for bicyle path in the Study area.

Seminar Suggestions:

- Proposition of ciclyroads network on roads among the Districts of Icoaraci and Belem (Augusto Montenegro Ave., Arthur Bernardes Road), Bernardo Sayão Ave., Independencia Ave., 1° de Dezembro Ave., Liberdade Ave., Coqueiro Road, Tapanã Road, anticipating the modal integration bus and bicycle on integration terminals.
- Proposition of ciclyroads systems intro-districts.

Problem 4:

Major circulation / ring roads precariously exist in the Study Area at present. In future, it is necessary to plan major ring roads in the Study Area.

• **Seminar Suggestions:**

- Proposition of revitalization on Bernardo Sayão Road to facilitate the section among Arthur Bernardes Road and Perimetral by pass traffic
- Proposition of diametric roads potencialization (North/South)

3.1.3. PUBLIC TRANSPORT SYSTEM

Problem 1:

At present, the current bus operational system of the public transport is inadequate and incompatible with the RMB passenger dimension such as extension of physical opeartional area, bus operation, and fare system. Urban Bus routes concentrate to only one road on main radial corridors. On the other hand, inter-municipal bus routes also lack.

Seminar Suggestions:

- To propose the implementation of the current public transport system such as bus routes, operation system and fare collection system.
- To consider new public transport technologies to improve passenger capacity.
- To consider alternatives of trunk-feeder bus system.
- To consider inter-modal integration (car and bicycle) at bus terminal areas.
- To propose bus parking facilities near pheriferic areas in Historic Center area (car and bicycle).
- To evaluates new bus lines to cope with new trunk-feeder bus system.
- To studies the bus terminal facilities considering the possibility of commercial activity out of the Central Area.
- To propose alternative routes to cope with passenger demand.
- To define the integrated bus system with inter-district bus and urban bus services to cope with the district characteristics.

Problem 2:

Inadequated localization of Bus Terminals

Seminar Suggestions:

- To propose the transfer of Inter-Municipal Bus Terminal to place near Alça Viaria on BR-316 in the Marituba Municipality.
- To study the future utilization of current bus terminals as an integrated urban bus terminal system.

Problem 3:

Unbalance of public transport demand and supply.

Seminar Suggestions:

- To recommend the implementation of operation control system with data supported by electronic control equipment installed in each vehicle.

Problem 4:

Selective transport operating insufficiently without attending their objectives

Seminar Suggestions:

- To study how to assure security on selective transport
- To study reformulation or redefinition of network of selective transport and complementary transport to the main system, attending inter-districts sections.
- To consider transportatio for specials necessities

Problem 5:

No regulation of emission gas and noise pollution from bus fleets.

Seminar Suggestions:

- To research "clean" emission technologies
- To enact specific legislation for emission gas and noise pollution.
- To recommend certification of quality of public transport to environment.

Problem 6:

Inadequate or insufficient support of infrastructure to the public transport.

Seminar Suggestions:

- To recommend the improvement of infrastructure to maintaine bus operation with minimum confortable service on main routes.

3.1.4. TRAFFIC MANAGEMENT SYSTEM

Problem 1:

Traffic signs and signals are inadequate and precarious not to cope with road hierarchy in the urban area.

Seminar Suggestions:

-To propose an intelligent and integrated traffic control system.
- To propose the modernization of traffic control and management system.
- To recommend the improvement of traffic signal,
- To recommend the orientations and campaigns for the traffic safety education.

Problem 2:

Disarticulation among land use and circulation policies.

Seminar Suggestions:

To propose land use and circulation policies, with priority to the public transport and pedestrian circulation, incorporating the necessary adaptations to facilitate circulation of carrier with special necessities.

Problem 3:

Absence of parking policy to central area.

Seminar Suggestions:

- To propose solutions to restrict the use of private vehicles on Historic Center.
- To propose pheriferal parking on Central Area with physical and fare integration to public transport of selective system, parking restrictions in certain roads and adoption of rotate parking in other central area roads.

Problem 4:

Absence of cargo transport regulation

Seminar Suggestions:

To reevaluate the cargo transport regulation considering the land use legislation proposing criterions for schedules, types and roads.

Problem 5:

Absence of a project for orientation of circulation system on districts, tourist points and historic center.

Seminar Suggestions:

To recommend the development and implementation projects for orientation of signale on districts, tourist points and historic

3.2. FORMULATED ALTERNATIVES

3.2.1. ROAD NETWORK

Due to problem previously identified, alternative projects of the road system for implementation were formulated, considering the current set of structural roads. These roads are complemented by new link axis between important poles of trip generation. From this on, it was established two hierarchic levels for these roads taking in count the function of each road into the spatial structure and in the population mobility as is shown in FIGURE 3.2-1.

From this basic conception of main hierarchic axis, secondary roads were added to extend the links between these axes. For economic evaluation, the set of main and secondary roads was grouped into seven corridors as shown in FIGURE 3.2-2.

- Group 1– Set of roads that has the Independencia Avenue as main axle that is in stage of construction by the Para Government, and will extend its capacity until the project target year. It creates the alternative of access from the areas of the Cidade Nova, the PAAR and the Curuçamba to the 1.ª Legua Patrimonial. This group stands the extension of the Marinha Street linking the BR-316 Road, next to the Castanheira Shopping, to Independencia Avenue;
- Group 2 – Set of roads that has the 1.° de Dezembro Avenue as main axis in the section between Dr. Freitas Avenue and Alça Viária and it is in stage of partial construction by the Belem Municipal Prefecture. It creates alternative to the BR-316 Road for the private traffic and cargo. In this group there is a set of complementary roads that make the link between 1.° de Dezembro Avenue and the areas of the Cidade Nova, the PAAR, the Curuçambá and the Augusto Montenegro Road;
- Group 3 – Set of roads that has the Liberdade Avenue as main axis, project created by the State Government. It forms an alternative of access for the private traffic and cargo linking the Alça Viária to Perimetral Avenue. In this group there are also other secondary axes of access to 1.° 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 form the alternative of linking between Icoaraci and the 1.ª Legua Patrimonial, besides the restrictions of circulation along the Arthur Bernardes Road and to the priority of the Augusto Montenegro Road for the public transport;
- Group 5 – Set of roads are the parallel road to BR-316 Road at north as main axis that is used as an area of a transmission line of energy from Curuçamba in Ananindeua until PA-391 Road. The south has the extension of the 1° de Dezembro Avenue as main axis from Alça Viaria to the entry of Benevides City Hall;
- Group 6 – Set of roads that has the link between Ananindeua and Icoaraci as main axis which create the alternative of linking between the areas of Cidade Nova, PAAR, Curuçamba and Icoaraci besides connecting to Alça Viaria;
- Group 7 – Set of roads that has the Bernardo Sayão Avenue as main axis, which will be duplicated consolidating the road ring of the 1.ª Legua Patrimonial interconnected to secondary roads. These roads aim the accessibility in districts of the Terra Firme, Guamá, Condor e Jurunas. In this group there is the extension of the Generalissimo Deodoro Avenue with Quintino Bocaiuva Street, consolidating the inner-center road ring.

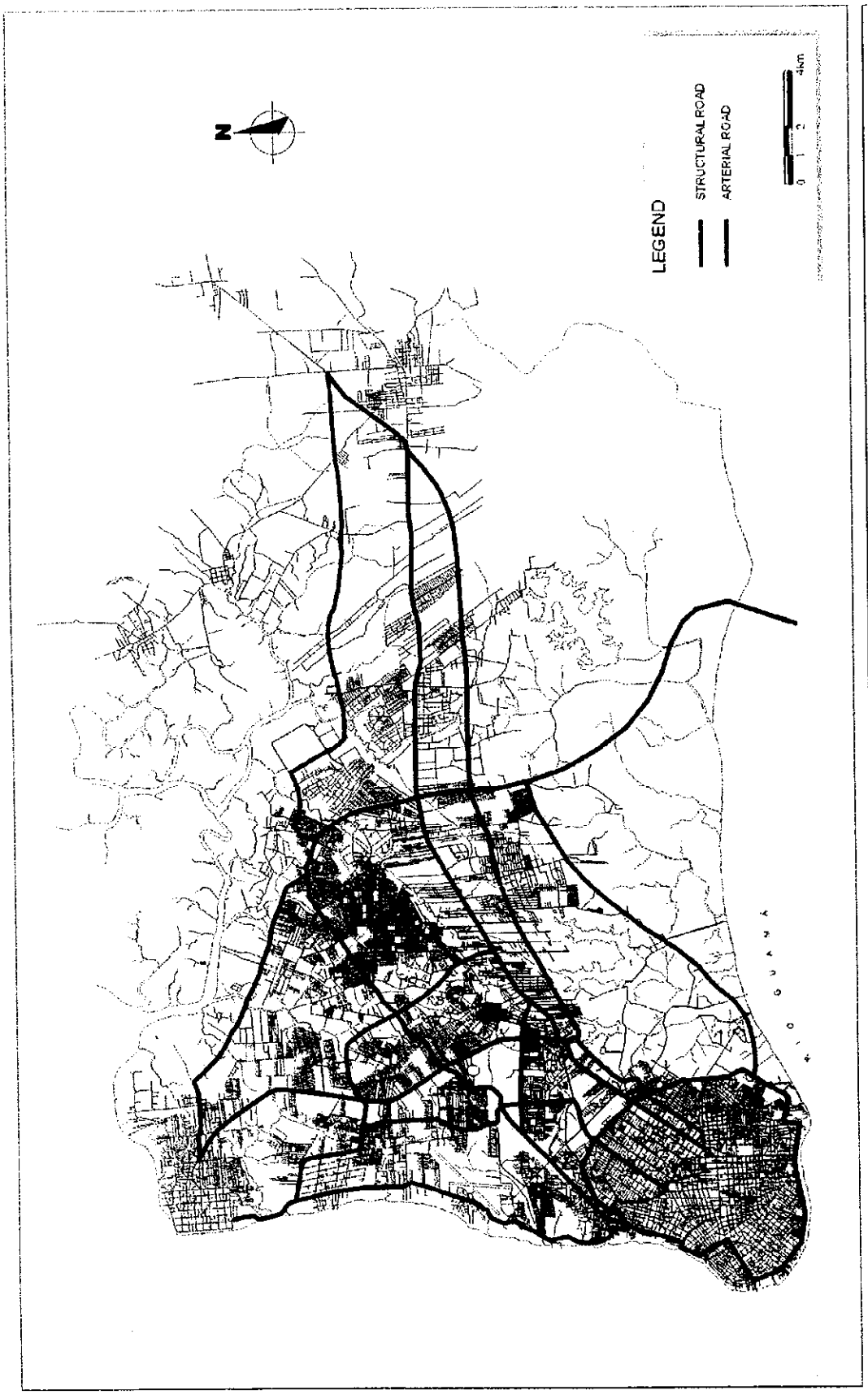


FIGURE 3.2-1 - Model Conception of Future Network

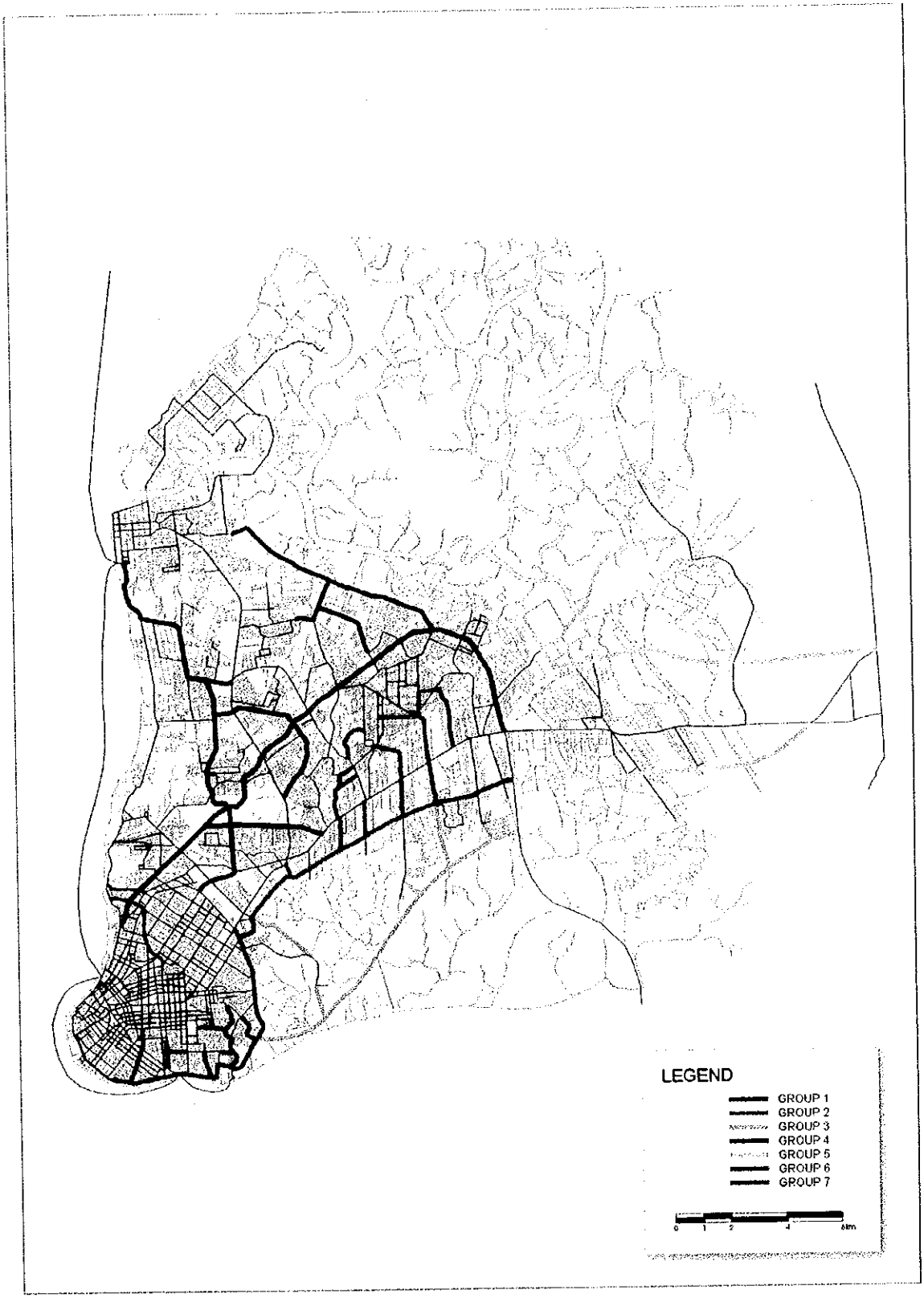


FIGURE 3.2-2 - Alternatives of Development to the RMB Road System

3.2.2. PUBLIC TRANSPORT NETWORK

The operational conception proposed to the public transport system is supported on creation of an integrated network. This network is formed by trunk lines, feeder lines and conventional lines. Utilization of bus is recommended as proprer transport technology, which can be articulated and/or bi-articulated based on each line demand:

The passangers fee integration will be done through the intelligent card on strategic places for the concentration of a number of feeder lines. Adding to this, the introduction of a regular system of public hidro-transport with the transport system by bus through the intelligent card and the terminals.

The public transport network and the terminals of integration proposed for construction to be operated until 2005 are shown in FIGURE 3.2-3. Keeping the same basic conception, the future network shows a increase of lines because of the demand growth and the increase of the road network.They are shown in FIGURE 3.2-4.

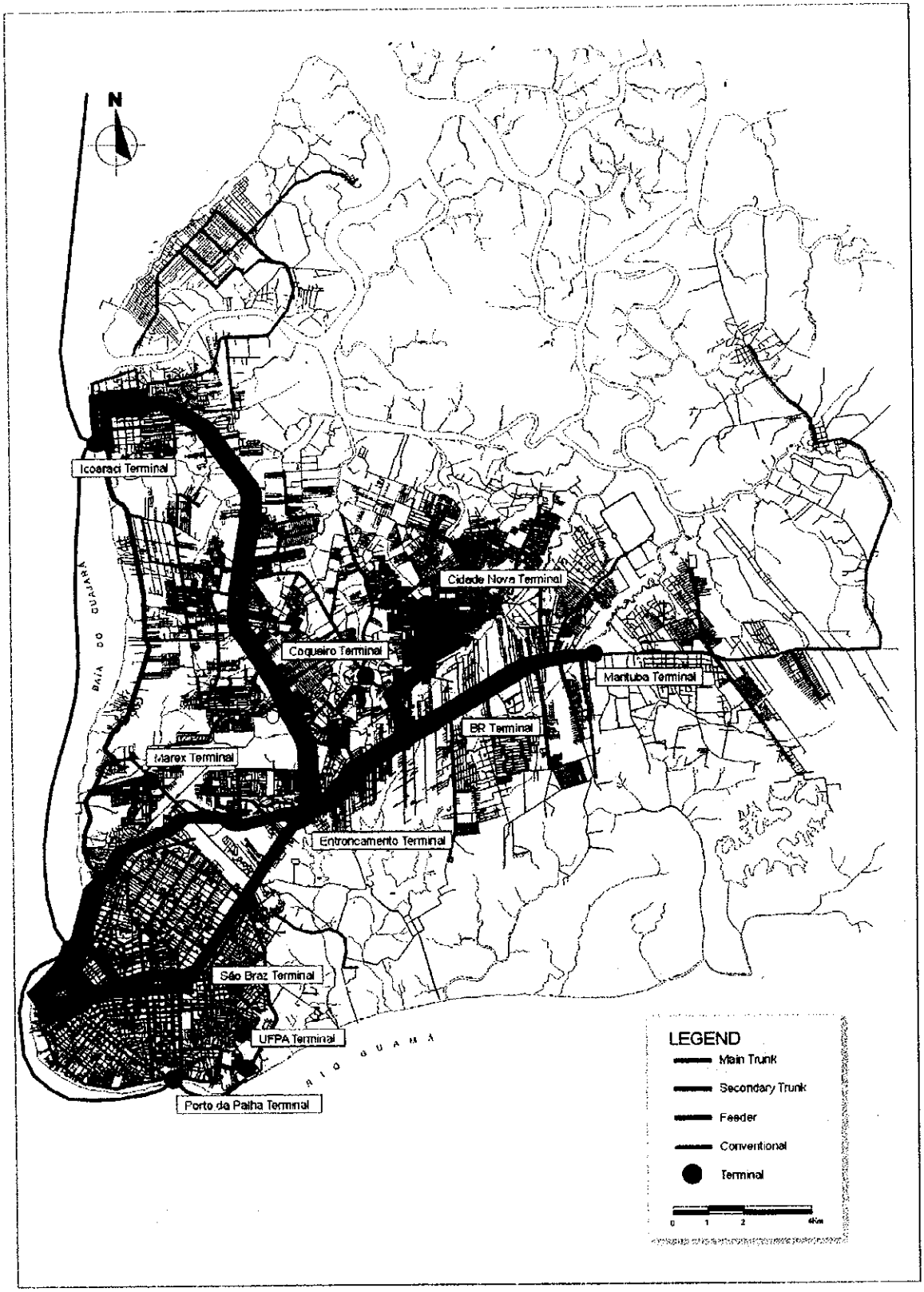


FIGURE 3.2-3 -Public Transport Network Proposed - 2005

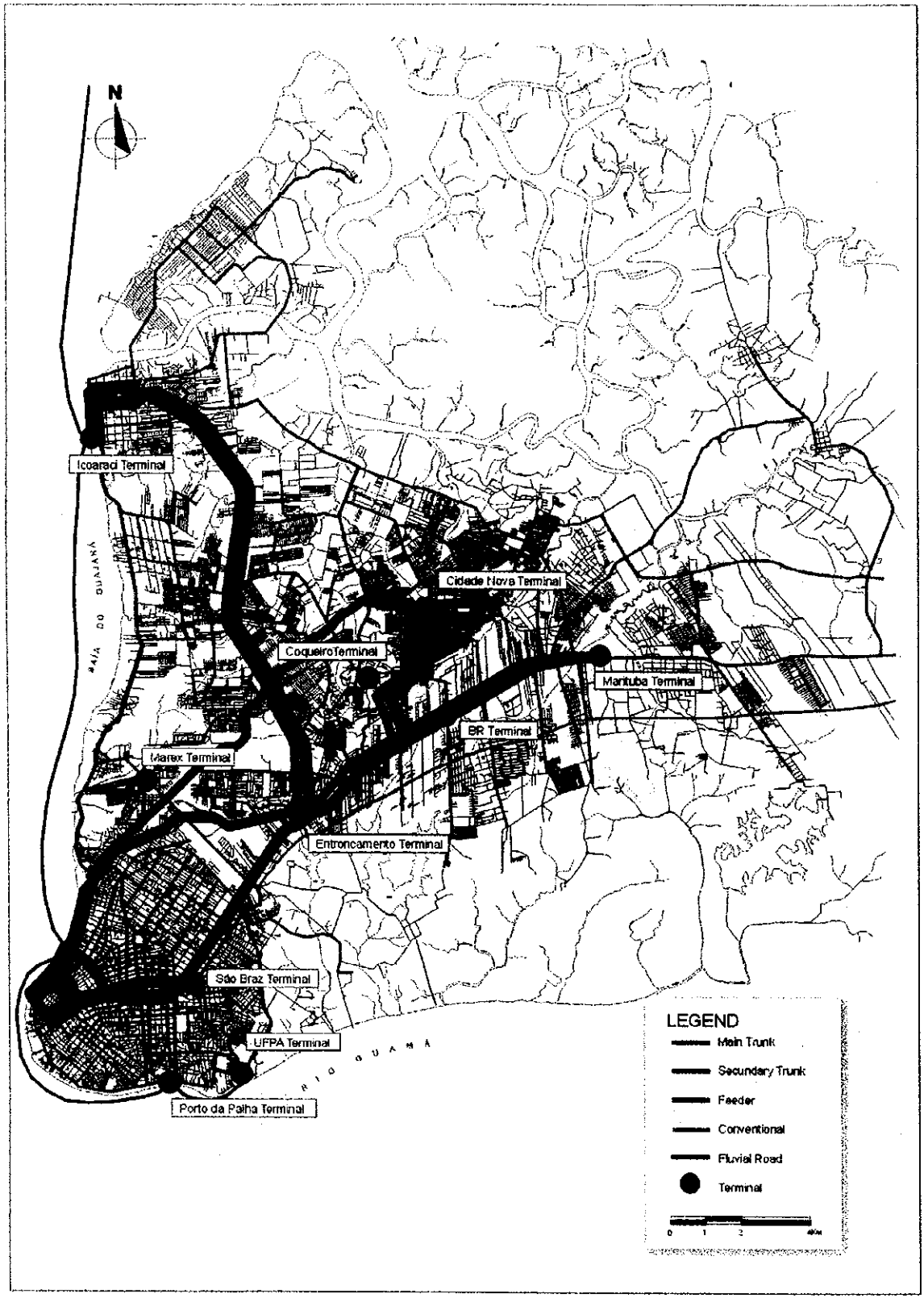


FIGURE 3.2-4 - Public Transport Network Proposed - 2020

3.3. DEMAND FORECASTS FOR THE METROPOLITAN AREA

3.3.1. MODELING

Travel demand forecast was conducted for the estimation of private and public transport demand in Belem Metropolitan Region. Both road and public transport development projects were evaluated based on the familiar four-step model as described below.

ADJUSTMENT OF SURVEYED O/D MATRICES

The origin and destination trip data in the Belem Metropolitan Region and traffic volume data crossing on the screen line were collected in Person Trip and Screen Line Surveys, respectively. The Person Trip data was collected on the random sampling basis. After expansion process of the trip data, first version of O/D matrices were obtained, but assigned volumes of car trips to the network did not well match with the traffic volumes counted on the two screen lines.

A process of "link analysis" was then executed, which examines the number of trips of origin / destination pairs that cross on the screen line and adjusts the traffic volume in the relevant cells of the O/D matrix to the traffic volumes on the Screen Line (FIGURE 3.3-1).

For trips for public transport passengers, the similar procedure as that of private vehicles was adopted. The comparing the assigned volumes to bus passenger data on the bus lines available in COHAB was conducted.

The screen adjustment was done for the hourly trip OD matrices in the morning peak hour and the daily trip OD matrices were expanded based on the hourly distribution of traffic volume referred to traffic volume count survey.

TRIP GENERATION MODEL

After adjusting the trip O/D matrices in 2000, trip generation models were made by three travel modes. One is travelers who do not choose private mode but car owners, the second is those who choose public transport mode but car owners, and the other is those who make car trips.

Trip generation and attraction models by mode were estimated according to all purposes due to the fact that available data did not warrant separate purposes analysis. In the way, the derived model equations will allow the projection of travel demand for all future years being analyzed.

The trip generation models which were analogously calibrated were developed in that way in order to support the modal choice step.

In the travelers who choose car mode, the variable of car ownership in the equations of the generation models show high correlation factor with car trip generation, which is an importance factor in the country and will have great impact on mode choice in future.

FIGURE 3.3-1 - Results of *Screen Line* Adjustment

Trip Generation Models:

Non-motorized Modes (walking, bicycles, etc)

Generation: {0,0902 * Pop} + {0,1407 * [Household Income]}
$R^2 = 0,84$

Attraction: {0,3096 * Employment} + {1,1081 * [School Enrollment / Pop]}
$R^2 = 0,88$

Car Mode

Generation: {0,0592 * [Productive Pop]} + {8,0381 * [Cars / 1,000 inhab.]}
$R^2 = 0,68$

Attraction: {0,1122 * Employment} + {0,4667 * [School Enrollment / Pop]}
$R^2 = 0,83$

Bus Mode

Generation: {0,0366 * [Productive Pop]} + {2,1674 * [Cars / 1,000 inhab.]}
$R^2 = 0,68$

Attraction: {0,0408 * Employment } + {0,4385 * [School Enrollment / Pop]}
$R^2 = 0,75$

Future Travel Demand FORECAST

The trip generation and attraction models were used for forecasting future travel demand with some further remarks:

The values for the variables such as household average income, employment, school enrollment and population by each traffic analysis zone were obtained from the future socioeconomic frame.

The present value for the population by zone – corresponding to all individuals engaged in some sort of productive activity – was estimated from the Person Trip data, and was projected based on the assumption that the proportion between population within a given zone and total population will hold in future

As for car ownership, a strong correlation with income (GNP per capita) is shown in other studies, as can be seen below; FIGURES 3.3-2 and 3.3-3.

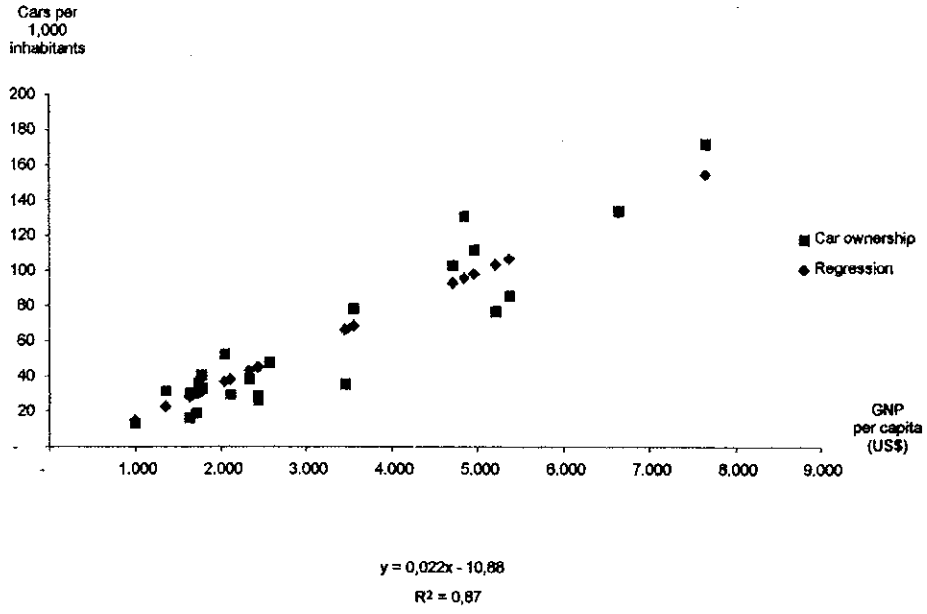


FIGURE 3.3-2 – Car Ownership x GNP per Capta in States of Brazil

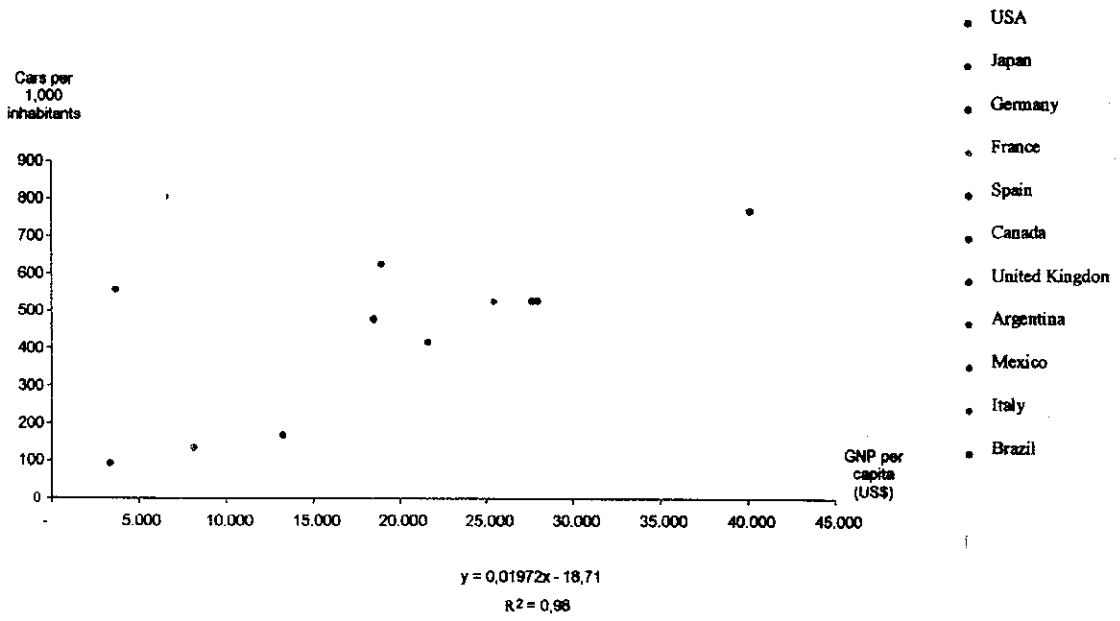


FIGURE 3.3-3 – Car Ownership x GNP per Capta in selected Countries

In order to estimate future values of car ownership for Belem zones, a statistical adjustment was obtained by means of a linear regression on household income, as described below.

In order to well estimate the future car ownership in the Belem zones, a linear regression model with variable of household income was developed by a statistical analysis, as described below.

Car Ownership = {0.0843*[Household Income]} – 18.634

$$R^2 = 0.80$$

In this way, all future variables could be adequately estimated, and the future trip generation and attraction were forecasted by the equations of the trip generation model.

Modal Choice

Mode choice in the PDTU was done at the trip generation / attraction level and not at the origin / destination level, i.e., trip end model. It processed trip distribution and was incorporated in the trip generation model as mentioned above. This could be done since there is a variable in the model that takes into account of the relationship between household income and car availability throughout time, explaining the migration of users from non-mororaized mode to choice sets and, within the latter one, those who choose car and those who choose Bus mode.

Given that the model considering the migration of users from one set to another was successfully calculated, and that one can observe the changes in the number of trip ends generated in each set as a function of income and car ownership..

Traditional logit models attempt to simulate the impact of large differences in the future generalized cost of travel between zones for different modes. Typically it is used to simulate the introduction of a new large capacity mode,

It is worthless that the upgrades being considered for the Belem highway and transit networks, will not significantly alter the parameters for mode choice. If the case was of the creation of a major new mode – like a subway system for instance – that would cause a big reduction in generalized travel costs between modes, further analysis would be needed.

Since future improvements in both networks will lower costs and increase benefits for all users but will introduce no structural changes, and considering the current Brazilian pattern of car trips, share increase closely following the growth in income and car ownership, this integral trip generation and modal choice model is justified.

Summarizing this item and the procedure:

The socioeconomic data was forecasted by each traffic zone

The trip generation and attraction by three trip modes were estimated with the regression equations

The income level by zone is estimated from the socioeconomic frame and then, future car ownership is estimated with the regression equations. The trip generation by mode is forecasted by the model in which the variable of car ownership related to the modal choice is included. Therefore, the diversion from the one mode to other mode is forecasted by the future car ownership level.

The future trip generation and attraction by mode was estimated by each zone in the morning peak hour.

TRIP DISTRIBUTION

For the trip distribution step, "a doubly constrained growth factor method" was adopted. Hourly trip OD matrices in the morning peak hour in future by three modes were estimated by use of present trip OD matrices and future trip generation and attraction obtained in the trip generation model.

There are some reasons for selecting the growth factor model against the gravity model. The growth factor model, specially the double constraint on the trip generation and attraction, can be used for prediction of trip distribution in the future transport networks where no major investments in any specific zones will dramatically be provided and their accessibility will not be structurally changed so as to cause major diversions in users route selection.

In the Belem Metropolitan Region, future networks for both road and public transport do not dramatically change with improvements that will bring reductions in travel cost and time between zones. The employment of the gravity model will not be strong enough because the changes in land use patterns are weak.

After future trip distribution was estimated based on the trip generation and attraction obtained from the trip generation model, adding the outside trips that generate outside the study area final trip OD matrices were forecasted. The outside trips were estimated based on the trip OD matrices obtained in the Cordon Line Survey and the population growth in the future.

Trip Assignment

This is the final step for the assessment of benefits brought by proposed projects in the road and transport networks. The evaluation was conducted by comparison of "with" case and " without" case in which the future trip OD tables is assigned on "with" project network and "without" network. The traffic and passenger volumes on road and transport segments are forecasted by those cases, respectively.

The capacity restrained trip assignment model: equilibrium assignment method was used. This method is based on the theory that its equilibrium occurs when no user can reduce his or her cost of travel by choosing a different route in a network.

The iterative procedure for the assignment can be described as follows:

Initially, the network has free flow speeds in each link;

An assignment is made of all O/D interchanges from the matrix, along the corresponding minimum cost paths, producing a set of volumes on each link;

Link speeds are adjusted, based on the current volume/capacity ratio for each link, and link volumes are weighted from previous and current iterations; the process is cycled through this and the previous step until equilibrium is reached.

In order to better understand the complexity involved in the process, one should take into account the fact that there are N^2 possible origin/destination pairs to be assigned, N being the number of zones, and a large number of links connecting them. This means that for each origin/destination pair there will be one minimum cost path between them that is composed of many network links, and that each network link may be traversed by several paths for different pairs.

As it was mentioned, the assignment algorithm tries to minimize the cost of travel for each user. When large volumes, corresponding to origin / destination pairs in the trip matrix, are assigned to a specific link that is part of their minimum paths, the time to cross it increases due to capacity restrictions, making other links that were previously not included in the path more attractive, and increasing the probability that they be chosen for the paths connecting those origin / destination pairs in a next iteration. This process iterates until all trips are assigned and no trip can be assigned to a lesscost path.

The performance indicators of total vehicle (passenger) x Km, total vehicle (passenger) x hour and average speed can be calculated and compared between assignments of the same trip matrix on different networks.

Finally, it should be noted that for the economic evaluation of alternative networks, all three indicators should be calculated, and that isolated consideration of each indicator constitutes a theoretical error. In PDTU, it was observed that for some assignments of a future trip OD matrix to the same network, average speeds slightly increased even though the other two indicators greatly deteriorated. What this actually means is that the flows in the network spread out through links not previously used, thus the vehicle (passenger) x Km indicator increases. Even though the average speed increases, this does not mean that a benefit in travel time was obtained. As a matter of fact, total travel time by all trips in the network also increased because trips were forced to seek longer trip distance on less congested routes.

Car Ownership = {0.0843*[Household Income]} – 18.634
$R^2 = 0.80$

increased because flow volumes were forced to seek longer, in less congested routes.

3.3.2. RESULTS

The trip distribution forecasted by molding described in the previous section is shown by "desire lines" charts for car/all purposes and public transport/all purposes modes at the peak hour in morning in the years of 2000, 2010 and 2020 (FIGURES 3.3-4 and 3.3-5).

These figures show the great concentration of car and public transport flows for 1ª Légua zones, as much in the years of 2010 and 2020 as that at the present. However, it is perceived a discreet intensification of trips change between the peripheral zones in years of 2010 and 2020, with emphasis for macro zone 12 (Cidade Nova). These data enforce the need for extension of linking between the expansion area and the Légua, as well as the consolidation of peripheral rings to these areas.

Comparing the current network capacity with the future traffic demand (2020), the traffic assignment was carried out and the V/C vehicles/capacity (V/C) ratio was calculated by each network link (FIGURE 3.3-6)

This figure presents three capacity patterns as it is described in legend. The vehicles/capacity ratio (V/C) on Almirante Barroso Avenue from Dr. Freitas and BR-316 until the beginning of Júlia Seffer increases up to 50%. In these conditions, the average speed is as low as around 5km/h. The area where v/c ratio is up to 50% is shown in the rest of Almirante Barroso Avenue, BR-316 until Ananindeua and Augusto Montenegro in its whole segment.

The V/C ratio on roads where traffic demand in 2020 are assigned on the current network, shows the necessity of its network extension, especially strengthening of the links between the 1ª Légua and the Expansion Area.

TABLE 3.3-1 and FIGURES 3.3-7 and 3.3-8 show the traffic indices of vehicle-km, vehicle-hour and average speed in the morning peak hour, comparing the current network and the proposed networks in the years of 2005, 2010, 2015 and 2020.

TABLE 3.3-1 Traffic Indices of Vehicle-km, Vehicle-Hour and Average Speed according to Future road network and OD trips

NET	2000 OD Trips			2005			2010			2015			2020		
	Vehicle x Km	Vehi x h	Averag Speed	Vehicle x Km	Vehi. x h	Averag Speed	Vehicle x Km	Vehi x h	Averag Speed	Vehicle x Km	Vehi x h	Averag Speed	Vehicle x Km	Vehi x h	Averag Speed
2000	191.592	4.319	45,52	306.066	6.656	45,98	420.080	9.398	44,57	502.620	12.294	41,69	587.927	16.197	38,85
2005	187.742	4.155	46,51	301.536	6.363	47,63									
2010	185.924	4.044	46,96				407.963	8.441	47,81						
2015	185.630	4.001	47,24							486.487	10.230	47,05			
2020	185.756	3.999	47,08										556.976	12.106	45,36

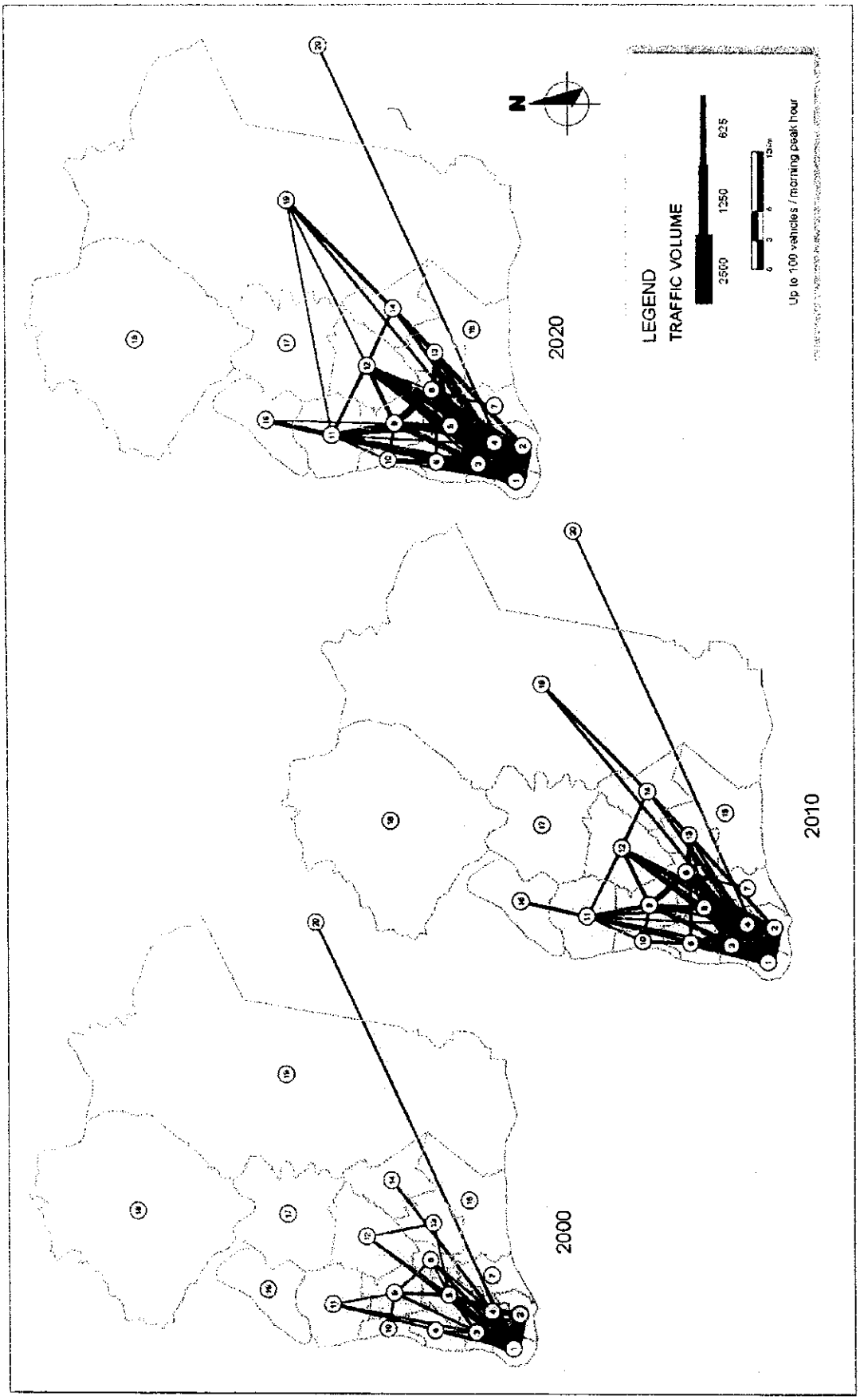


FIGURA 3.3-4 - Desire Lines - Car Mode / All Proposes

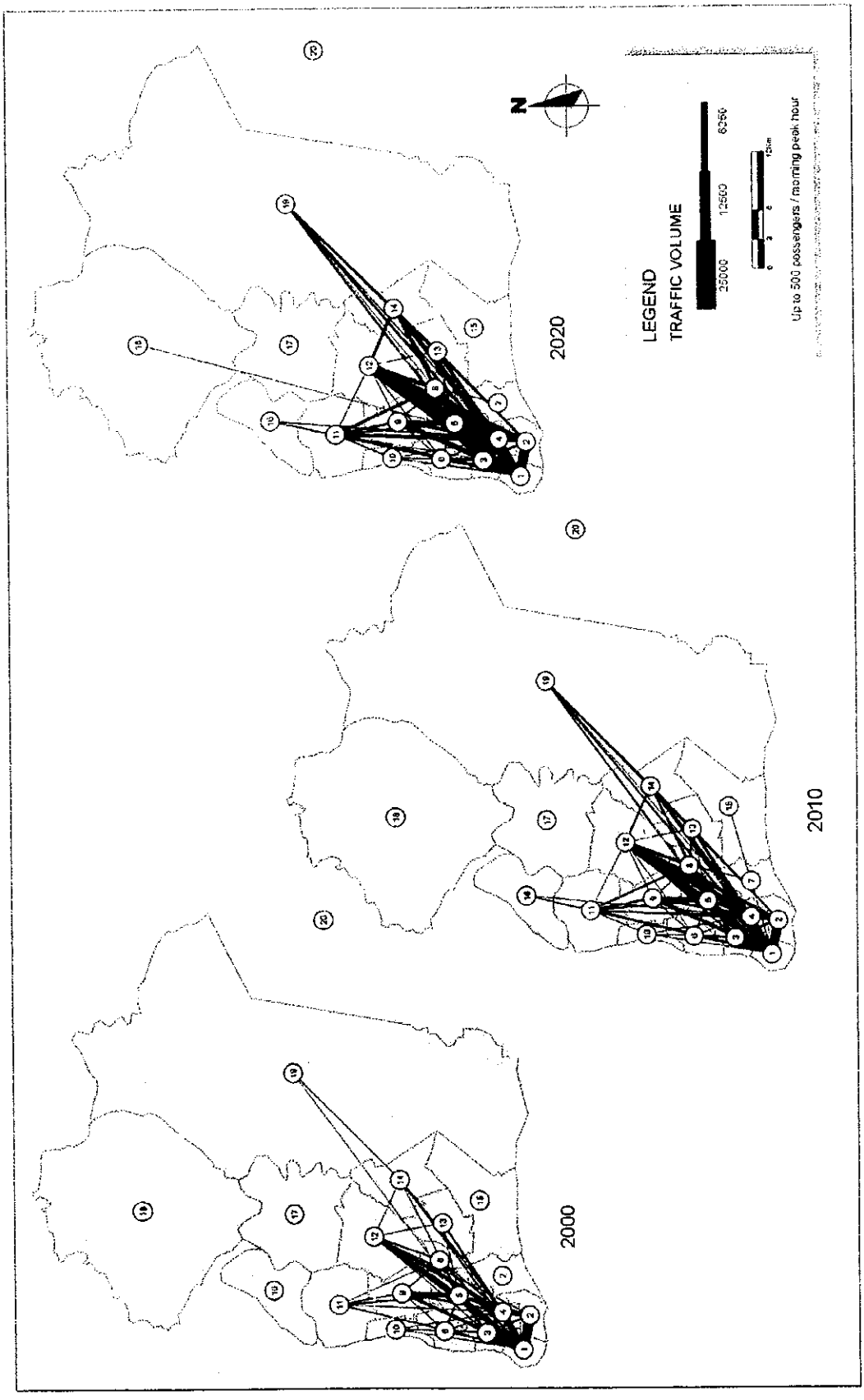


FIGURA 3.3-5 - Desire Lines - Bus Mode / All Proposes

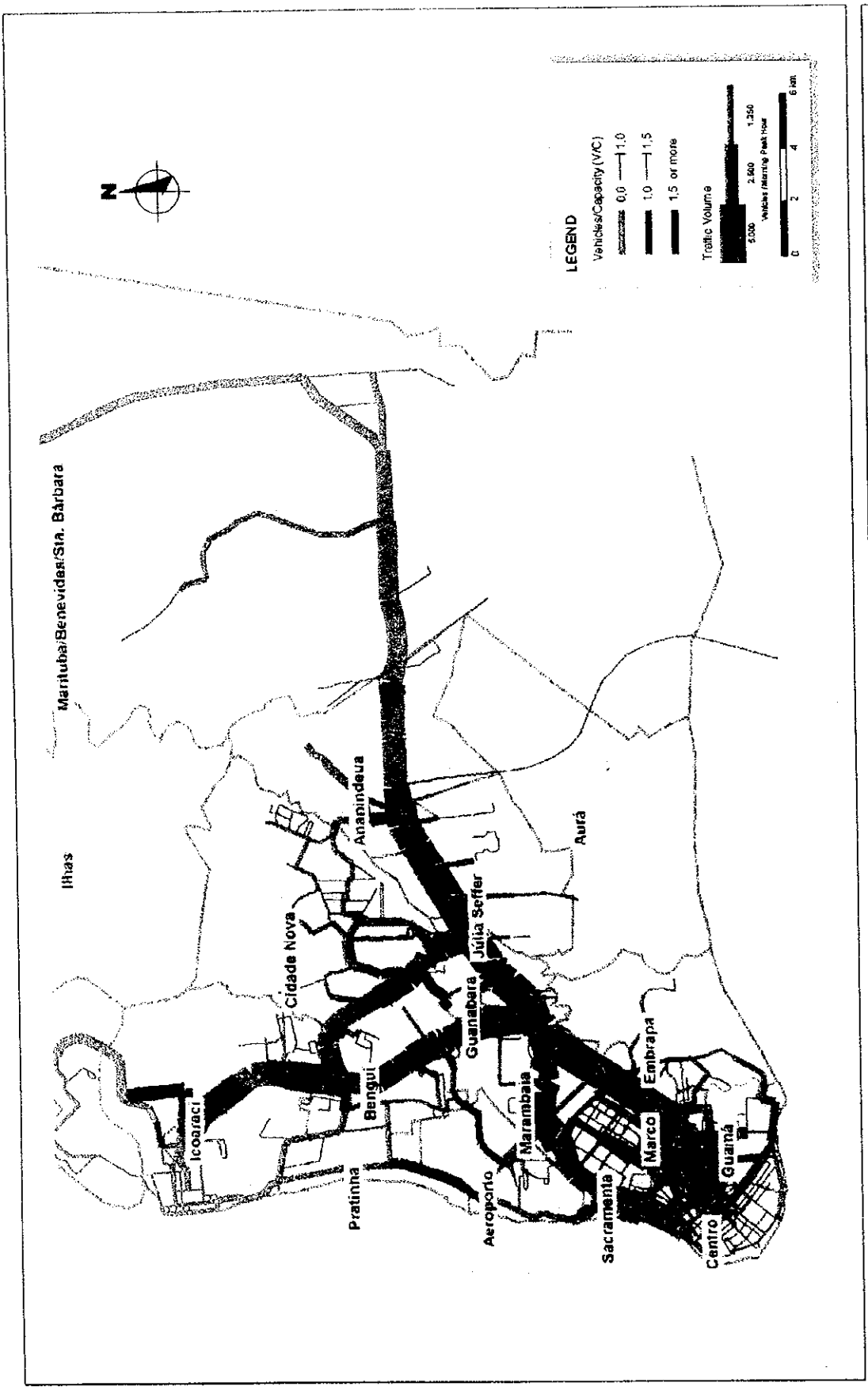


FIGURE 3.3-6 - Traffic Assignment and V/C by Link - Network 2000 x OD Trip 2020

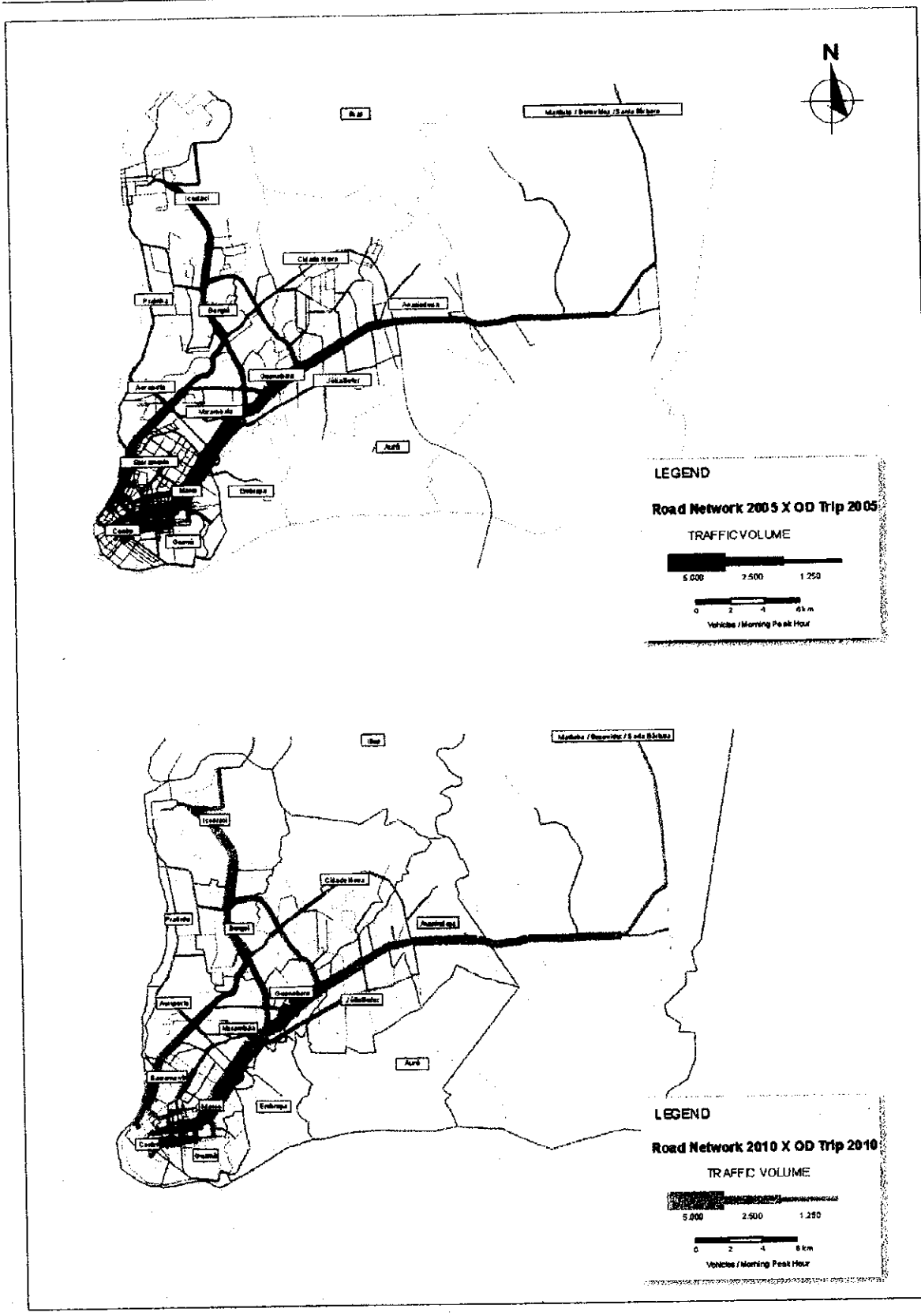


FIGURE 3.3-7 - Traffic Assignment - 2005 and 2010

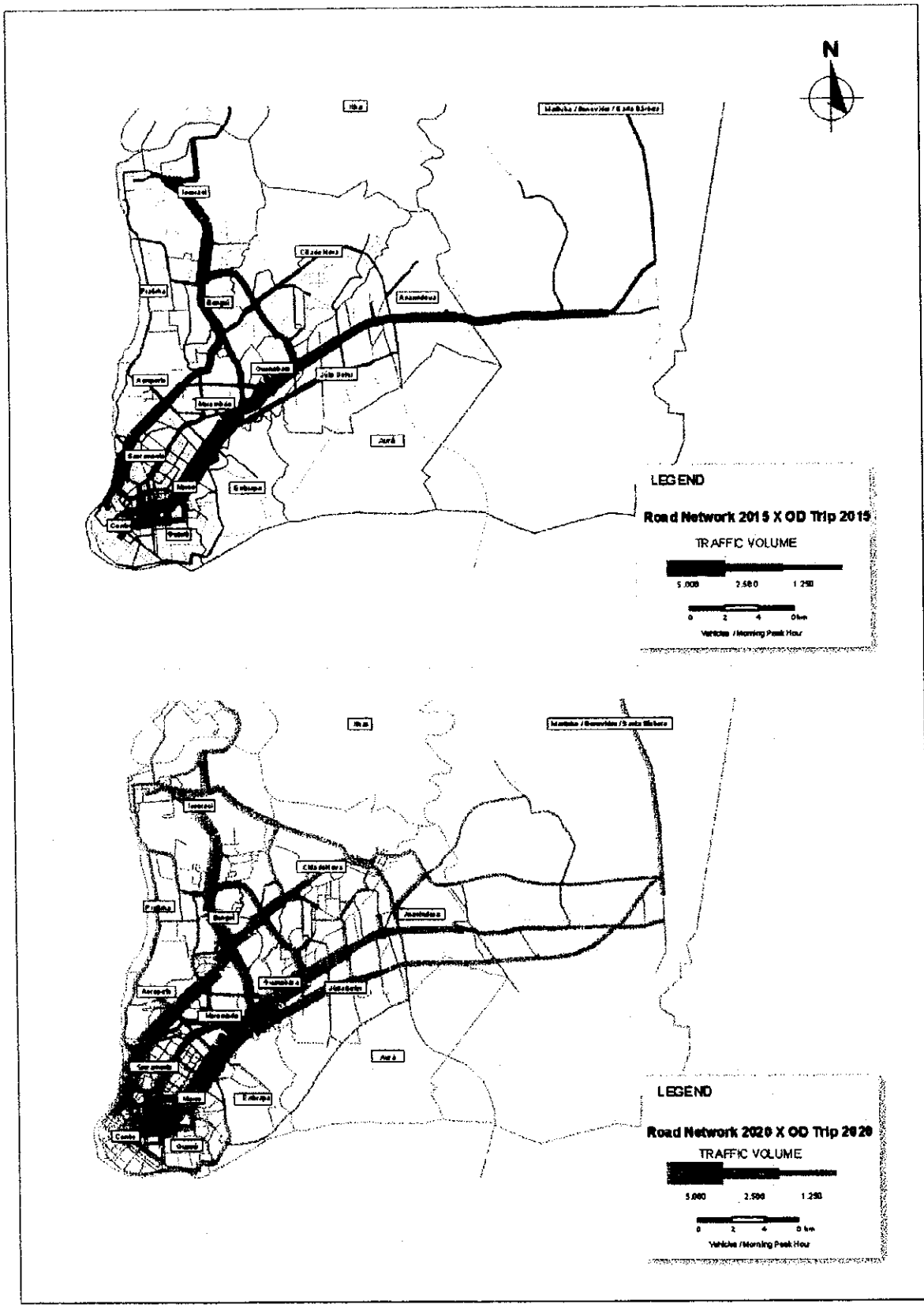


FIGURE 3.3-8 - Traffic Assignment - 2015 and 2020

TABLE 3.3-2 Traffic Indices of Vehicle-km, Vehicle-Hour and Average Operation Speed in Public Transport

BUS NET	2000 OD Trips			2005			2010			2015			2020		
	Pass. x Km	Pass. x H	Veloc.	Pass. x Km	Pass. x h	Veloc.	Pass. x Km	Pass. x h	Veloc.	Pass. x Km	Pass. x h	Veloc.	Pass. x Km	Pass. x h	Veloc.
ACTUAL	580.341	25.474	23,15	839.421	35.802	23,80	1.118.111	47.007	24,17	1.339.068	56.066	24,33	1.591.866	66.253	24,46
FUTURE BUS NET in 2005	533.297	16.873	34,48	688.008	22.108	34,02	850.168	27.541	33,80	978.094	31.579	33,87			
FUTURE BUS NET in 2020	570.484	17.049	35,07										1.223.640	36.905	35,19

TABLE 3.3-3 Passengers-km and -hour according to 2000 OD Trips and 2005 Bus System

Technology	Pass. x km	Pass. x h
Feeder	213.922,77	8.556,91
Articulated	297.280,54	7.432,01
Conventional	22.093,61	883,74
Total of Net	533.297	16.873

TABLE 3.3-4 Passengers-km and -hour according to 2005 OD Trips and 2005 Bus System

Technology	Pass. x km	Pass. x h
Feeder	299.632,04	11.985,28
Articulated	360.795,18	9.019,88
Conventional	27.580,86	1.103,23
Total of Net	688.008	22.108

TABLE 3.3-5 Passengers-km and -hour according to 2010 OD Trips and 2005 Bus System

Technology	Pass. x km	Pass. x h
Feeder	385.018,62	15.400,74
Articulated	431.041,83	10.776,05
Conventional	34.107,91	1.364,32
Total of Net	850.168	27.541

TABLE 3.3-6 Passengers-km and -hour according to 2015 OD Trips and 2005 Bus System

Technology	Pass. x km	Pass. x h
Feeder	436.828,20	17.473,13
Articulated	503.010,46	12.575,26
Conventional	38.255,15	1.530,21
Total of Net	978.094	31.579

TABLE 3.3-7 Passengers-km and -hour according to 2000 OD Trips and 2020 Bus System

Technology	Pass. X km	Pass. X h
Feeder	174.190,77	6.750,55
Articulated	159.806,67	3.995,17
Bi-articulated	194.020,79	4.850,52
Conventional	20.934,70	837,39
Fluvial Road	21.531,10	615,17
Total of Net	570.484	17.049

TABLE 3.3-8 Passengers-km and -hour according to 2020 OD Trips and 2020 Bus System

Technology	Pass. x km	Pass. x h
Feeder	429.267,86	16.324,25
Articulated	326.247,26	8.156,18
Bi-articulated	373.961,59	9.349,04
Conventional	33.726,00	1.349,12
Fluvial Road	60.434,82	1.726,71
Total of Net	1.223.640	36.905

The traffic bus volume in the years of 2000 and 2020 in the main corridors in the morning peak hour is presented in FIGURE.3.3-9. There is a great reduction of the bus volume in these corridors. This reduction will be possible with the implementation of trunk bus system together with the change from current conventional buses to buses with larger capacity like articulated and bi-articulated buses. This possibility will provide a significant capacity increase of the road system with improvement of bus service level.

FIGURE.3.3-10 shows the traffic conditions in the year of 2020 in terms of the V/C ratio. It can observe that there are some over-saturated segments with the V/C ratio up to 1.5. The V/C ratios in some segments on Independencia, Almirante Barroso, 1º de Dezembro Avenues and BR-316 Road reach 1 to 1.5. This data shows that on the target year of the project, the proposed network will reaches its capacity limit. At this moment the plan should be revised. Corrective measures for the natural process of concentration of commercial activities in Central Area are minimized the effects presented in this figure.

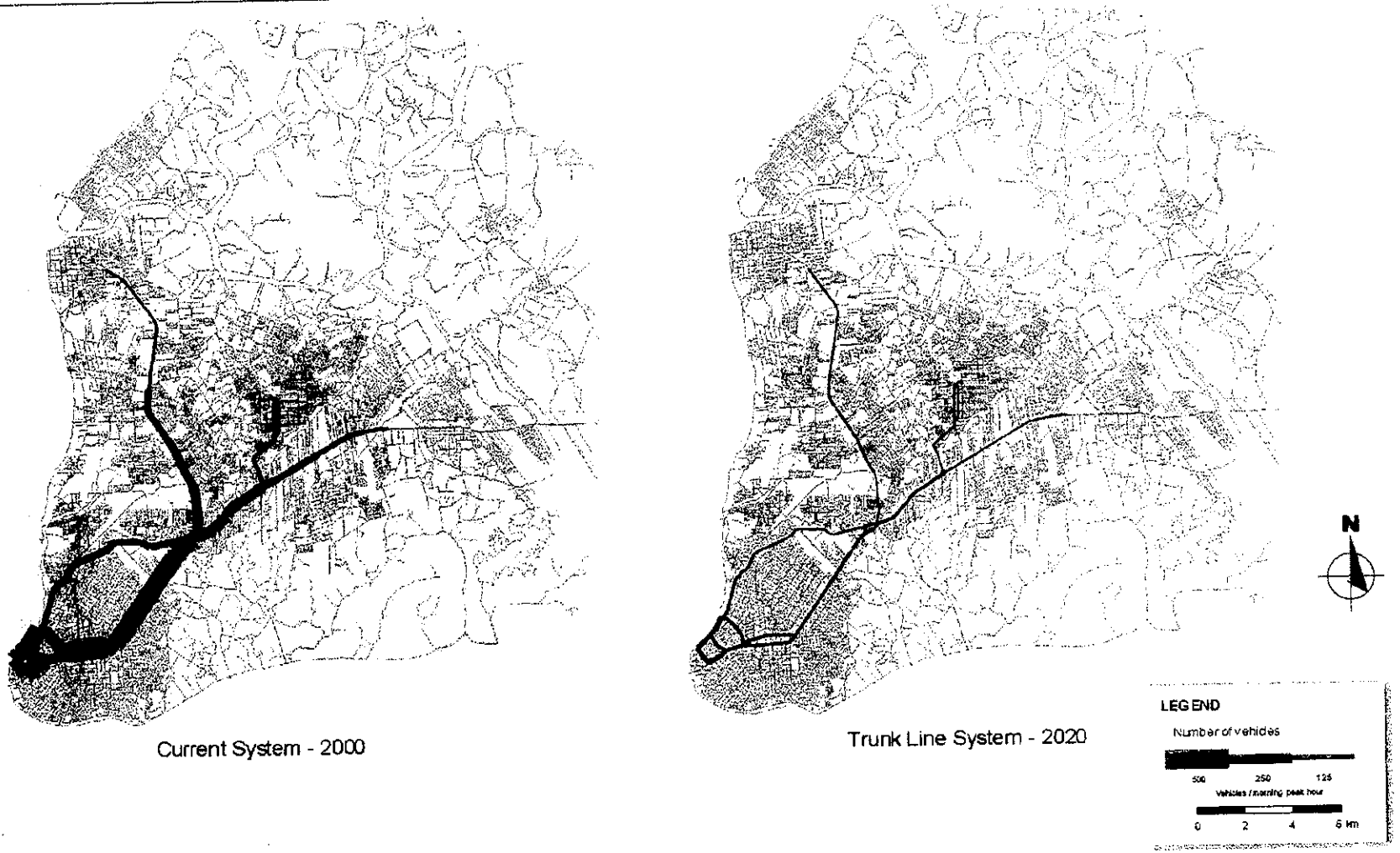


FIGURE 3.3-9 - Number of Vehicles on Public Transport - Current System and Trunk Line System (Principal Axis)

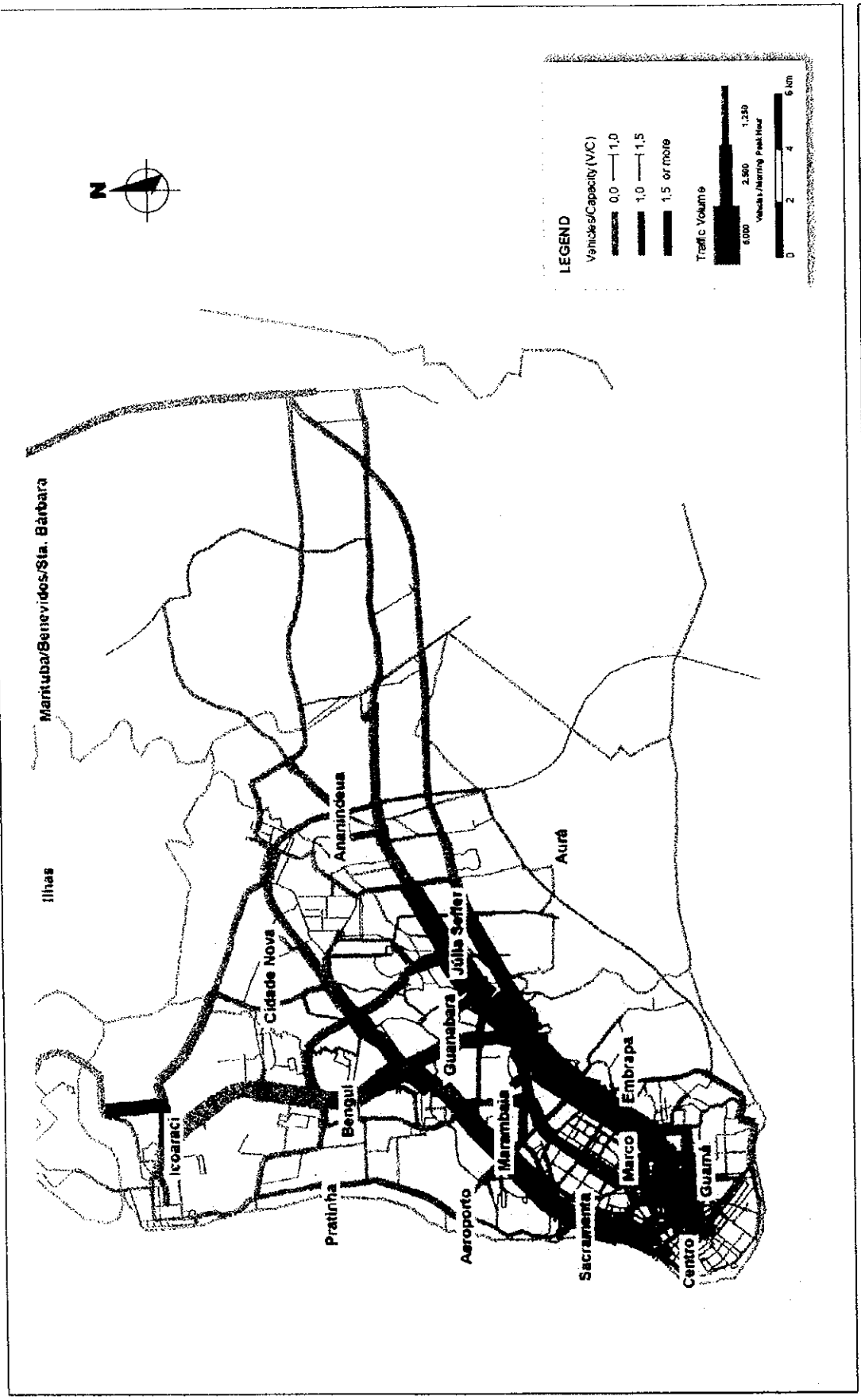


FIGURE 3.3-10 - Traffic Assignment and V/C by Link - Network 2020 x OD Trip 2020

3.4. EVALUATION AND PROGRAM OF IMPLEMENTATION OF PROPOSITIONS

3.4.1. COST ESTIMATE OF SUBSTRUCTURE OF ROAD AND TRANSPORT PROJECTS

To estimate the costs of the road projects, items considered are follows:

Cost of execution of the road constructions except other constructions costs such as bridges fly over, etc. – due to the condition diversity for execution of the road projects, its costs were estimated considering two different values. The first reached US$ 307,690,00/km, based on the first stage frame execution of Independencia Avenue, (section BR-316 to Augusto Montenegro Road) considering only one road with two traffic lanes, sideways, curb and sidewalk. The second reached US$ 520,000,00/km, considering one road with platform of 11.80 m, with two lanes, sideways and sidewalk, it was obtained from the budget of Independencia Avenue (section of Marginal of Canal Sao Joaquim). These costs were used according to the characteristics of each proposed project.

Cost of execution of other – based on costs of the first stage of Independencia Avenue, was estimated an average value for execution of a bridge with platform of 10.4 m width that reached US$1,027,500,00 / km. For estimation the number of art work, were used air photos that enable to identify the necessity of transposition over rivers and waterways besides the necessity of large complexity intersections.

Costs of Dispossession – based on values of the Macro Drenagem Project, in recent dispossession done by COHAB and in patterns of density and building area observed in the air photographic survey done by COHAB, established four average values of dispossession/km cost considering the platform of 12m road:

- Areas of large density and the highest constructive patterns as marginal of Una channel and Bernardo Sayão Avenue US$ 170,000.00/km;
- Areas of high density and lower constructive patterns as the extension of 1° de Dezembro near to Júlia Seffer US$ 126,000.00/km;
- Areas of density and lower constructive patterns as in Icui Guajará US$ 107,000.00; and
- Land without construction in dominion area of 50m, as in the extension of 1.° de Dezembro Avenue near to City Hall of Benevides US$ 20,000.00/km.

The composition of these costs per group of project resulted in costs showed in TABLE 3.4-1.

TABLE 3.4-1 – Cost Per Road Project

Group of Projects		Extension	Cost of Art Work	Cost of Dispossession	Cost of Road	Total Cost	Cost per km
N.°	Name	(km)	(US$ x 1.000)	(US$/Km) x 1.000	(US$ x 1.000)	(US$ x 1.000)	(US$ x 1.000)
1	Independencia	39.52	6,160,00	3,405,80	15,019,72	24,585,52	622,10
2	1.° de Dezembro	38.57	16,440,00	2,023,60	14,177,54	32,641,14	846,28
3	Liberdade	22.30	6,165,00	427,40	10,496,23	17,088,63	766,31
4	Pedro Miranda	18.42	3,082,50	1,057,30	14,689,26	18,829,06	1,022,21
5	Curuçamba-Benevides	35.63	18,495,00	885,95	14,835,53	34,216,48	960,33
6	Ananindeua - Icoaraci	14.92	9,247,50	1,031,40	5,709,61	15,988,51	1,071,62
7	Bernardo Sayao	23.98	5,137,50	2,655,00	11,446,82	19,239,32	802,31
TOTAL		193.34	64,727,50	11,486,45	86,374,71	162,588,66	840,95

The transport projects were calculated separately, and its costs are divided into four great project groups:

Structural public transport corridors, BR-316 and Augusto Montenegro Roads and Almirante Barroso Avenue, that will be totally modified with the introduction of the bus exclusive road (busway), these calculation were done based on similar projects already introduced in other Brazilian cities;

Integration Terminals - in this item there are new terminals to be constructed and existent terminals to be reformed. Its costs is different and the base also had been obtained from costs of terminals introduced in other cities;

Other roads in Central Area - in these roads, although there is no previous implementation plan of busway, there will be necessary interventions like pavement support, traffic light and some geometry changes, that also will have costs; and

Binary Senador Lemos-Pedro Alvares Cabral - this project attends fundamentally to the secondary trunk lines. Although it does not have previous busway, the binary construction requires finantial resources superior to roads of Central Area, because of the dispossession and art work. Though they are presented separately.

TABLE 3.4-2 shows the composition of these costs per project.

TABLE 3.4-2 – Transport Cost per Project

Project	Extension (km)	Road Cost (US$)x1.000	Work Art (US$)x1.000	Dispose. (US$)x1.000	Total (US$)x1.000	Cost/km (US$)x1.000
BR-316 Road	10.29	7,690,00	2,085,00	0,00	9,775,00	949,95
Almirante Barroso Avenue	6.85	5,580,00	695,00	0,00	6,275,00	916,06
Augusto Montenegro Road	15.88	3,477,20	2,085,00	0,00	5,562,20	350,26
Road Network of Central Area	15.01	6,724,48	0,00	0,00	6,724,48	448,00
Binary P. Alvares Cabral Sen. Lemos	13.94	10,928,96	1,390,00	0,00	12,318,96	883,71
Terminal Marituba (new)		8,234,24	0,00	0,00	8,234,24	
Terminal Cidade Nova (new)		8,298,00	0,00	25,00	8,323,00	
Terminal Icoaraci (new)		6,168,00	0,00	72,00	6,240,00	
Terminal Porto da Palha (new)		7,817,45	0,00	43,00	7,860,45	
Terminal Entroncamento (new)		2,141,44	0,00	0,00	2,141,44	
Terminal Sao Braz		1,344,00	0,00	0,00	1,344,00	
Terminal UFPA		1,344,00	0,00	0,00	1,344,00	
Terminal Marex		1,344,00	0,00	0,00	1,344,00	
Terminal Coqueiro		1,344,00	0,00	0,00	1,344,00	
Terminal BR		1,344,00	0,00	0,00	1,344,00	
TOTAL	61.97	73,779,77	6,255,00	140,00	80,174,77	

3.4.2. PRIORITIES OF ROAD PROJECTS

For the priority for implantation of road projects on Metropolitan Area it was used a process of evaluation of impacts from the performance of each one of the seven project groups showed on item 3.2.1 and FIGURE 3.2-2.

The procedure was to evaluate how the current road system would work in 2020, referring to the operational cost and time for movement of users (auto + taxi + truck) and to compare this situation in the same year adding individually, each group of proposed project to the road system.

The priority criteria was to consider more important the group of projects with a favorable balance between the benefit of its implantation (operational cost and the user time reduction) and the cost that will be necessary to implant it.

This process was used to obtain the ranking of the set of projects since the numerical relation between the benefit and costs were done only to reach the relative position of each group to its priority. Therefore, only in the economic analysis (item 3.4.3) .The useful life of the project was considered and the numbers is useful to estimate the economies and effective merit to be obtained through the implementation of projects.

The equations used for the priority of the projects were:

a) Benefit of Operational Cost Reduction

$$COa = Cc \cdot PecC \cdot \Sigma dij + Aa \cdot \Sigma dij$$

Where:
COa = operational cost of ucp, in R$
Cc = combustible consumption (gasoline), in l / km
PecC = economic price of gasoline (R$ / l) = 1,73
Σdij = sum of the extensions of the links ij covered, in km
Aa = medium cost unit of the consumption items dependent on the covered extension (R$ / km) = 0.138573446, obtained through the data of taxi frame of Juiz de Fora, in February, 2001:

Lubricant	0.003368644
Pieces and Accessories	0.117846045
Rotation	0.017358757
Total	0.138573446

CC = 0,0954 + (1,2664 / V) - (0,00029 . V), IF V < 72 KM/H

Where:
V = commercial velocity of ucp, without projects, em km / h
V = commercial velocity of ucp, pdtu, in km / h

The results obtained from the simulation from the TRANS-CAD related to the total distance in kilometers in peak time were:

	vehc x Km
Actual Situation	598,125
Project 1	596,997
Project 2	588,632
Project 3	608,877
Project 4	599,568
Project 5	603,667
Project 6	600,334
Project 7	605,176

The following parameters were used for expansion effect:

	Parameters
Peak participation related to the volume daily	0.136
No. of useful days / month	26
Dollar quotation	2

The results from the comparison between the operational costs and the different groups of project are synthesized by the Table as follow:

TABLE 3.4-3 – Comparation Between Operational Cost per Project

Without Project - 2020		Road Project	PDTU - 2020		Operational Cost (US$million)		Benefit (US$million)
Σdij(million)	V (Km/h)		Σdij (million)	V (Km/h)	Nada Fazer	PDTU	
1,372,169	38,422	Proj.1	1,369,582	42,40	234,202	228,736	5,467
		Proj.2	1,350,392	41,72		226,328	7,874
		Proj.3	1,396,835	41,43		234,473	-0,270
		Proj.4	1,375,480	39,95		232,741	1,462
		Proj.5	1,384,884	38,95		235,647	-1,445
		Proj.6	1,377,236	39,21		234,006	0,197
		Proj.7	1,388,345	39,27		235,807	-1,605

b) Benefit of Reduction of Trip Time

$$CTV = S\ [RM\ (TVtn + 0{,}5\ .\ TVo)\ x\ EF(1+ES)]$$

Where:
CTV = cost of trip time, R$
RM = individual average income, in R$ / hour
TVtn = trip time by work or business purpose, in hours/year
TVo = trip time by other purposes, in hours / year
EF = percentage of formal work in RM = 53,09% (Source: Person Trip Survey PDTU)
ES = social charge = 35% (Source: COHAB)

The results obtained from the simulation from the TRANS-CAD to the moving time of vehicles in peak hour were:

	vehc x h
Actual situation	16,801
Project 1	14,182
Project 2	14,219
Project 3	14,914
Project 4	15,950
Project 5	16,914
Project 6	16,659
Project 7	16,831

The following parameters were used for effect of expansion:

	Parameters
Occupation Rate	2.11
Purpose work/business (%)	0.188
Others purposes (%)	0.812
Peak participation related to the diary volume	0.136
N°. of useful days / month	26
Dollar Quotation	2

The results from the comparison between trip time and the different groups of project are as follows:

TABLE 3.4-4 – Comparation Between Trip Time Cost per Project

Average Income (R$/hour)(*)	Without Project - 2020			Road Project	PDTU - 2020			Benefit (US$ million)
	TVtn (hours/ year) million	Tvo (hours/ year) million	Cost of Trip Time (US$ million)		TVtn (hours/year) million	Tvo (hours/year) million	Cost of Trip Time (US$ million)	
3,58	15,290	66,039	61,977	Proj.1	12,90570153	55,74164703	52,313	9,664
				Proj.2	12,93989007	55,88931243	52,452	9,525
				Proj.3	13,57223402	58,62050014	55,015	6,962
				Proj.4	14,51525001	62,69352663	58,837	3,139
				Proj.5	15,39215173	66,48099578	62,392	-0,415
				Proj.6	15,16028938	65,47954775	61,452	0,525
				Proj.7	15,31669927	66,15510534	62,086	-0,109

(*) Source: Interim Report – PDTU 2001

The next table synthesize the total of benefit (only for the year of 2020) associated to the single implantation of each of the seven group projects:

TABLE 3.4-5 – Benefit Total (US$ million)

Nada Fazer - Costs - 2020			2020	PDTU - Costs -2020			Benefit
COa	TVA	Total		COa	TVa	Total	
234	62	296	Proj.1	229	52	281	15
			Proj.2	226	52	279	17
			Proj.3	234	55	289	7
			Proj.4	233	59	292	5
			Proj.5	236	62	298	-2
			Proj.6	234	61	295	1
			Proj.7	236	62	298	-2

Through the comparative evaluation, we reach the following "ranking" of priorities for the projects:

TABLE 3.4-6 – Ranking of Priorities(US$ million)

2020	PDTU					
	Finantial Cost	Economic Cost (*)	Benefit	B-C	B/C	Ranking
Proj.1	24,590	22,967	15,130	-2	0,658794806	1
Proj.2	32,641	30,487	17,399	-2	0,570714716	2
Proj.3	17,089	15,961	6,692	-1	0,419258978	3
Proj.4	18,829	17,586	4,601	-1	0,261633132	4
Proj.5	34,216	31,958	-1,860	-2	-0,058204258	6
Proj.6	15,989	14,933	0,722	-1	0,048318674	5
Proj.7	19,239	17,970	-1,714	-1	-0,09539585	7

Note:

The economic cost:
100% nationalization of the equipment and materials and a "shadow cost" = financial cost, considering the percentage of these items of 40% of the total cost of interventions.
A "shadow cost" of hand labor estimated as the equation of Haveman:

"shadow cost" = (market remuneration) x (1,25 - unemployment rate / 0,2),

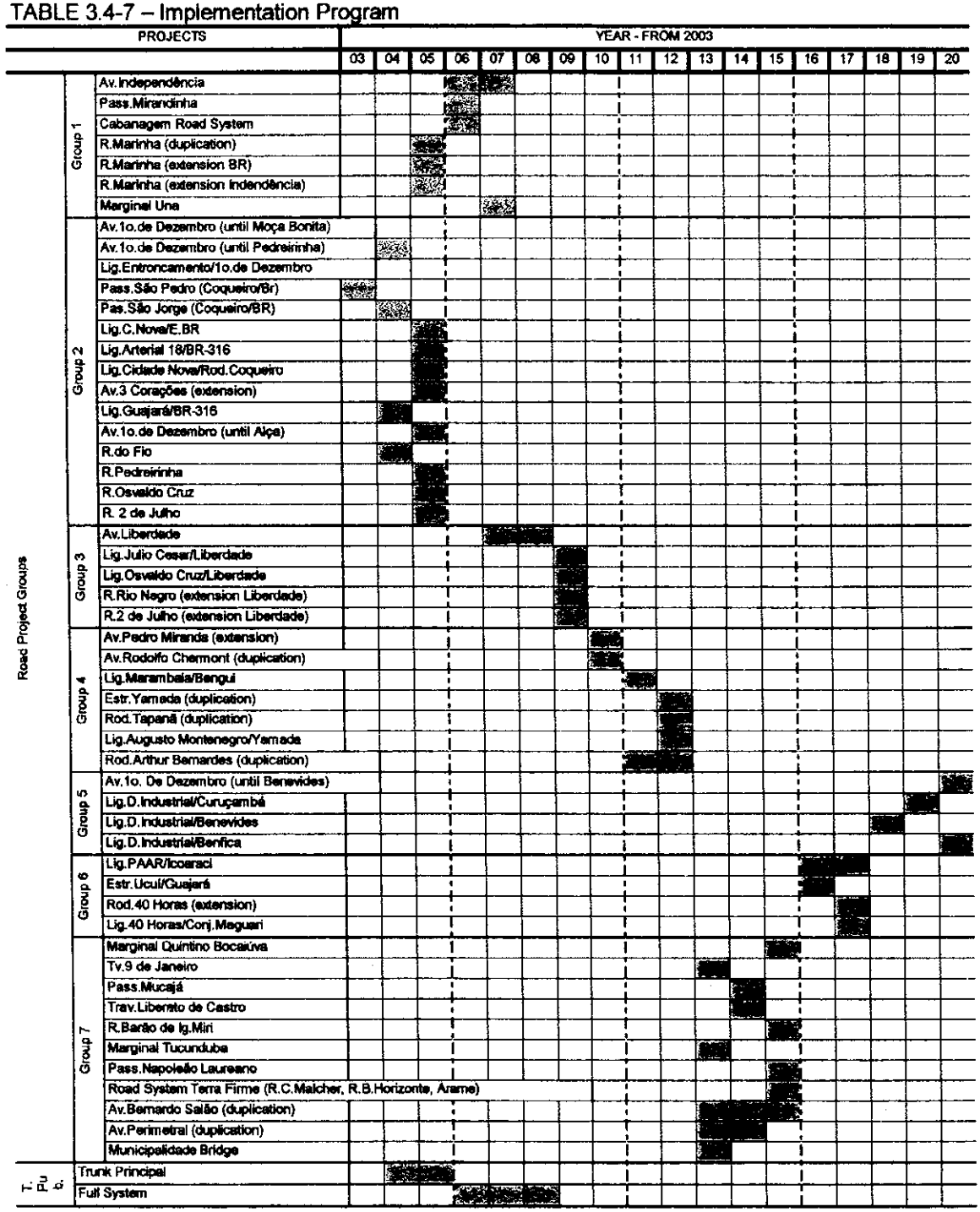
Being the unemployment rate = 7,2% (source: Person Trip Survey do PDTU) and considering the percentage of hand labor around 20% of the total cost of interventions (source: local survey)

Economic Cost = [20%(shadow cost) + 80%] x financial cost
Economic Cost = [20%(1,25 - 0,072/0,2) + 80%] x financial cost
Economic Cost = 0,978 x financial cost

3.4.3. IMPLEMENTATION PROGRAM

Based on the *ranking* of priorities obtained in the previous item and in association of dependency between each group of projects, the implantation time is shown in the schedule as follows (TABLE 3.4-7):

TABLE 3.4-7 – Implementation Program



3.4.4. ECONOMIC EVALUATION OF PDTU

The economic evaluation of sets of projects proposed in PDTU/2001 was done from results of simulations in modeling, comparing the economic costs of interventions with benefits of with/without projects from the reductions of:

operational costs of general vehicles;
operational costs of public transport;
passengers trip times of general vehicles; and
passengers trip times of public transport.

Considering two distinct technological alternatives for the public transport system: the diesel bus system operated by conventional vehicles and bi-articulated; and a hybrid bus system (electric-diesel) operated by vehicles with same capacities.

To quantify the benefits from reduction of trip time of users, there are two distinct hypothesis:

a) Hypothesis 1
100.0% of economy benefit from value of average hour of user, in trips with work or business purpose; and
50.0% of economy benefit from value of average hour of user, in trips with other purposes.

b) Hypothesis 2
50% of economy benefit from value of average hour of user, in trips with work or business purpose; and
No benefit in reduction of trips time by other purposes.

Finally, analysis of sensibility was made considering oscillations up to 20.0% of increase in costs and 20.0% decrease in benefits.

3.4.4.1. Reduction Benefits of Operational Cost

a) Vehicles in general (auto+taxi+truck)

The benefits of reduction of operational costs of general vehicles were estimated by the equation:

$$\mathbf{COa = Cc \cdot PecC \cdot \Sigma dij + Aa \cdot \Sigma dij}$$

Where:
COa = operational cost of ucp, in R$
Cc = fuel cost consume (gasoline), in l/km
PecC = economic price of fuel cost (R$/l) = 1,73
Σdij = sum of extensions of sections ij done, in km
Aa = average cost unit of items of consume dependents of extension done (R$/km) = 0,138573446.

$$\mathbf{Cc = 0{,}0954 + (1{,}2664 / V) - (0{,}00029 \cdot V),\ if\ V < 72\ km/h}$$

Where:
V = commercial velocity of ucp, in km/h

The value of US$ used for conversion was R$2,00 and the percentage of peak hour related to volume of diary traffic was of 10.0%, in all modes.

The parameter **Aa** was obtained from the Taxi Frame of Juiz de Fora, 02/2001.

Lubricant	0,003368644
Pieces and Accessories	0,117846045
Rotation	0,017358757
Total	0,138573446

The results obtained per year is described in (TABLE 3.4-8).

TABLE 3.4-8 – Benefits Result Reached per Year

Year	Without Project		PDTU		Operational Cost(R$ 1000)		Benefit
	Σdij 1000	V (km/h)	Σdij 1000	V (km/h)	Without Project	PDTU	(US)
2.001	498.139	45,52	498.139	45,52	163.842	163.842	0
2.002	572.547	45,64	569.603	46,05	188.213	186.882	665.395
2.003	646.955	45,75	641.066	46,58	212.558	209.814	1.371.981
2.004	721.364	45,87	712.530	47,10	236.876	232.639	2.118.635
2.005	795.772	45,98	783.994	47,63	261.169	255.360	2.904.285
2.006	855.059	45,70	839.336	47,67	280.999	273.342	3.828.626
2.007	914.346	45,42	894.678	47,70	300.884	291.317	4.783.355
2.008	973.633	45,13	950.020	47,74	320.825	309.287	5.768.827
2.009	1.032.921	44,85	1.005.362	47,77	340.822	327.252	6.785.404
2.010	1.092.208	44,57	1.060.704	47,81	360.877	345.210	7.833.457
2.011	1.135.129	43,99	1.101.536	47,66	376.117	358.744	8.686.447
2.012	1.178.050	43,42	1.142.369	47,51	391.457	372.297	9.579.906
2.013	1.220.970	42,84	1.183.201	47,35	406.901	385.870	10.515.291
2.014	1.263.891	42,27	1.224.034	47,20	422.450	399.462	11.494.140
2.015	1.306.812	41,69	1.264.866	47,05	438.110	413.074	12.518.082
2.016	1.351.172	41,12	1.301.520	46,71	454.348	425.704	14.321.991
2.017	1.395.531	40,55	1.338.175	46,37	470.703	438.377	16.163.077
2.018	1.439.891	39,99	1.374.829	46,04	487.181	451.095	18.042.970
2.019	1.484.251	39,42	1.411.483	45,70	503.784	463.857	19.963.409
2.020	1.528.610	38,85	1.448.138	45,36	520.519	476.666	21.926.239

b) Public Transport– Alternative Diesel

$$\mathbf{COo = CCd \cdot PecD \cdot \Sigma dij + Ao \cdot Sdij + Bo \cdot \Sigma tij}$$

Where:
COo = operational cost of public transport, in R$
CCd = consume unit of oil diesel, in l/km
PecD = economic price of liter of oil diesel, in R$= 0,7631
Σdij = sum of extensions of sections ij done, in km
Ao = average cost unit of tires, spare tires and maintenance, in R$/km (variable cost)
Bo = average cost unit of administration, labor for operation and depreciation, in R$/vehc.hour (fixed cost)
Σtij = times sum of operation of public transport in link ij

$$\mathbf{CCdhp = 0,4978 + (1,3791 / V) - (0,0071\ V) + (0,00008\ V^2)}$$

Where:
CCdhp = consume unit of oil diesel, in l/km, in peak hour
V = average velocity of operation (commercial, includes times of stop), in km/h

The capacity accepted for buses was of 80 passengers for the conventional, 150 for articulated and 260 for bi-articulated.

The parameters **Ao** and **Bo** were obtained from frame of tariff calculation of Belem for conventional case. The information of the VOLVO Co. was considered that the life time of conventional bus is 7 years, on the other hand, other two tipes are 10 years.

Ao			
Conv.(1)	Articul.(2)	Bi-art.(3)	
0,0311	0,0381	0,0483	*tires*
0,0778	0,0833	0,0875	*tubes*
0,2389	0,2719	0,2675	*maitenance*
0,3478	0,3933	0,4033	*total*

Bo			
Conv.(1)	Articul.(2)	Bi-art.(3)	
3,677492	12,01846	18,86308	*admnistration*
3,044215	3,044215	3,044215	*labor*
27,69	27,69	27,69	*depreciation*
2,044246	2,044246	2,044246	*remuneration*
36,45595	44,79692	51,64154	*total*

The results obtained are show in TABLE 3.4-9.

TABLE 3.4-9 – Benefits of Network of Public Transports - Alternative Diesel

Year	Without Project			PDTU									Operational Cost (R$1000)		Benefit (US$)
	Conventional			Conventional			Articulated			Double Articulated					
	dij	V (km/h)	tij	dij	V (km/h)	tij	dij	V (km/h)	tij	dij	V (km/h)	tij	Without	PDTU	
2.001	7.254	23,15	318	7.254	23,15	318							43.016	43.016	
2.002	8.064	23,31	351	6.463	25,87	280	601	25,87	15				47.492	40.625	3.433.510
2.003	8.874	23,48	383	5.672	28,59	241	1.203	28,59	30				51.965	38.277	6.843.777
2.004	9.683	23,64	415	4.881	31,30	202	1.804	31,30	45				56.435	35.967	10.234.218
2.005	10.493	23,80	448	4.090	34,02	164	2.405	34,02	60				60.902	33.688	13.607.379
2.006	11.189	23,87	476	4.320	33,98	173	2.499	33,98	62				64.776	35.387	14.694.393
2.007	11.886	23,95	504	4.550	33,93	182	2.593	33,93	65				68.648	37.086	15.780.763
2.008	12.583	24,02	532	4.780	33,89	191	2.686	33,89	67				72.518	38.785	16.866.491
2.009	13.280	24,10	560	5.009	33,84	200	2.780	33,84	69				76.388	40.485	17.951.581
2.010	13.976	24,17	588	5.239	33,80	210	2.874	33,80	72				80.257	42.185	19.036.037
2.011	14.529	24,20	610	5.379	33,81	215	2.970	33,81	74				83.369	43.401	19.984.044
2.012	15.081	24,23	633	5.519	33,83	221	3.068	33,83	77				86.481	44.617	20.931.878
2.013	15.634	24,27	656	5.659	33,84	226	3.161	33,84	79				89.593	45.833	21.879.542
2.014	16.186	24,30	678	5.799	33,86	232	3.257	33,86	81				92.704	47.050	22.827.034
2.015	16.738	24,33	701	5.939	33,87	238	3.353	33,87	84				95.814	48.266	23.774.356
2.016	17.370	24,36	726	6.362	34,13	247	3.118	34,13	78	288	34,13	7	99.333	50.253	24.539.799
2.017	18.002	24,38	752	6.785	34,40	257	2.882	34,40	72	575	34,40	14	102.851	52.240	25.305.614
2.018	18.634	24,41	777	7.208	34,66	266	2.646	34,66	66	863	34,66	22	106.369	54.225	26.071.779
2.019	19.266	24,43	803	7.631	34,93	276	2.411	34,93	60	1.151	34,93	29	109.886	56.210	26.838.273
2.020	19.898	24,46	828	8.054	35,19	286	2.175	35,19	54	1.438	35,19	36	113.404	58.193	27.605.076

c) Public Transport–Hybrid Alternative

The equations used for the hybrid were equal to the diesel, changing the parameters **Ao** and **Bo** by considering the increase of 20.0% of the vehicle cost and of 30.0% of economy of operation, according to information from the producer, the ELETRA of São Paulo:

Ao			
Conv.(1)	Articul.(2)	Double-art.(3)	
0,0311	0,02667	0,03381	*Tires*
0,0778	0,05831	0,06125	*Tubes*
0,2389	0,19033	0,18725	*Maintenace*
0,3478	0,27531	0,28231	*Total*

Bo			
Conv.(1)	Articul.(2)	Double-art.(3)	
3,677492	12,01846	18,86308	*Administration*
3,044215	3,044215	3,04421	*Labor*
27,69	33,228	33,228	*Depreciation*
2,044246	2,453095	2,453095	*Remuneration*
36,45595	50,74377	57,58839	*Total*

The results obtained for the hybrid alternative, is in TABLE 3.4-10.

TABLE 3.4-10– Benefits of Network of Public Transport - Alternative Hybrid

Year	Without Project			PDTU									Operational Cost (R$1000)		Benefit (R$)
	Conventional			Conventional			Articulated			Double Articulated					
	dij	V (km/h)	tij	dij	V (km/h)	tij	dij	V (km/h)	tij	dij	V (km/h)	tij	Without	PDTU	
2.001	7.254	23,15	318	7.254	23,15	318	0	0,00	0	0	0	0	43.016	43.016	0
2.002	8.064	23,31	351	6.463	25,87	260	601	25,87	15	0	0	0	47.492	40.673	3.409.525
2.003	8.874	23,48	383	5.672	28,59	241	1.203	28,59	30	0	0	0	51.965	38.373	6.795.806
2.004	9.683	23,64	415	4.881	31,30	202	1.804	31,30	45	0	0	0	56.435	36.110	10.162.265
2.005	10.493	23,80	448	4.090	34,02	164	2.405	34,02	60	0	0	0	60.902	33.880	13.511.442
2.006	11.189	23,87	476	4.320	33,96	173	2.499	33,96	62	0	0	0	64.776	35.586	14.594.720
2.007	11.886	23,95	504	4.550	33,93	182	2.593	33,93	65	0	0	0	68.648	37.293	15.677.354
2.008	12.583	24,02	532	4.780	33,89	191	2.686	33,89	67	0	0	0	72.518	39.000	16.759.346
2.009	13.280	24,10	560	5.009	33,84	200	2.780	33,84	69	0	0	0	76.388	40.707	17.840.701
2.010	13.976	24,17	588	5.239	33,80	210	2.874	33,80	72	0	0	0	80.257	42.414	18.921.421
2.011	14.529	24,20	610	5.379	33,81	215	2.970	33,81	74	0	0	0	83.369	43.638	19.865.601
2.012	15.081	24,23	633	5.519	33,83	221	3.066	33,83	77	0	0	0	86.481	44.862	20.809.606
2.013	15.634	24,27	656	5.659	33,84	226	3.161	33,84	79	0	0	0	89.593	46.086	21.753.444
2.014	16.186	24,30	678	5.799	33,86	232	3.257	33,86	81	0	0	0	92.704	47.309	22.697.109
2.015	16.738	24,33	701	5.939	33,87	238	3.353	33,87	84	0	0	0	95.814	48.533	23.640.604
2.016	17.370	24,36	726	6.362	34,13	247	3.118	34,13	78	288	34,134	7	99.333	50.523	24.405.096
2.017	18.002	24,38	752	6.785	34,40	257	2.882	34,40	72	575	34,398	14	102.851	52.511	25.169.959
2.018	18.634	24,41	777	7.208	34,66	266	2.646	34,66	66	863	34,662	22	106.369	54.499	25.935.173
2.019	19.266	24,43	803	7.631	34,93	276	2.411	34,93	60	1.151	34,926	29	109.886	56.485	26.700.715
2.020	19.898	24,46	828	8.054	35,19	286	2.175	35,19	54	1.438	35,19	36	113.404	58.470	27.466.567

3.4.4.2. Reduction Benefits of Trip Times

a) General vehicles (auto+taxi+truck)

CTV = Σ [RM (TVtn + 0,5 . TVo) x EF(1+ES)]

Where:
CTV = cost of trip time, R$
RM = average income individual, in R$ / hour
TVtn = trip time for work or business purpose, in hours/year
TVo = trip time for other purposes, in hours/year
EF = percentage of formal work in RM = 53.09%, according to the Person Trip Survey of PDTU
ES = social charges = 35.0% (Source: COHAB/PA)

Considering the values of 100.0% of trips for work and business purpose that sum 18.8% of the total time of trips and 50.0% of values of trips for other purposes which are 81.2% of the total time of trips. The results expressed in TABLE 3.4-11.

TABLE 3.4-11 – Benefits Reached per Year in General Traffic – Hypothesis 1

Year	Average Income (R$/hour)(*	Without Project			PDTU			Benefit (US$)
		TVtn (hour/year)	TVo (hour/year)	Cost of Trip Time (R$)	TVtn (hour/year)	TVo (hour/year)	Cost of Trip Time (R$)	
2.001	1,92	2.111.127	4.559.136	6.053.234	2.111.127	4.559.136	6.053.234	0
2.002	1,97	2.396.709	5.175.871	7.036.871	2.360.904	5.098.548	6.931.746	52.562
2.003	2,02	2.682.290	5.792.605	8.064.201	2.610.681	5.637.960	7.848.911	107.645
2.004	2,07	2.967.871	6.409.339	9.136.756	2.860.458	6.177.371	8.806.076	165.340
2.005	2,11	3.253.453	7.026.074	10.256.112	3.110.234	6.716.783	9.804.633	225.739
2.006	2,17	3.588.525	7.749.687	11.583.653	3.364.166	7.265.167	10.859.428	362.112
2.007	2,22	3.923.598	8.473.301	12.968.964	3.618.098	7.813.551	11.959.172	504.896
2.008	2,27	4.258.670	9.196.915	14.414.053	3.872.029	8.361.935	13.105.415	654.319
2.009	2,33	4.593.742	9.920.529	15.920.990	4.125.961	8.910.320	14.299.753	810.619
2.010	2,38	4.593.742	9.920.529	16.302.769	4.125.961	8.910.320	14.642.655	830.057
2.011	2,48	4.947.634	10.684.783	18.291.539	4.344.577	9.382.437	16.062.021	1.114.759
2.012	2,58	5.301.525	11.449.038	20.417.920	4.563.192	9.854.554	17.574.358	1.421.781
2.013	2,69	5.655.416	12.213.292	22.689.934	4.781.808	10.326.671	19.184.957	1.752.489
2.014	2,80	6.009.307	12.977.546	25.116.034	5.000.424	10.798.788	20.899.384	2.108.325
2.015	2,92	6.009.307	12.977.546	26.164.295	5.000.424	10.798.788	21.771.656	2.196.320
2.016	3,04	6.486.254	14.007.548	29.419.585	5.229.671	11.293.864	23.720.126	2.849.730
2.017	3,17	6.963.200	15.037.550	32.901.029	5.458.918	11.788.941	25.793.316	3.553.856
2.018	3,30	7.440.147	16.067.552	36.621.833	5.688.166	12.284.017	27.998.244	4.311.795
2.019	3,44	7.917.094	17.097.553	40.595.913	5.917.413	12.779.094	30.342.293	5.126.810
2.020	3,58	7.917.094	17.097.553	42.290.254	5.917.413	12.779.094	31.608.682	5.340.786

The values of only 50.0% of the saved time of trips for work and business purposes and no values to others, the results is shower in TABLE 3.4-12.

TABLE 3.4-12 - Benefits Reached per Year in General Traffic – Hypothesis 2

Year	Average Income (R$/hour)(*)	Without Project			PDTU			Benefit (US$)
		TVtn (hour/year)	TVo (hour /year)	Cost of Trip time (R$)	TVtn (hour/year)	TVo (hour /year)	Cost of Trip Time (R$)	
2.001	1,92	1.055.564	0	1.455.253	1.055.564	0	1.455.253	0
2.002	1,97	1.198.354	0	1.691.728	1.180.452	0	1.666.456	12.636
2.003	2,02	1.341.145	0	1.938.708	1.305.340	0	1.886.950	25.879
2.004	2,07	1.483.936	0	2.196.560	1.430.229	0	2.117.062	39.749
2.005	2,11	1.626.726	0	2.465.664	1.555.117	0	2.357.124	54.270
2.006	2,17	1.794.263	0	2.784.817	1.682.063	0	2.610.706	87.055
2.007	2,22	1.961.799	0	3.117.858	1.809.049	0	2.875.095	121.382
2.008	2,27	2.129.335	0	3.465.271	1.936.015	0	3.150.662	157.304
2.009	2,33	2.296.871	0	3.827.553	2.062.980	0	3.437.792	194.880
2.010	2,38	2.296.871	0	3.919.336	2.062.980	0	3.520.229	199.553
2.011	2,48	2.473.817	0	4.397.454	2.172.288	0	3.861.458	267.998
2.012	2,58	2.650.762	0	4.908.656	2.281.596	0	4.225.038	341.809
2.013	2,69	2.827.708	0	5.454.869	2.390.904	0	4.612.240	421.314
2.014	2,80	3.004.654	0	6.038.126	2.500.212	0	5.024.404	506.861
2.015	2,92	3.004.654	0	6.290.137	2.500.212	0	5.234.107	528.015
2.016	3,04	3.243.127	0	7.072.739	2.614.836	0	5.702.537	685.101
2.017	3,17	3.481.600	0	7.909.710	2.729.459	0	6.200.951	854.380
2.018	3,30	3.720.074	0	8.804.226	2.844.083	0	6.731.036	1.036.595
2.019	3,44	3.958.547	0	9.759.631	2.958.706	0	7.294.567	1.232.532
2.020	3,58	3.958.547	0	10.166.966	2.958.706	0	7.599.018	1.283.974

b) Public Transport

$$\mathbf{CTV = \Sigma \{[RM\ (TVtn + 0,5\ .\ TVo)\ x\ EF(1+ES)]conv + [RM\ (TVtn + 0,5\ .\ TVo)\ x\ EF(1+ES)]art + [RM\ (TVtn + 0,5\ .\ TVo)\ x\ EF(1+ES)]bi\text{-}art\}}$$

Where:
CTV = cost of trip time, R$
RM = average income individual, in R$/hour
TVtn = trip time for work or business purpose, in hours/year
TVo = trip time for other purposes, in hours/year
EF = percentage of formal work in RM = 53,09%, according to the Person Trip Survey of PDTU
ES = social charges = 35.0% (Source: COHAB/PA)
conv = conventional bus
art = articulated bus
bi-art = bi-articulated bus

Considering the values of 100.0% of trips for work and business purpose that sum 18.8% of the total time of trips and 50.0% of values of trips for other purposes which are 81.2% of the total time of trips the result is express in TABLE 3.4-13.

TABLE 3.4-13 – Benefits Reached per Year in Public Transport – Hypothesis 1

Year	Average Income (R$/hour)(*)	Without Project			PDTU							Benefit (US$)
		Conventional		Cost of Trip Time (R$)	Conventional		Articulated		Double Articulatedd		Cost of Trip Time (R$)	
		TVtn (h/year)	TVo (h/year)		TVtn (h/year)	TVo (h/year)	TVtn (h/year)	TVo (h/year)	TVtn (h/year)	TVo (h/year)		
2.001	0,67	12.451.691	26.890.354	12.476.299	12.451.691	26.890.354	0	0	0	0	12.476.299	0
2.002	0,69	13.713.773	29.615.914	14.070.375	10.936.184	23.621.824	1.102.229	2.380.346	0	0	12.353.503	856.436
2.003	0,70	14.975.854	32.341.473	15.733.728	9.424.677	20.353.293	2.204.459	4.760.693	0	0	12.217.644	1.758.042
2.004	0,72	16.237.936	35.067.032	17.468.763	7.911.171	17.084.762	3.306.688	7.141.039	0	0	12.068.166	2.700.298
2.005	0,74	17.500.018	37.792.591	19.277.962	6.397.664	13.816.231	4.408.917	9.521.385	0	0	11.904.494	3.686.734
2.006	0,76	18.595.418	40.158.191	20.975.865	6.757.083	14.592.424	4.560.601	9.892.148	0	0	12.789.049	4.093.408
2.007	0,77	19.690.819	42.523.790	22.744.113	7.116.503	15.368.618	4.752.284	10.262.911	0	0	13.709.182	4.517.466
2.008	0,79	20.786.220	44.889.390	24.585.104	7.475.922	16.144.811	4.923.967	10.633.673	0	0	14.666.090	4.959.507
2.009	0,81	21.881.621	47.254.990	26.501.309	7.835.342	16.921.004	5.095.650	11.004.436	0	0	15.661.007	5.420.151
2.010	0,83	22.977.022	49.620.589	28.495.276	8.194.761	17.697.197	5.267.333	11.375.198	0	0	16.695.206	5.900.035
2.011	0,87	23.882.629	51.533.125	30.828.714	8.413.576	18.169.743	5.443.224	11.755.048	0	0	17.901.938	6.463.388
2.012	0,90	24.748.237	53.445.661	33.307.295	8.632.390	18.642.289	5.619.115	12.134.897	0	0	19.180.318	7.063.488
2.013	0,94	25.633.845	55.358.197	35.939.089	8.851.204	19.114.834	5.795.006	12.514.746	0	0	20.534.225	7.702.422
2.014	0,98	26.519.453	57.270.734	38.732.507	9.070.018	19.587.380	5.970.896	12.894.595	0	0	21.967.735	8.382.386
2.015	1,02	27.405.061	59.183.270	41.696.518	9.288.833	20.059.926	6.146.787	13.274.444	0	0	23.485.137	9.105.691
2.016	1,06	28.400.942	61.333.949	45.015.258	9.665.224	20.872.771	5.714.778	12.341.488	913.962	1.973.789	25.825.798	9.594.730
2.017	1,11	29.396.823	63.484.628	48.536.391	10.041.616	21.685.617	5.282.769	11.408.532	1.827.924	3.947.539	28.320.933	10.108.729
2.018	1,15	30.392.704	65.635.308	52.277.197	10.418.008	22.498.463	4.850.759	10.475.576	2.741.886	5.921.308	30.979.358	10.648.919
2.019	1,20	31.388.585	67.785.987	56.243.543	10.794.399	23.311.309	4.418.750	9.542.620	3.655.849	7.895.077	33.810.357	11.216.593
2.020	1,25	32.384.466	69.936.667	60.449.909	11.170.791	24.124.155	3.986.741	8.609.664	4.569.811	9.868.847	36.823.705	11.813.102

(*) Source: Interim Report - PDTU/2001

The values of only 50.0% of the economized time of trips by work and business purposes and no values to others, the results is shown in TABLE 3.4-14.

TABLE 3.4-14 - Benefits Reached per Year in Public Transport – Hypothesis 2

Year	Average Income (R$/hour)	Without Project			PDTU							Benefit (US$)
		Conventional		Cost of Trip Time (R$)	Conventional		Articulated		Double Articulated		Cost of Trip Time (R$)	
		TVtn (h/year)	TVo (h/year)		TVtn (h/year)	TVo (h/year)	TVtn (h/year)	TVo (h/year)	TVtn (h/year)	TVo (h/year)		
2.001	0,67	6.225.846	0	2.999.417	6.225.846	0	0	0	0	0	2.999.417	0
2.002	0,69	6.856.886	0	3.382.648	5.468.092	0	551.115	0	0	0	2.969.896	206.376
2.003	0,70	7.487.927	0	3.782.533	4.712.339	0	1.102.229	0	0	0	2.937.234	422.649
2.004	0,72	8.118.968	0	4.199.661	3.955.585	0	1.653.344	0	0	0	2.901.298	649.177
2.005	0,74	8.750.009	0	4.634.599	3.198.832	0	2.204.459	0	0	0	2.861.950	886.325
2.006	0,76	9.297.709	0	5.042.791	3.378.542	0	2.290.300	0	0	0	3.074.605	984.093
2.007	0,77	9.845.410	0	5.467.894	3.558.251	0	2.376.142	0	0	0	3.295.814	1.086.040
2.008	0,79	10.393.110	0	5.910.485	3.737.961	0	2.461.983	0	0	0	3.525.863	1.192.311
2.009	0,81	10.940.810	0	6.371.159	3.917.671	0	2.547.825	0	0	0	3.765.050	1.303.054
2.010	0,83	11.488.511	0	6.850.527	4.097.381	0	2.633.667	0	0	0	4.013.681	1.418.423
2.011	0,87	11.931.315	0	7.411.507	4.206.788	0	2.721.612	0	0	0	4.303.791	1.553.858
2.012	0,90	12.374.119	0	8.007.38(	4.316.195	0	2.809.557	0	0	0	4.611.125	1.696.128
2.013	0,94	12.816.923	0	8.640.083	4.425.602	0	2.897.503	0	0	0	4.936.617	1.851.733
2.014	0,98	13.259.726	0	9.311.651	4.535.009	0	2.985.448	0	0	0	5.281.246	2.015.203
2.015	1,02	13.702.530	0	10.024.227	4.644.416	0	3.073.394	0	0	0	5.646.043	2.189.092
2.016	1,06	14.200.471	0	10.822.082	4.832.612	0	2.857.389	0	456.981	0	6.206.760	2.306.661
2.017	1,11	14.698.412	0	11.669.076	5.020.808	0	2.641.384	0	913.962	0	6.806.613	2.430.231
2.018	1,15	15.196.352	0	12.567.919	5.209.004	0	2.425.380	0	1.370.943	0	7.447.723	2.560.098
2.019	1,20	15.694.293	0	13.521.466	5.397.200	0	2.209.375	0	1.827.924	0	8.128.321	2.696.572
2.020	1,25	16.192.233	0	14.532.715	5.585.396	0	1.993.370	0	2.284.905	0	8.852.758	2.839.978

3.4.4.3. Total of Reached Benefits

The total of reached benefits per year is shown in TABLE 3.4-15.

TABLE 3.4-15 - Total of Benefits per Year – Hypothesis 1

Year	Benefit of Diesel					Benefit of Hybrid					Aditional Benefit
	COa	COo	TVa	TVo	Total	COa	COo	TVa	TVo	Total	
2001											
2002	665.395	3.433.510	52.562	858.436	5.009.903	665.395	3.409.525	52.562	858.436	4.985.919	-23.984
2003	1.371.981	6.843.777	107.645	1.758.042	10.081.445	1.371.981	6.795.808	107.645	1.758.042	10.033.476	-47.969
2004	2.118.635	10.234.218	165.340	2.700.298	15.218.491	2.118.635	10.162.265	165.340	2.700.298	15.146.538	-71.953
2005	2.904.285	13.607.379	225.739	3.686.734	20.424.138	2.904.285	13.511.442	225.739	3.686.734	20.328.200	-95.937
2006	3.828.626	14.694.393	362.112	4.093.408	22.978.540	3.828.626	14.594.720	362.112	4.093.408	22.878.867	-99.673
2007	4.783.355	15.780.763	504.896	4.517.466	25.586.480	4.783.355	15.677.354	504.896	4.517.466	25.483.071	-103.409
2008	5.768.827	16.866.491	654.319	4.959.507	28.249.144	5.768.827	16.759.346	654.319	4.959.507	28.142.000	-107.144
2009	6.785.404	17.951.581	810.619	5.420.151	30.967.754	6.785.404	17.840.701	810.619	5.420.151	30.856.874	-110.880
2010	7.833.457	19.036.037	830.057	5.900.035	33.599.587	7.833.457	18.921.421	830.057	5.900.035	33.484.971	-114.616
2011	8.686.447	19.984.044	1.114.759	6.463.388	36.248.639	8.686.447	19.865.601	1.114.759	6.463.388	36.130.195	-118.443
2012	9.579.906	20.931.878	1.421.781	7.063.488	38.997.054	9.579.906	20.809.608	1.421.781	7.063.488	38.874.783	-122.271
2013	10.515.291	21.879.542	1.752.489	7.702.422	41.849.743	10.515.291	21.753.444	1.752.489	7.702.422	41.723.645	-126.098
2014	11.494.140	22.827.034	2.108.325	8.382.386	44.811.885	11.494.140	22.697.109	2.108.325	8.382.386	44.681.960	-129.925
2015	12.518.082	23.774.356	2.196.320	9.105.691	47.594.448	12.518.082	23.640.604	2.196.320	9.105.691	47.460.696	-133.752
2016	14.321.991	24.539.799	2.849.730	9.594.730	51.306.250	14.321.991	24.405.096	2.849.730	9.594.730	51.171.546	-134.704
2017	16.163.077	25.305.614	3.553.856	10.108.729	55.131.275	16.163.077	25.169.959	3.553.856	10.108.729	54.995.620	-135.655
2018	18.042.970	26.071.779	4.311.795	10.648.919	59.075.463	18.042.970	25.935.173	4.311.795	10.648.919	58.938.857	-136.606
2019	19.963.409	26.838.273	5.126.810	11.216.593	63.145.084	19.963.409	26.700.715	5.126.810	11.216.593	63.007.527	-137.558
2020	21.926.239	27.605.076	5.340.786	11.813.102	66.685.203	21.926.239	27.466.567	5.340.786	11.813.102	66.546.695	-138.509

Considering the alternative of lower value of time economy, the total reached benefits is shown in TABLE 3.4-16:

TABLE 3.4-16 - Total of Benefits per Year – Hypothesis 2

Year	Benefit of Diesel					Benefit of Hybrid					Aditional Benefit
	COa	COo	TVa	TVo	Total	COa	COo	TVa	TVo	Total	
2001											
2002	665.395	3.433.510	12.636	206.376	4.317.917	665.395	3.409.525	12.636	206.376	4.293.933	-23.984
2003	1.371.981	6.843.777	25.879	422.649	8.664.286	1.371.981	6.795.808	25.879	422.649	8.616.317	-47.969
2004	2.118.635	10.234.218	39.749	649.177	13.041.778	2.118.635	10.162.265	39.749	649.177	12.969.826	-71.953
2005	2.904.285	13.607.379	54.270	886.325	17.452.259	2.904.285	13.511.442	54.270	886.325	17.356.322	-95.937
2006	3.828.626	14.694.393	87.055	984.093	19.594.167	3.828.626	14.594.720	87.055	984.093	19.494.495	-99.673
2007	4.783.355	15.780.763	121.382	1.086.040	21.771.540	4.783.355	15.677.354	121.382	1.086.040	21.668.131	-103.409
2008	5.768.827	16.866.491	157.304	1.192.311	23.984.933	5.768.827	16.759.346	157.304	1.192.311	23.877.789	-107.144
2009	6.785.404	17.951.581	194.880	1.303.054	26.234.919	6.785.404	17.840.701	194.880	1.303.054	26.124.039	-110.880
2010	7.833.457	19.036.037	199.553	1.418.423	28.487.471	7.833.457	18.921.421	199.553	1.418.423	28.372.855	-114.616
2011	8.686.447	19.984.044	267.998	1.553.858	30.492.348	8.686.447	19.865.601	267.998	1.553.858	30.373.904	-118.443
2012	9.579.906	20.931.878	341.809	1.698.128	32.551.721	9.579.906	20.809.608	341.809	1.698.128	32.429.451	-122.271
2013	10.515.291	21.879.542	421.314	1.851.733	34.667.880	10.515.291	21.753.444	421.314	1.851.733	34.541.782	-126.098
2014	11.494.140	22.827.034	506.861	2.015.203	36.843.236	11.494.140	22.697.109	506.861	2.015.203	36.713.313	-129.925
2015	12.518.082	23.774.356	528.015	2.189.092	39.009.545	12.518.082	23.640.604	528.015	2.189.092	38.875.793	-133.752
2016	14.321.991	24.539.799	685.101	2.306.661	41.853.553	14.321.991	24.405.096	685.101	2.306.661	41.718.850	-134.704
2017	16.163.077	25.305.614	854.380	2.430.231	44.753.302	16.163.077	25.169.959	854.380	2.430.231	44.617.647	-135.655
2018	18.042.970	26.071.779	1.036.595	2.560.096	47.711.443	18.042.970	25.935.173	1.036.595	2.560.096	47.574.836	-136.606
2019	19.963.409	26.838.273	1.232.532	2.696.572	50.730.786	19.963.409	26.700.715	1.232.532	2.696.572	50.593.229	-137.558
2020	21.926.239	27.605.076	1.283.974	2.839.978	53.655.268	21.926.239	27.466.567	1.283.974	2.839.978	53.516.759	-138.509

3.4.4.4. Economic Evaluation

For total economic evaluation of the project it was used the economic cost of investments to be done in RMB. The determination of this cost considered:

100.0% of national made equipment and material and a "shadow cost" = financial cost, considering the percentage of these items in 40% of the total cost of interventions;

a "shadow cost "of hand labor estimated by equation of Haveman.

"shadow cost" = (market remuneration) x (1,25 - unemployment rate / 0,2)

Being the unemployment rate = 7,2% (source: Person Trip Survey of PDTU) and considering the percentage of hand labor around 20% of the total cost of interventions (source: PMB survey):

Economic Cost = [20%(shadow cost) + 80%] x financial cost
Economic Cost = [20%(1,25 - 0,072/0,2) + 80%] x financial cost = 0,978 x financial cost

The economic evaluation of all set of projects by PDTU per year, presented the following results TABLE 3.4-17, for hypothesis 1:

TABLE 3.4-17 – Economic Evaluation per Year – Hypothesis 1

Year	PDTU - Diesel			PDTU - Hybrid		
	Cost	Benefit	B-C	Cost (*)	Benefit	B-C
2001						
2002						
2003	5.929.156	10.081.445	4.152.288	5.929.156	10.033.476	4.104.320
2004	42.037.792	15.218.491	-26.819.301	42.037.792	15.146.538	-26.891.254
2005	57.943.917	20.424.138	-37.519.779	57.943.917	20.328.200	-37.615.716
2006	14.793.561	22.978.540	8.184.979	14.793.561	22.878.867	8.085.306
2007	21.108.624	25.586.480	4.477.855	21.108.624	25.483.071	4.374.447
2008	10.572.106	28.249.144	17.677.038	10.572.106	28.142.000	17.569.894
2009	3.600.460	30.967.754	27.367.294	3.600.460	30.856.874	27.256.414
2010	9.400.803	33.599.587	24.198.784	9.400.803	33.484.971	24.084.168
2011	3.575.707	36.248.639	32.672.931	3.575.707	36.130.195	32.554.488
2012	5.438.310	38.997.054	33.558.743	5.438.310	38.874.783	33.436.473
2013	6.291.562	41.849.743	35.558.181	6.291.562	41.723.645	35.432.083
2014	4.211.082	44.811.885	40.600.802	4.211.082	44.681.960	40.470.877
2015	8.313.411	47.594.448	39.281.038	8.313.411	47.460.696	39.147.285
2016	5.830.918	51.306.250	45.475.332	5.830.918	51.171.546	45.340.629
2017	9.805.844	55.131.275	45.325.432	9.805.844	54.995.620	45.189.777
2018	9.765.027	59.075.463	49.310.436	9.765.027	58.938.857	49.173.830
2019	2.898.939	63.145.084	60.246.146	2.898.939	63.007.527	60.108.588
2020	20.799.751	66.685.203	45.885.452	20.799.751	66.546.695	45.746.943
Residuo	-110.002.373		110.002.373	-110.002.373		110.002.373
Total	132.314.596	691.950.622	449.633.653	132.314.596	689.885.521	447.568.551

Being the figures of merit of economic evaluation expressed in TABLE 3.4-18.

TABLE 3.4-18 - Figures of Merit – Hypothesis 1

Alternatives	Figures of Merit			
	B-C	B/C	NPV	EIRR
PDTU - Diesel	449.633.653	5,23	79.598.594	30,32%
PDTU - Hybrid	447.568.551	5,21	79.011.672	30,13%

Observe that the results obtained for the two different technologies of propulsion are very close, indicating an advantage of comfort and pollution emission of hybrid technology. Considering that it should be studied deeply when the elaboration of Studies of Economic Feasibility, which will detail the technological and environmental aspects of the two alternatives.

Examining the sensibility of the result in a variation of 20%, it is still obtained great figures of merit in unfavorable hypothesis as shows inTABLE 3.4-19.

TABLE 3.4-19 – Analysis of Sensibility for Variations up to 20% – Hypothesis 1

Cost	Benefit	Alternatives	Figures of Merit			
			B-C	B/C	NPV	EIRR
Without Sensibility		PDTU - Diesel	449.633.653	5,23	79.599.994	30,32%
		PDTU - Hybrid	447.568.551	5,21	79.013.072	30,13%
+5%	-5%	PDTU - Diesel	402.920.273	4,73	66.454.088	25,99%
		PDTU - Hybrid	400.958.427	4,72	65.896.513	25,84%
+10%	-10%	PDTU - Diesel	356.206.894	4,28	53.308.182	22,40%
		PDTU - Hybrid	354.348.302	4,27	52.779.953	22,28%
+15%	-15%	PDTU - Diesel	309.493.514	3,87	40.162.276	19,34%
		PDTU - Hybrid	307.738.178	3,85	39.663.393	19,24%
+20%	-20%	PDTU - Diesel	262.780.134	3,49	27.016.371	16,66%
		PDTU - Hybrid	261.128.053	3,48	26.546.834	16,57%

The economic evaluation of all PDTU set, as the alternative of lower valorization of trip time is presented in TABLE 3.4-20.

TABLE 3.4-20. – Economic Evaluation per Year – Hypothesis 2

Year	PDTU - Diesel			PDTU - Hybrid		
	Cost	Benefit	B-C	Cost (*)	Benefit	B-C
2001						
2002						
2003	5.929.156	8.664.286	2.735.130	5.929.156	8.616.317	2.687.161
2004	42.037.792	13.041.778	-28.996.013	42.037.792	12.969.826	-29.067.966
2005	57.943.917	17.452.259	-40.491.657	57.943.917	17.356.322	-40.587.595
2006	14.793.561	19.594.167	4.800.607	14.793.561	19.494.495	4.700.934
2007	21.108.624	21.771.540	662.915	21.108.624	21.668.131	559.507
2008	10.572.106	23.984.933	13.412.827	10.572.106	23.877.789	13.305.683
2009	3.600.460	26.234.919	22.634.459	3.600.460	26.124.039	22.523.579
2010	9.400.803	28.487.471	19.086.668	9.400.803	28.372.855	18.972.052
2011	3.575.707	30.492.348	26.916.640	3.575.707	30.373.904	26.798.197
2012	5.438.310	32.551.721	27.113.411	5.438.310	32.429.451	26.991.141
2013	6.291.562	34.667.880	28.376.318	6.291.562	34.541.782	28.250.220
2014	4.211.082	36.843.238	32.632.155	4.211.082	36.713.313	32.502.230
2015	8.313.411	39.009.545	30.696.135	8.313.411	38.875.793	30.562.382
2016	5.830.918	41.853.553	36.022.636	5.830.918	41.718.850	35.887.932
2017	9.805.844	44.753.302	34.947.458	9.805.844	44.617.647	34.811.803
2018	9.765.027	47.711.443	37.946.416	9.765.027	47.574.836	37.809.809
2019	2.898.939	50.730.786	47.831.848	2.898.939	50.593.229	47.694.290
2020	20.799.751	53.655.268	32.855.517	20.799.751	53.516.759	32.717.008
Residuo	-110.002.373		110.002.373	-110.002.373		110.002.373
Total	132.314.596	571.500.438	329.183.468	132.314.596	569.435.336	327.118.367

Figures of merit of economic evaluation are presented in TABLE 3.4-21.

TABLE 3.4-21 – Figures of Merit – Hypothesis 2

Alternatives	Figures of Merit			
	B-C	B/C	NPV	EIRR
PDTU - Diesel	329.183.468	4,32	51.527.612	23,43%
PDTU - Hybrid	327.118.367	4,30	50.940.691	23,27%

Even in the more adverse hypothesis of the analysis of sensibility in a variation of 20.0% it presents great results, as indicated in TABLE 3.4-22.

TABLE 3.4-22 - Analysis of Sensibility for Variations up to 20.0% – Hypothesis 2

Cost	Benefit	Alternatives	Figures of Merit			
			B-C	B/C	NPV	EIRR
Without Sensibility		PDTU - Diesel	329.183.468	4,32	51.529.012	23,43%
		PDTU - Hybrid	327.118.367	4,30	50.942.091	23,27%
+5%	-5%	PDTU - Diesel	288.492.598	3,91	39.786.655	20,20%
		PDTU - Hybrid	286.530.752	3,89	39.229.080	20,06%
+10%	-10%	PDTU - Diesel	247.801.728	3,53	28.044.299	17,41%
		PDTU - Hybrid	245.943.136	3,52	27.516.070	17,30%
+15%	-15%	PDTU - Diesel	207.110.857	3,19	16.301.942	14,97%
		PDTU - Hybrid	205.355.521	3,18	15.803.059	14,87%
+20%	-20%	PDTU - Diesel	166.419.987	2,88	4.559.586	12,79%
		PDTU - Hybrid	164.767.906	2,87	4.090.048	12,71%