resources should not be destroyed by urbanization/industrialization. Thus, these areas shall be regarded as nature preservation area.

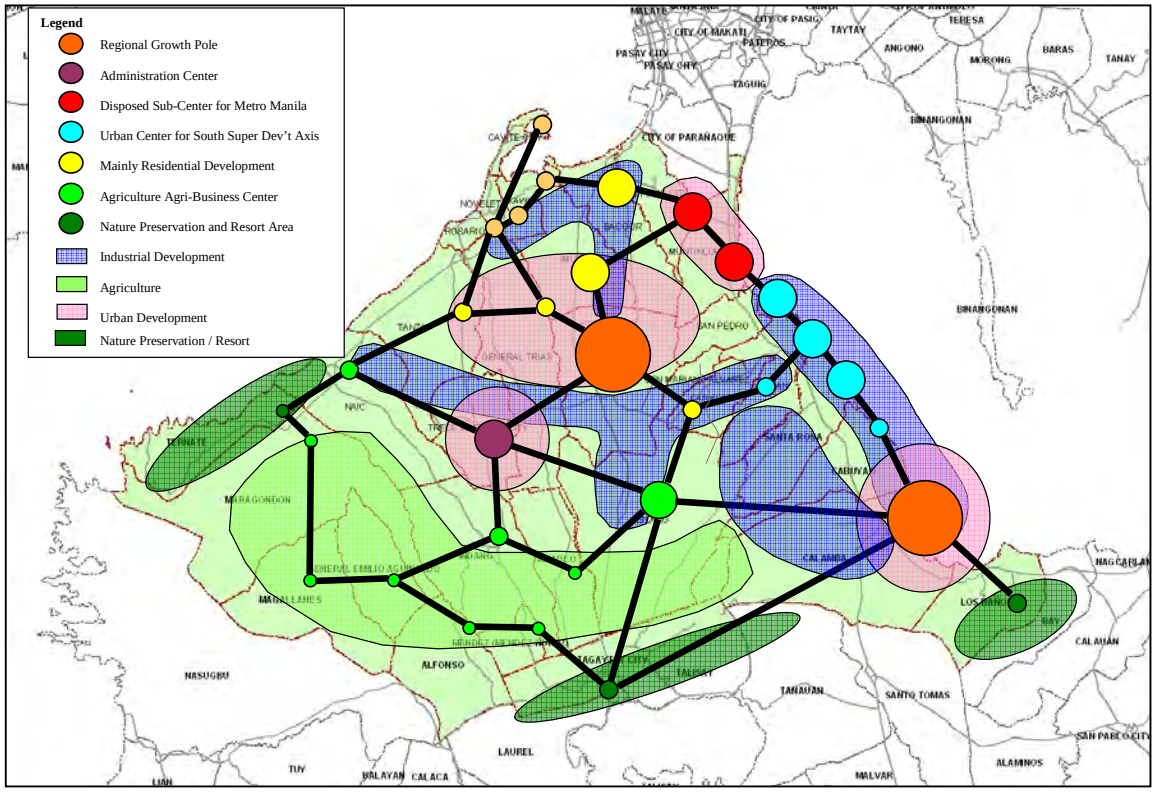
10) Agriculture Area

- Maragondon, Magallanes, General Emilio Aguinaldo, Mendez, Alfonso, Amadeo, Naic and Indang

  Looking at the southern part of the study area, such rapid urbanization trend has not taken place yet. The current land use is mainly agriculture and there remains some nature to be conserved. They shall continue to keep agricultural production function. Medium- and small-scale primary product processing industries shall be developed for income generation and social development. In some places, eco-tourism and agriculture-experience tourism shall be developed.

In conclusion, the future land use pattern of the CALA area has been determined as illustrated in Figure 4.4.2.

Figure 4.4.2 Holistic Development (Scenario Case 4)



4.4.3 Socio-Economic Development Framework of the Integrated Development Scenario (Case 4)

Population

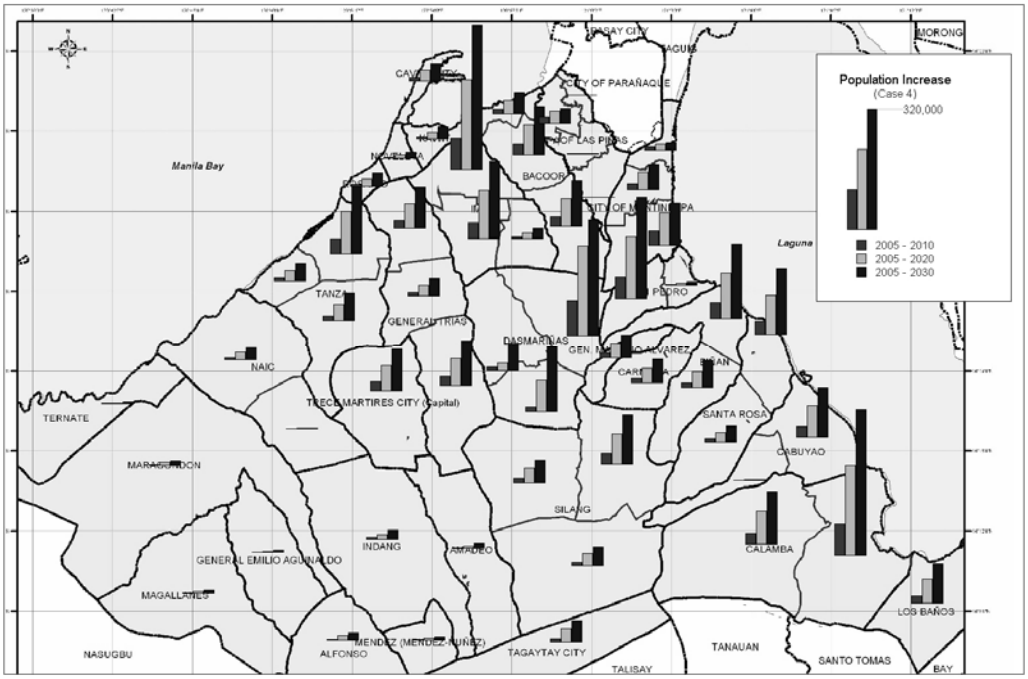
Various parameters of growth shall have their share of effort in the development of CALA. There are considerations on the regional growth pole, role of the

administrative centers, dispersal of Metro Manila's economic and social activities, urban renewal and controlled growth of fast urbanizing areas, agriculture and agri-business centers, and nature preservation and resort center. The direction for population growth shall take varying directions per municipality/city as shown in Table 4.4.1. As preferred scenario, this case will be adopted for working out possible road networks.

Table 4.4.1 Direction of Population Growth in Case 4

No.	Municipality	Basic Direction for Development	Development Speed
1	Dasmariñas, Calamba (Regional growth pole)	They shall be developed as two largest regional commercial core.	1.0
2	Imus, General Trias and Tanza (In linkage with Dasmariñas, they cater for development area.)	There are lots of vacant lands in the municipalities. They are advantageously located as adjacent to Dasmariñas, Bacoor (strongly growing area). There is abundant potentiality of urban development.	2.0
3	Trece Martires City (Administration center)	It shall become and be developed as the administration center in Cavite. It is abundant in vacant land.	2.0
4	Bacoor (Urban center for steady growth and urban renewal)	It is already developed. It shall grow slowly but steadily.	0.6
5	Cavite City, Kawit, Noveleta, and Rosario (Urban center for controlled growth and urban renewal)	Those municipalities began to grow earlier and there is not so much land availability. They shall grow slowly.	0.4
6	San Pedro, Carmona, Biñan, Santa Rosa, and Cabuyao(Urban Centers for South Super Development Axis)	Those municipalities are located along the South Super Expressway. They are destined to grow steadily. They shall be the place for industrial location and residential development.	1.0
7	General Mariano Alvarez (Urabn center, but the land area is limited)	GMA is located along the South Super Expressway. But, the area of GMA is very small and difficult to accommodate big population.	0.5
8	Silang (Agri-business center)	Silang is abundant in agricultural land. It shall grow as agri-business center, paying attention to avoidance of urban sprawl.	1.0
9	Tagaytay and Los Baños (Nature preservation and resort area)	They are abundant in nature. They shall be developed as resort spot and place for second house development.	1.0
10	Ternate, Naic, Maragondon, Magallanes, GEA, Alfonso, Amadeo, Indang, and Mendez (Agriculture area9	They are abundant in nature and agricultural land. The nature and agriculture land shall be preserved. Urban sprawl shall be prevented in those municipalities.	0.4
11	Las Piñas and Muntinlupa (Dispersed sub-center for Metro Manila)	They are included in NCR. They shall be developed as high-middle income class residential and commercial development. They shall grow as dispersed sub-center for Metro Manila	0.2

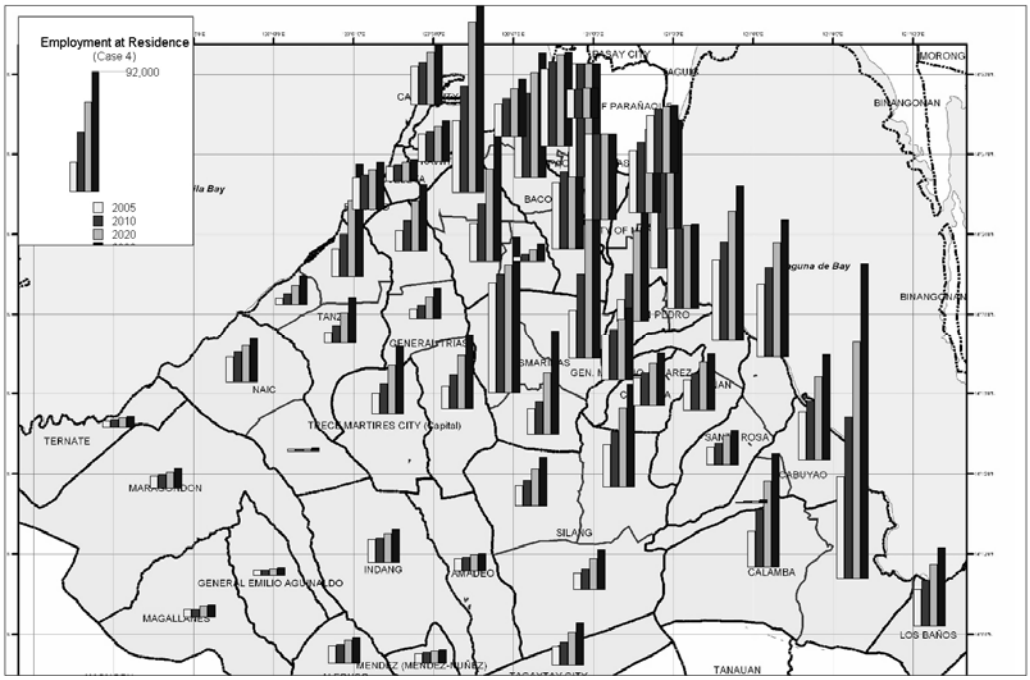
Figure 4.4.3 Increase in Population (Case 4)



Employment

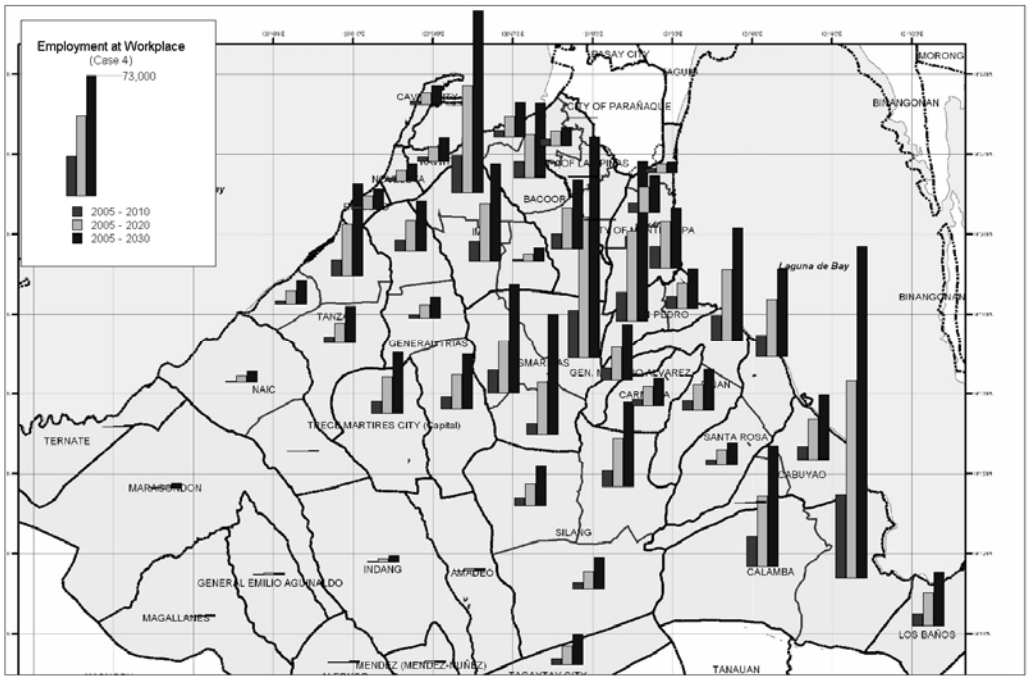
At residence: Employment rate shall likewise grow in all municipalities but taking varying speed based on the development of each local government units described in Table 4.4.1. Employment is projected to reach 3.05 million.

Figure 4.4.4 Increase in Employment at Residence (Case 4)



At workplace: The employment at workplace is projected to be a little lower at 3.02 million and the W/R ratio is projected to be 0.989.

Figure 4.4.5 Increase in Employment at Workplace (Case 4)



Enrollment

At residence in Secondary Education: The enrolment rate for this case will start out at the same pace as case 3 but will have a slightly lower number in year 2030.

At residence in Higher Education: The enrolment rate of all municipalities will follow the same rate as cases 2 and 3 but will register a slightly lower number in 2030.

At school place in Higher Education: With a balanced growth realized in the region, a slightly higher enrollment for the colleges and universities will be seen as compared to case 1 but a more conservative number than cases 2 and 3.

Figure 4.4.6 Increase in School Enrolment (Case 4)

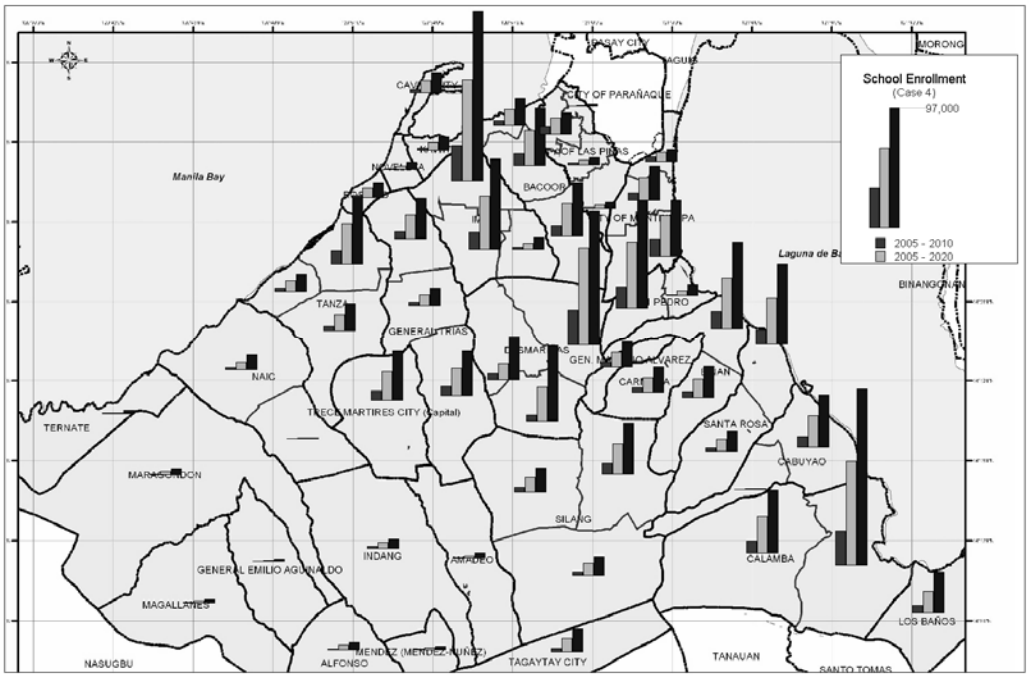
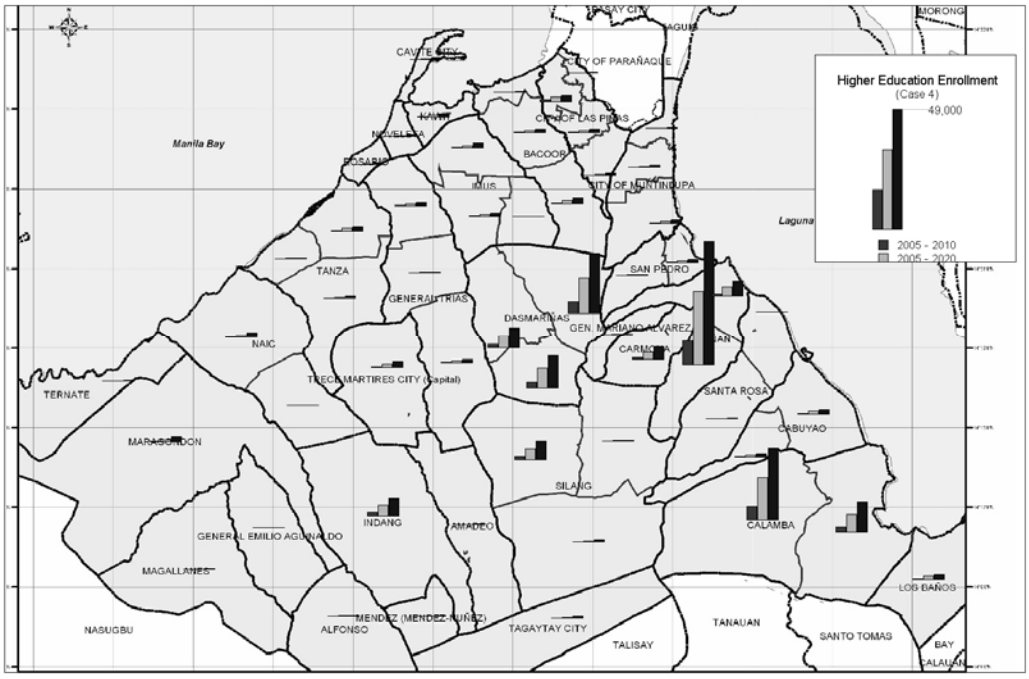


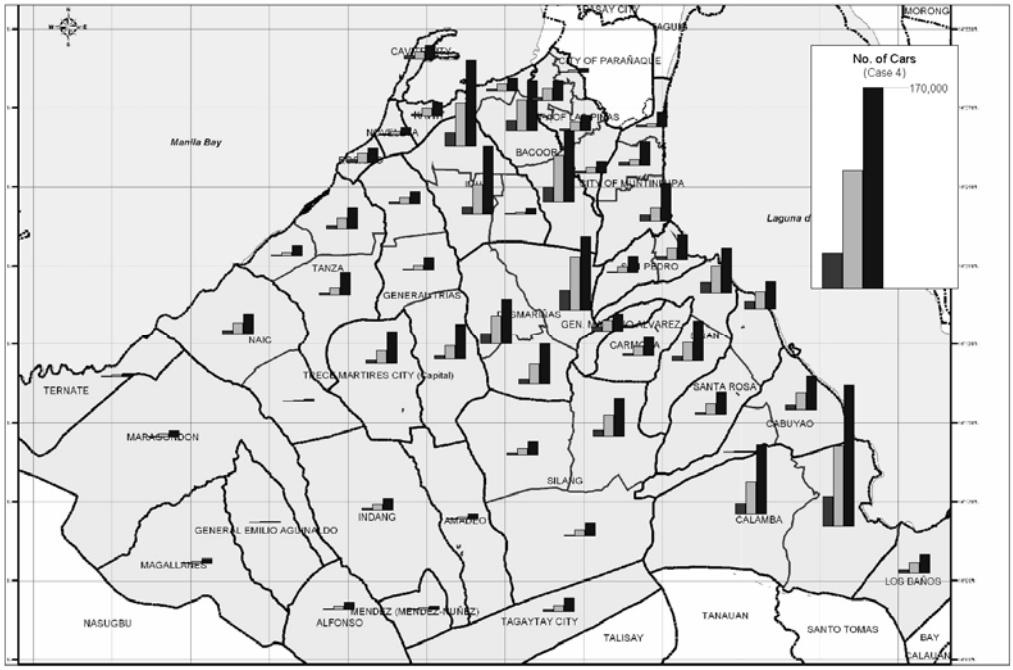
Figure 4.4.7 Increase in Higher Education Enrolment (Case 4)



Car Ownership

With a well balanced growth and distribution of economic and social activities, the number of cars will increase at a fairly moderate rate and will account for 2.45 million vehicles in 2030. This will be the optimum scenario for consideration in the road network planning.

Figure 4.4.8 Number of Cars (Case 4)

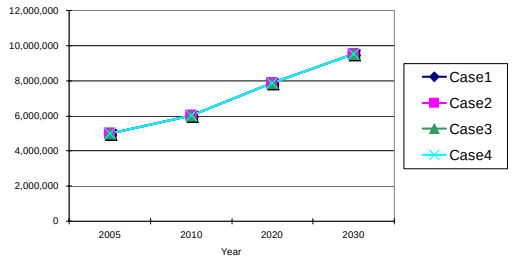


Comparison with Other Cases and with Metro Manila

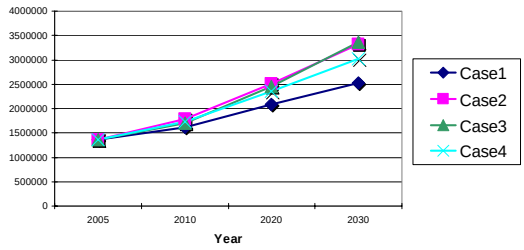
Figure 4.4.9 compares population and employment at workplace of the study area with those of other scenarios (Case 1-3).

Figure 4.4.9 Comparison of Major Development Indicators, Case 1-4

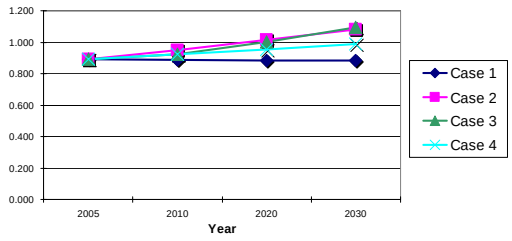
Population



Employment at Workplace



W/R Ratio
(Employment: at Workplace/at Residence)



Case comparison in terms of W/R Ratio

	2005	2010	2020	2030
Case 1	0.893	0.888	0.884	0.882
Case 2	0.893	0.951	1.015	1.082
Case 3	0.893	0.925	1.001	1.095
Case 4	0.893	0.922	0.954	0.989

(Source): Projected by the Study Team

When compared to Metro Manila, the study area accounts for 55% in terms of population and 40% in terms of employment at workplace of Metro Manila as shown in Table 4.4.2. This implies that a huge urban area comparable to Metro Manila will appear in the near future in the south of the National Capital Region.

Table 4.4.2 Comparison with Metro Manila (2015)

(million)

	Population	Employment at Workplace
Study Area * (This Study)	6.9	2.1
Metro Manila (MMUTIS)	12.5	5.3

Note: (*) includes a part of Metro Manila (Las Piñas and Muntinlupa)

4.5 Alternatives for Regional Transport Network

Discussion herein is focused on the trunk transport network scenario. The alternative network scenarios have been prepared based on the physical and socioeconomic conditions so as to analyze advantages and disadvantages of each alternative scenario on a quantitative basis.

4.5.1 Existing Network Zero-option (Alternative 0)

- Zero-option is Do-nothing Case. There is no improvement from current road network except for ongoing projects.
- Widening-option is the option that the current road network system will be widened to required number of lanes from future traffic demand.
- This option will examine how much burden on the current network system shall be absorbed for the future traffic demand.

4.5.2 Arterial Grid-Pattern Economic Road Structures and Balanced Development (Alternative 1)

- Based on MMUTIS and WB CALA Study, grid-pattern road network system is provided, which will be consisted of arterial roads with 4 to 6 lanes. Due to the low class of design standards (compared with expressway), the construction cost will be lower and the alignment will be more flexible to minimize the impacts to the existing buildup areas.
- Grid pattern road network system will provide alternative routes and disperse the traffic so as to alleviate the traffic congestion in the region.
- The grid pattern will encourage a balanced development in the region, providing better accessibility for intra-regional traffic.
- Through traffic between Metro Manila and Laguna region shall be shouldered on the planned new expressway such as C6.

4.5.3 Metro Manila – Laguna Transport Corridor Enhancement (Two North-South Axis) (Alternative 2)

- Alleviation of traffic congestion on North-South Corridor and enhancement of the network in the corridor by providing a new north–south axis (high-standard

highway including expressway) parallel to the South Luzon Expressway, forming the ladder pattern in the corridor.

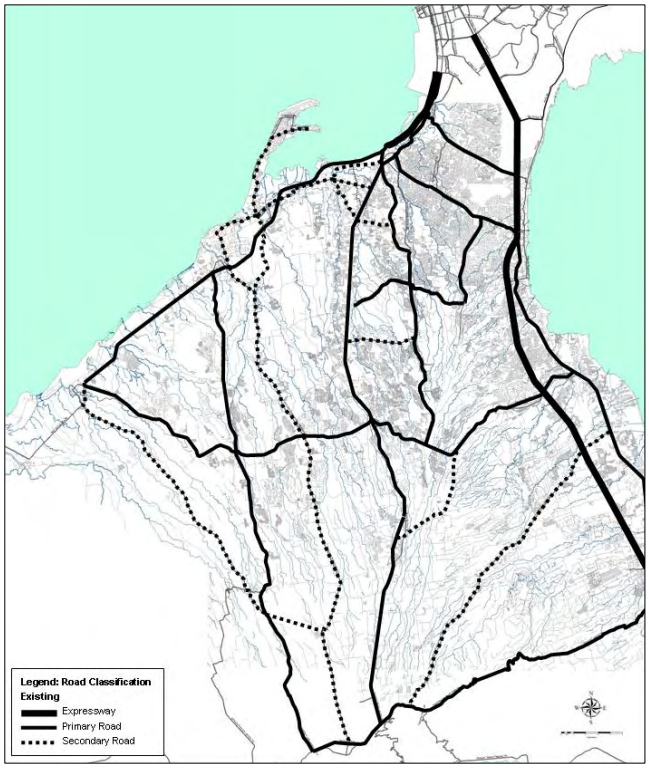
- The Metro Manila – Laguna – Batangas Corridor will be one of the significant economic development corridors in the country for both industrialization and urbanization. Thus, improvement of the transport accessibility will lead to further industrialization and urbanization.
- For the intra-regional traffic, grid pattern arterial system (same as (2) will be provided.
- Severe socio environment impact concerns will depend on the alignment of the new north-south axis due to the its high-standard and high traffic demand. There are two alternative options for the alignment, either east or west of Aguinaldo Highway. The east route will follow the Busway alignment.

4.5.4 East-West and North-South Axis Scenario (Strategic Industrialization and Urbanization in the Region) (Alternative 3)

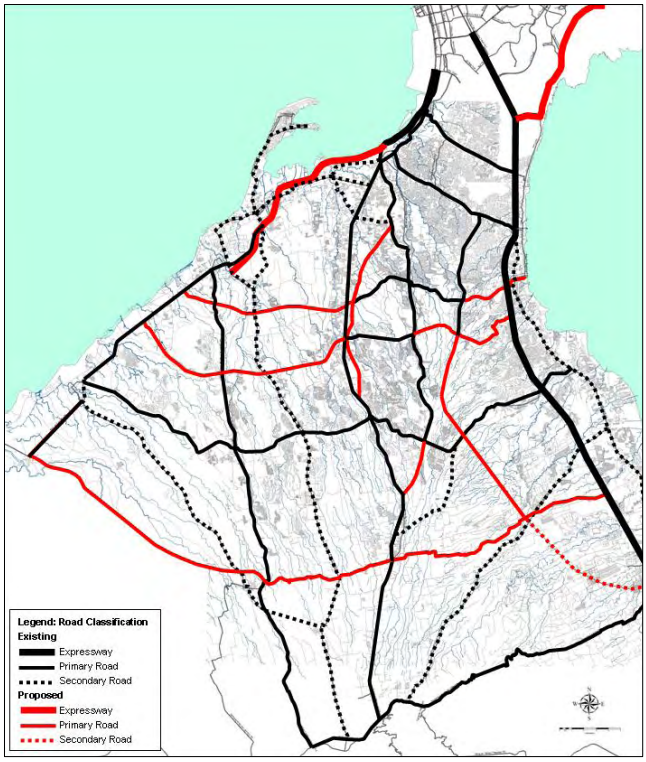
- High-standard highways will be provided for East-West and North-South axis. The urbanization and industrialization in the region will be promoted according to the hierarchy of the road network system.
- A part of the through traffic between Metro Manila and Laguna will be transferred to the new axis contributing to the alleviation of the traffic congestion on and around the Metro Manila boundary.
- Other intra-regional network system will be formed revising the grid pattern mentioned above.
- One of the options for north-south axis will be Cavite Busway alignment according to the study on Feasibility Study on the Cavite North-South Road. Another option is the alignment running north to south in the west area of Aguinaldo Highway.

Figure 4.5.1 Alternative Transport Network Scenarios

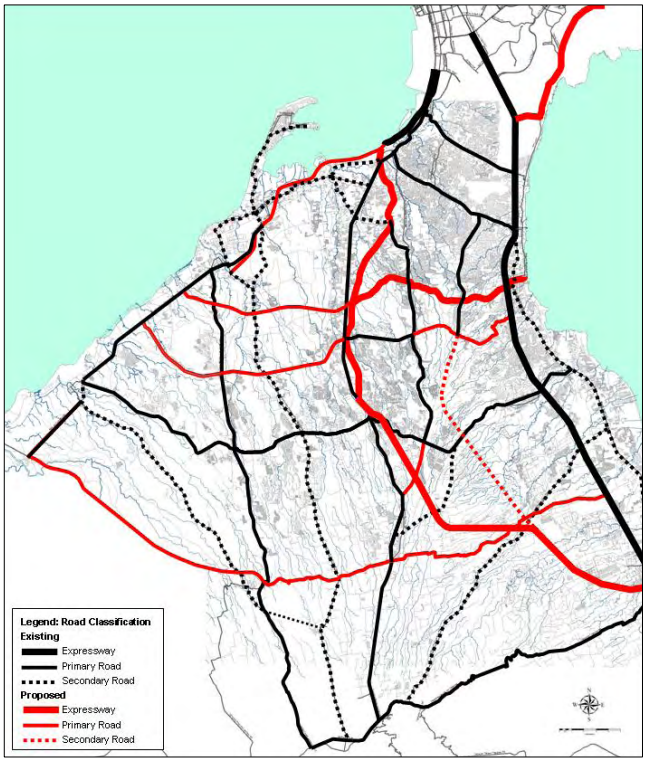
Alternative 0



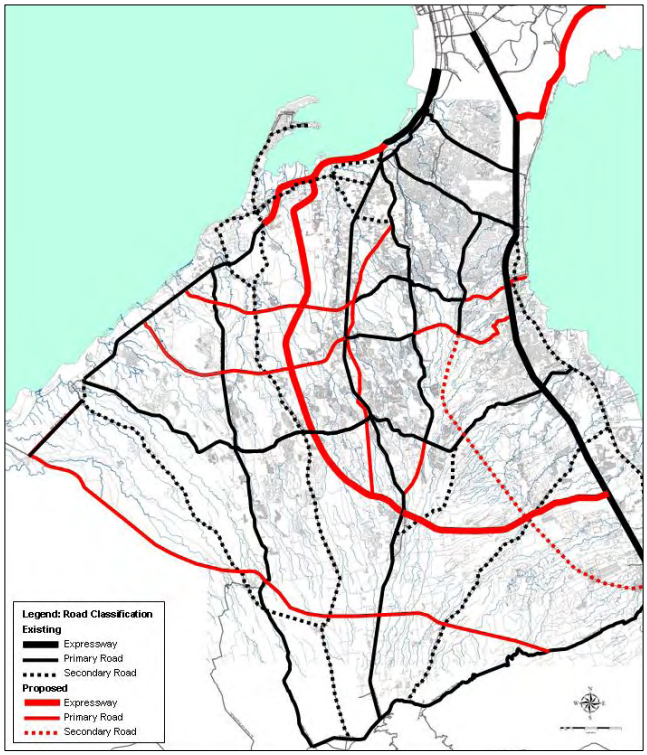
Alternative 1



Alternative 2



Alternative 3



5 TRANSPORT DEMAND FORECAST AND REGIONAL TRANSPORT NETWORK ALTERNATIVES

5.1 Transport Demand Forecast

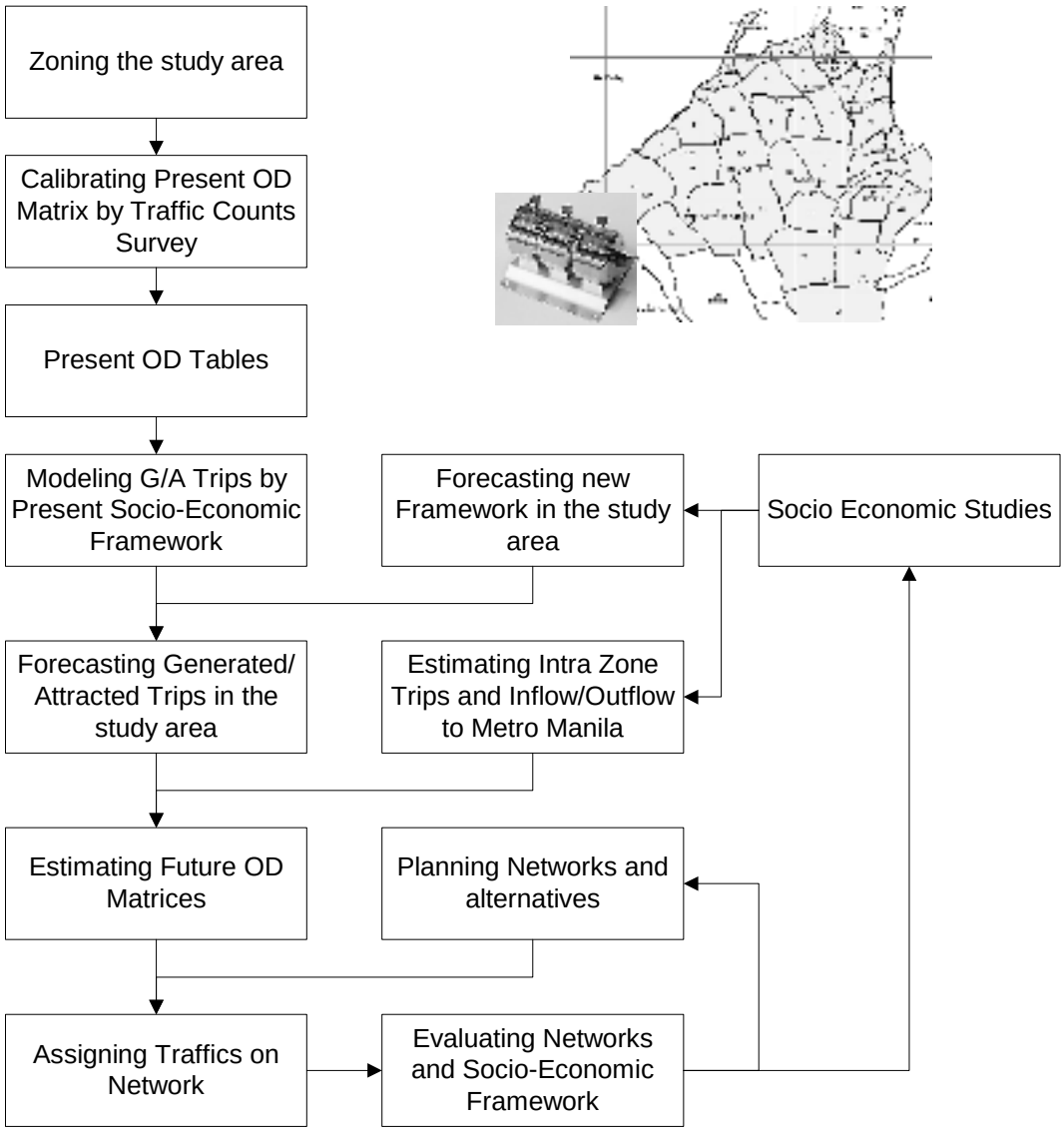
5.1.1 Background

(1) Procedure of Traffic Forecast

Traffic demands depend on the future socio-economic frames, which should be designed in the Master Plan. However, the process of how to achieve the Master Plan differs by planning scenarios. After describing future scenarios, the following steps are necessary to forecast future traffic demands.

- Zoning the study area
- Calibrating Present OD Matrix by Traffic Count Survey
- Modeling G/A Trips by Present Socio-Economic Framework
- Forecasting new Framework in the study area
- Forecasting Generated/Attracted Trips in the study area
- Estimating Intra Zone Trips and Inflow/Outflow to Metro Manila
- Estimating OD Matrices
- Planning Networks and alternatives
- Assigning Traffics on Network
- Evaluating Networks and Socio-Economic Framework

Figure 5.1.1 Flowchart for Traffic Forecast



(2) Zone System

In the past 10 years, three previous projects on traffic analysis related with CALA area were carried out. Every study refers to previous study and forecasts future OD tables in years 2005, 2010 and 2015. In the previous project, the zone systems, which are based mainly on MMUTIS zones and are added on some zones if need be, are as follows:

Table 5.1.1 Zone Systems in Previous Studies

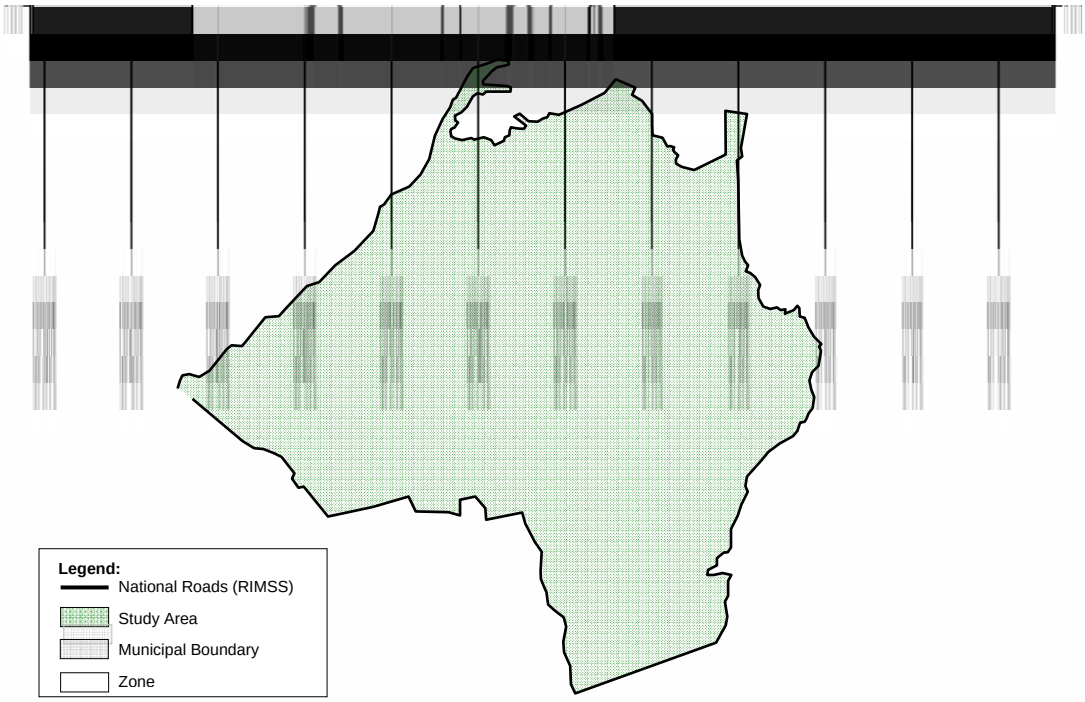
Year	Previous Project on CALA	Zone System
1996	Metro Manila Urban Transportation Integration Study by JICA	394 = Survey Zones 181 = Analysis Zones
1998	CALA Transport Study by World Bank	102 Zones
2001	Cavite Busway System by JICA	125 Zones

In this Study, the zone system combines some zones of the most recent Cavite Busway project since it is necessary to simplify the evaluation of alternative road networks. Total number of zones in this Study is 59, in which 38 zones are located in the study area. The 38 zones in the study area include 29 zones in Cavite, 2 zones in Laguna and 7 zones in Manila.

Table 5.1.2 Zone System in CALA 2005

1 Bacoor 1	16 Tanza 3	31 General Emilio Aguinaldo	46 Calamba 2
2 Bacoor 2	17 Trece Martires City	32 Magallanes	47 Los Baños
3 Bacoor 3	18 Naic 1	33 Maragondon	48 Muntinlupa (Manila SE) 1
4 Imus 1	19 Naic 2	34 Ternate	49 Muntinlupa (Manila SE) 2
5 Imus 2	20 Dasmariñas 1	35 San Pedro 1	50 Muntinlupa (Manila SE) 3
6 Imus 3	21 Dasmariñas 2	36 San Pedro 2	51 Las Piñas (Manila SW) 1
7 Cavite City	22 Dasmariñas 3	37 Gen. Mariano Alvarez	52 Las Piñas (Manila SW) 2
8 Kawit	23 Silang 1	38 Carmona	53 Las Piñas (Manila SW) 3
9 Noveleta	24 Silang 2	39 Biñan 1	54 Las Piñas (Manila SW) 4
10 Rosario	25 Silang 3	40 Biñan 2	55 Other Manila & North
11 General Trias 1	26 Tagaytay City	41 Santa Rosa 1	56 Rizal
12 General Trias 2	27 Amadeo	42 Santa Rosa 2	57 Outside SW
13 General Trias 3	28 Indang	43 Cabuyao 1	58 Outside SS
14 Tanza 1	29 Mendez	44 Cabuyao 2	59 Outside SE
15 Tanza 2	30 Alfonso	45 Calamba 1	

Figure 5.1.2 Zone System in this CALA Study



(3) Calibration of OD tables

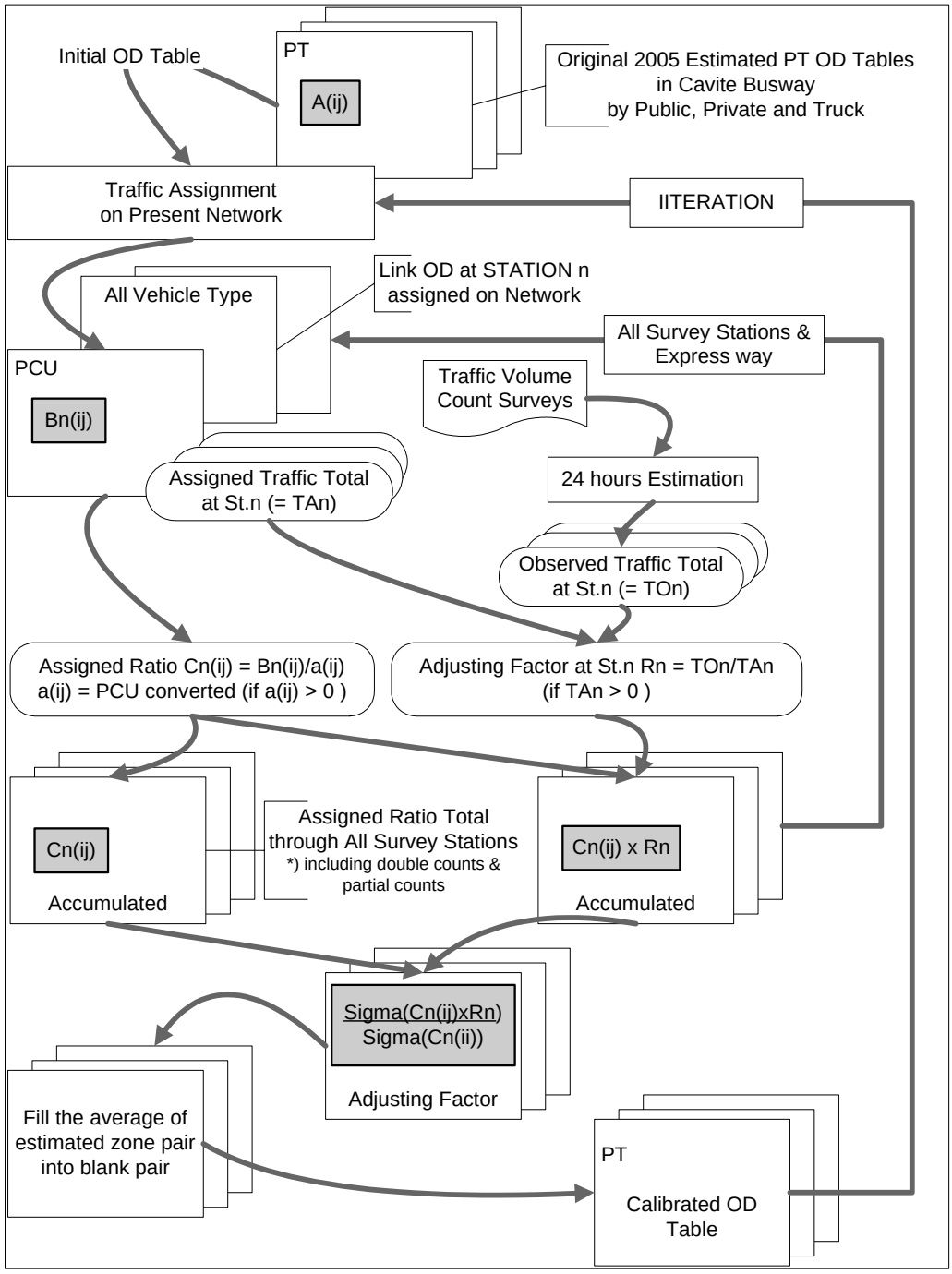
According to traffic count survey, the present OD tables have been calibrated and updated through the following procedures.

The estimated OD tables in Cavite Busway Project 2002 were used for the initial basic OD tables. They consist of public, private and truck person trips. The initial OD tables were assigned on the present road network by the incremental method because optimum paths of OD pair are fixed under the equilibrium method. In the process of traffic assignment for calibration, they were converted to PCUs (Passenger Car Unit) by average occupancies. Through a series of traffic assignments, the OD tables were calibrated step by step.

By the ratio between observed and assigned traffic volumes at a survey station, the traffic volume passing through the link was adjusted by OD pair and vehicle type. Weighted average of all survey stations was applied for adjustment by OD pair. In the calibration process, the routes of transit modes were not considered because OD tables should depend only on the demands between generating zone and attracting zone.

In the study area, the total average adjustment factor was applied to those other OD pairs that were not covered by traffic surveys but it might not be very reliable. The outside zones such as “other Manila,” Rizal and southern zones were not calibrated and the same OD patterns as the Cavite Busway Project were used except for the OD pairs passing through the study area.

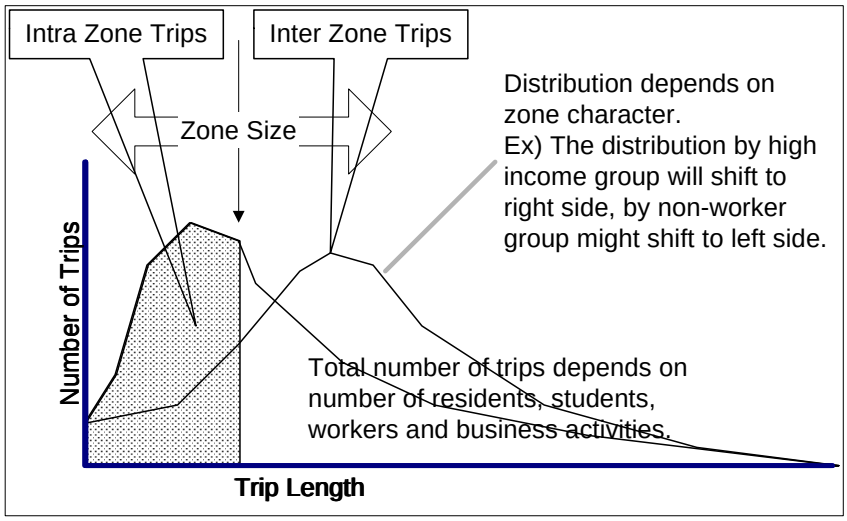
Figure 5.1.3 Method for Calibration



(4) Consideration on Intra Zone Trips

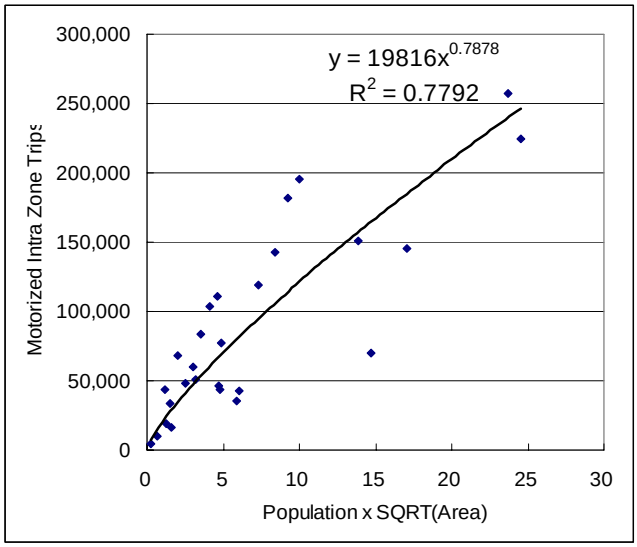
Intra zone trips cannot be estimated from traffic count survey because they do not pass through any screen lines. In general, intra zone trips increase with zone size and the population in the zone in case that trip length distributions are almost the same anywhere. If there are more active residents as commuters or students who go to remote zones, the ratio of intra zone trips becomes low. And it will be high in agricultural area since most residents work near their homes. For the estimation of intra zone trips, MMUTIS' Home Interview is still the latest data.

Figure 5.1.4 Intra Zone Trips in Trip Distribution



According to MMUTIS, the number of intra zone trips shows strong relation with population x sqrt(area), as shown in Figure 5.1.5. This Study used this relationship for estimating intra zonal trips.

Figure 5.1.5 Model of Intra Zone Trips



5.1.2 Present Traffic Demand

Present traffic demand was estimated by thus calibrating the OD and present traffic OD matrices of public mode, private mode and truck were prepared for Year 2005.

(1) Calibrated Present OD Table

The total generated/attracted person trips of CALA study area reached 7.7 million as of 2005. Number of trips between CALA and Manila is 0.9 million. As for trips between outside zones, some trips pass through the study area, while others pass through the opposite side of Laguna de Bay.

Table 5.1.3 Calibrated Present OD Table of Person Trips, 2005

Total PT OD Table		1 CALA Area	2 Manila & North	3 Rizal	4 South Outside	Total
1	CALA Area	6,647,850	858,652	12,896	142,335	7,661,733
2	Other Manila & North	858,652	-	535,480	27,365	1,421,497
3	Rizal	12,896	535,480	-	3,397	551,773
4	South Outside	142,335	27,365	3,397	-	173,097
Total		7,661,733	1,421,497	551,773	173,097	9,808,100

Note: The shaded area means no calibration.

The person trips generated/attracted in CALA study area are shown in Table 5.1.4 by mode. Number of trips by public mode is 5.5 million while number of trips by private mode is 1.9 million.

Table 5.1.4 Generated/Attracted Trips from/to CALA Study Area

Generated/Attracted Area		CALA Area Generated/Attracted Trips			
		Total	Public	Private	Truck
1	CALA Area	6,647,850	4,892,832	1,582,864	172,154
2	Other Manila & North	858,652	503,009	314,655	40,988
3	Rizal	12,896	6,535	4,284	2,077
4	South Outside	142,335	94,513	46,937	885
Total		7,661,733	5,496,889	1,948,740	216,104

(2) Present Traffic Assignment

After the calibrated OD trips (PCU) were assigned onto the present network, the assigned traffic volumes were checked at the survey locations by the result of traffic survey carried out on March 2005. The traffic volume was converted from vehicle to PCU and estimated for 24 hours because the surveys at some locations were carried out for only 16 hours if traffic volumes were small at night time.

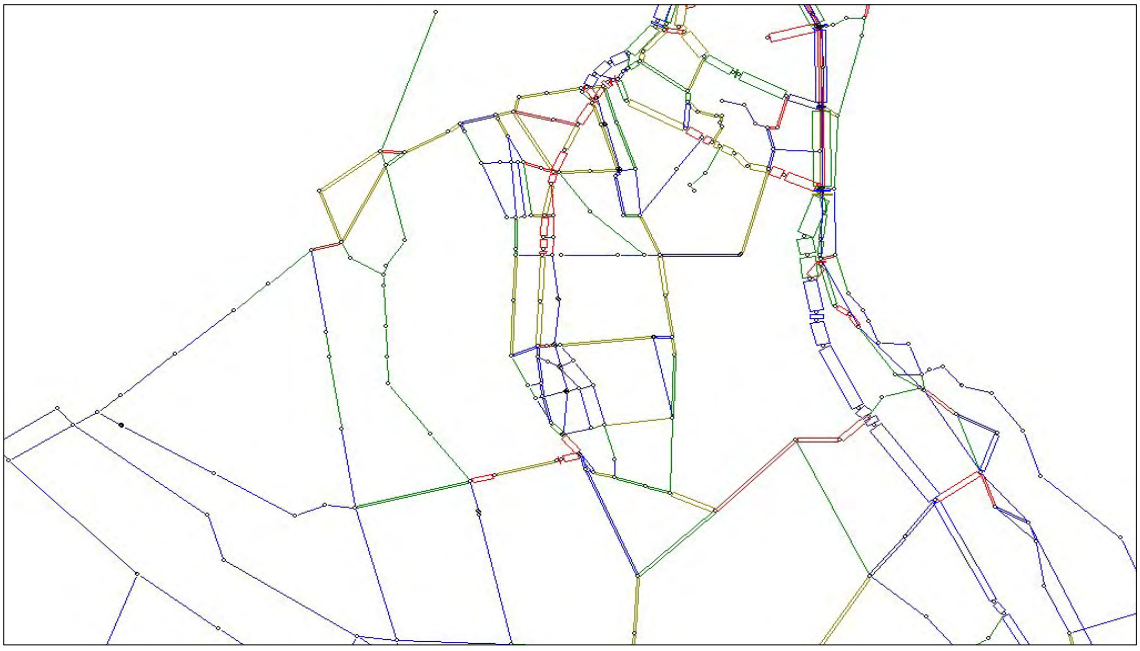
Table 5.1.5 shows the comparison between observed and assigned traffic volumes. They are almost the same at most survey locations. Therefore, it was confirmed that the calibrated present OD tables represent the present traffic pattern.

Table 5.1.5 Comparison between Observed and Assigned Traffic Volume

Survey Station	Observed 24 hours PCU				Assigned PCU
	Public Vehicle	Private Vehicle	Truck & Others	Total	
Station 01	17,241	61,159	8,740	87,140	92,392
Station 02	16,826	32,335	9,588	58,749	59,316
Station 03	16,995	22,326	6,601	45,922	36,884
Station 04	9,177	16,873	5,979	32,029	35,483
Station 05	5,839	21,238	7,987	35,064	38,278
Station 06	449	5,311	2,098	7,858	9,241
Station 07	19,209	12,398	5,844	37,451	39,300
Station 08	7,028	8,802	1,777	17,607	19,512
Station 09	8,351	21,823	5,303	35,477	34,174
Station 10	182	17,574	2,923	20,679	18,459
Station 11	457	11,759	2,590	14,806	16,477
Station 12	5,280	7,169	1,343	13,792	19,626
Station 13	3,098	6,884	2,665	12,647	11,972
Station 14	4,134	4,266	1,702	10,102	11,218
Station 15	391	2,531	1,369	4,291	3,566
Station 16	6,846	13,693	4,152	24,691	24,329
Station 17	10,427	11,896	6,435	28,758	16,150
Station 18	16,272	16,327	7,013	39,612	45,012
Station 19	1,465	10,664	3,298	15,427	16,792
South Luzon Expressway					
Filinvest - Susana	43,390	98,748	15,097	157,235	160,722
Southwoods–Carmona	37,256	74,189	14,578	126,023	129,616
Carmona-Mamplasan	36,766	68,344	14,268	119,378	124,167

Figure 5.1.6 shows the present traffic flow assigned onto the present network. The congested links on arterial roads appear in the northern part of Aguinaldo Highway and near South Luzon Expressway on Governor's Drive.

Figure 5.1.6 Distribution of Assigned Traffic Volume, 2005



(3) Recent Trends of Traffic Demand

In general, economic growth increases traffic volumes; therefore, in CALA, the number of motorized trips per person has increased by 23 % in the last decade. As compared with 1.3 trips per person in year 1996, the number has become 1.5 trips in 2005. The share of public transport has decreased as that of private mode has increased. This is due to the growth of car ownership. On the other hand, the increase of truck trips is definitely caused by the developments of industrial estates.

Table 5.1.6 Trips per Person

Year	Year 1996 (MMUTIS)			Year 2005 (This Study)		
Population	3,423,846			5,011,900		
Mode	Total Trips	Mode Ratio	Per Person	Total Trips	Mode Ratio	Per Person
Public	3,539,776	78.1%	1.034	5,496,889	71.7%	1.097
Private	916,948	20.2%	0.268	1,948,740	25.4%	0.389
Truck	76,403	1.7%	0.022	216,104	2.8%	0.043
All Modes	4,533,127		1.324	7,661,733		1.529

Another significant feature of the present OD tables is decreased dependency on Manila. The dependency of Bacoor, which is located near Manila, has decreased from 20% to 7%, and Imus from 9% to 6%. The decrease of dependency has most likely been caused by the development of CALA. But in the future, the trend will not always be what it has been because the expanded economic activities need more connections with larger region.

Table 5.1.7 Dependency of CALA on Metro Manila

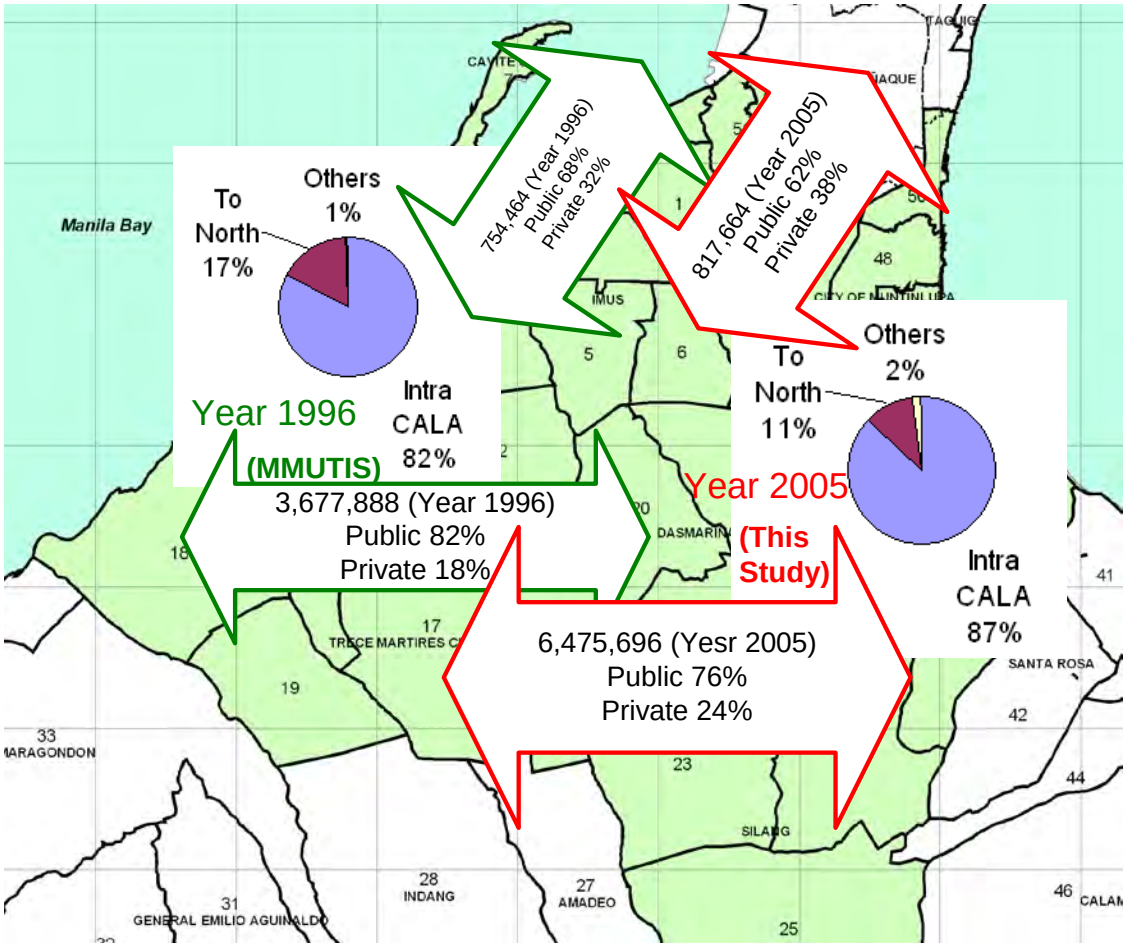
Trips to Metro Manila per Total trips		All Trips	Public Mode	Private Mode	Truck
1996	MMUTIS	17.1%	14.3%	26.5%	33.5%
1999-2002	Other Studies	17.7%	15.7%	23.9%	26.8%
2005	This Study	11.2%	9.2%	16.1%	19.0%

(4) Modeling of Generated/Attracted Trips

Traffic models are developed based on the present OD matrices calibrated by traffic count surveys. The models forecast future generated/attracted trips. In the model, the explanatory variables should be mutually independent because the mutually related variable exerts interference with each other.

Total trips of public and private mode increase in proportion to the number of active people, as shown in Figure 5.1.8.

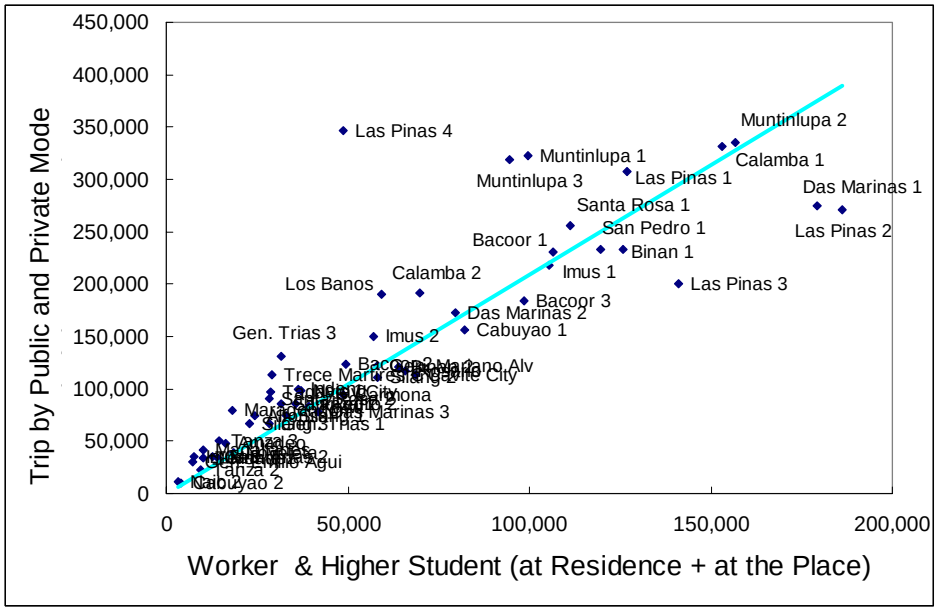
Figure 5.1. 7 Person Trips in Year 1996 and Year 2005 (Public & Private except Truck)



*) Each arrow shows the traffic volume of Year 1996 and Year 2005

*) Each circle shows the destination of trips from CALA

Figure 5.1.8 Generated/Attracted Trips Model by Public & Private Mode



Active people include workers at residence(X2), secondary(X3) and tertiary(X4) workers at work place, higher level school students at residence(X5) and at school(X6). The number of trips can be estimated by multivariable regression model using the above variables.

(Public + Private) Trips = A*X2 + B*(X3+X4) + C*(X5+X6) + C
(Multiple Correlation Factor = 0.873)

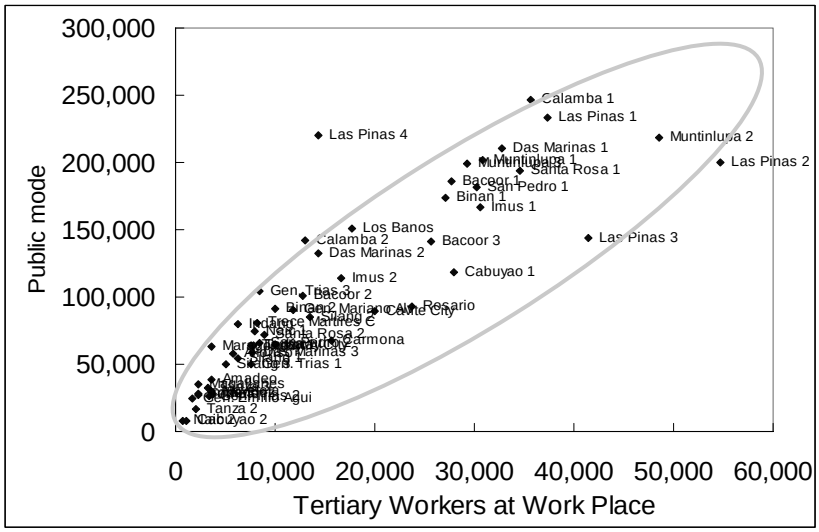
In this model, all coefficients are positive and explanatory variables are almost independent. However, in some zones, there is a deviation of the number between the estimated value and the actual value. It is expected, however, that this deviation converges to the model value in the future according to the development of whole CALA region. Therefore, the bias from the model was assumed to converge to the theoretical value in the next 25 years.

The next step is to prepare a model by mode, that is, public and private. Trips by public mode are strongly relevant to X2=Number of Workers at Residence and X4=Tertiary Workers at Work Place.

Trips by Public Mode = A*X2 + B*X4+ C (Multiple Correlation Factor = 0.898)

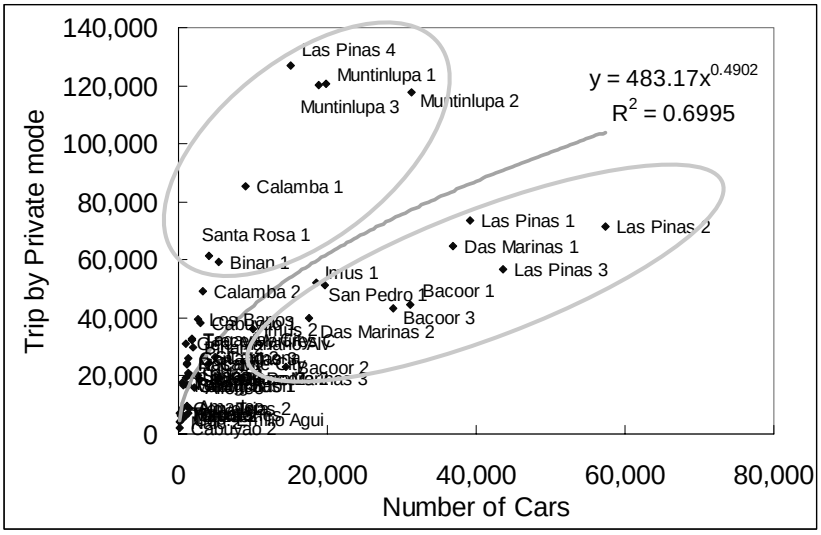
The more commuters live and tertiary workers get their jobs in a zone, the more commuting trips are generated and service demands are attracted. Since public mode is the main transportation in this area, those variables have a strong impact on the total number of trips. For forecasting the future trips, it was assumed that the model bias would diminish towards the target year.

Figure 5.1. 9 Trips by Public Mode



Trips by private mode generally depend on car ownership. However, car ownership data in the study area are not very reliable.

Figure 5.1.10 Trips by Private Mode



Thus, the model for trips by private mode adopts two parameters; (X7^0.4902) for Car Ownership and X4=Number of Tertiary Workers at Work Place.

Trips by Private Mode = A*(X7^0.4902) + B*X4 + C
(Multiple Correlation Factor=0.773)

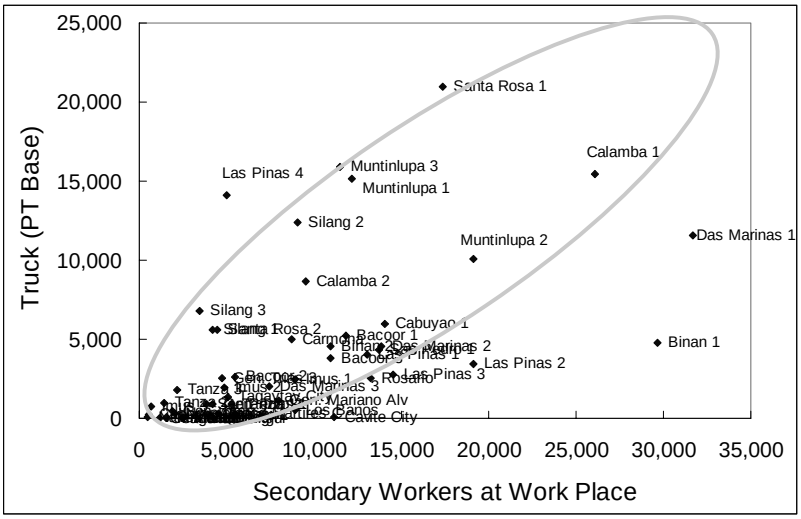
Car ownership, which is related with trip generation, indicates whether or not the zone is rich. Number of tertiary workers is a factor of trip attraction. According to the estimated coefficient, the increase of 100 cars generates about 1,150 person trips by private mode. In this model, it is also assumed that the model bias will diminish in the future.

It is difficult to calibrate OD table of truck trips because the pattern is not as stable as that of other person trips. After the basic pattern of truck trips was surveyed by Home Interview Survey in MMUTIS in 1996, other studies have tried to calibrate the pattern and worked out truck OD Tables.

For modeling truck trips, two variables, X1=Population and X3=Number of Secondary Workers at Work Place, were selected according to the value correlation factors. Population stands for the number of consumers and secondary worker stands for secondary industry. The model formula is statistically significant but some zones show biases because truck trips depend on local industrial activities. However, truck trips will not seriously affect the basic pattern of traffic flow due to its small percentage.

Trips by Truck = A*X1 + B*X3 + C (Multiple Correlation Factor = 0.5847)

Figure 5.1.11 Trips by Truck



Based on the above equations, the generation/attraction model of trips was constructed.

On trip distribution pattern, OD patterns in the near future will not change significantly in case of no additional road networks; however, in the long term, new road network, mass transit services and other socio economic factors may change the patterns drastically. In order to forecast the future OD patterns under new networks, the Gravity model was related to its coefficients and was estimated below. The coefficients distance is different by mode. Trips by private mode are distributed longer than by public mode.

Gravity Model

Trips from zone i to j zone j = C*(Gi*Aj)/Dij^b
Gi: Generated trips from zone i Aj: Attracted trips to zone j Dij: Distance

Public Mode	b = 1.79
Private Mode	b = 1.31
Truck	b = 1.56

5.1.3 Forecast of Future Traffic Demand

Firstly, in order to forecast future traffic demand, trip generation and attraction by zone and by mode was estimated by the formula explained above. Secondly, number of intra zonal trips was estimated. Thirdly, trip distribution patterns were estimated by Fratar method and Gravity model. The target years were 2010, 2020 and 2030. Finally, truck trips from/to ports were added based on other studies.

In more detail:

- Generated/attracted and intra zonal trips depend on socio-economic indices. The ratio of intra zonal trips was assumed to be the same by mode in each zone.

- In the Do-Nothing Case, the future OD was estimated by the Present Pattern Method. In other improved network cases, the OD patterns were transposed by the Gravity Patterns.
- Model deviation, i.e. the difference between actual and theoretical values seen at present was assumed to dissolve into zero within 25 years. The same was assumed also for intra zonal trips.
- Trips per person by mode were assumed to never decrease in the future.
- The growth of trips in Metro Manila which is outside of the study area was assumed to be 1% per annum. The growth of trips in the south of the study area was assumed to be the same as this study area because the southern area is also expected to grow quickly.

5.1.4 Result of Traffic Assignment on Future Network Alternatives

Based on the estimated future traffic demand, the traffic assignment for each road network alternative, which was presented in the previous chapter, was conducted to examine the performance of the alternatives.

Figure 5.1.12 shows the result of traffic assignment by network alternative for 2020 and the summary of the result is shown in Table 5.1.8. If there is no development (zero-option), the average volume/capacity ratio of the study area exceeds 2.0 and average travel speed will decrease to 13 km/h. According to this result, alternative 3 and 4 show higher performance.

Figure 5.1.12 Future Traffic Demand (2020)

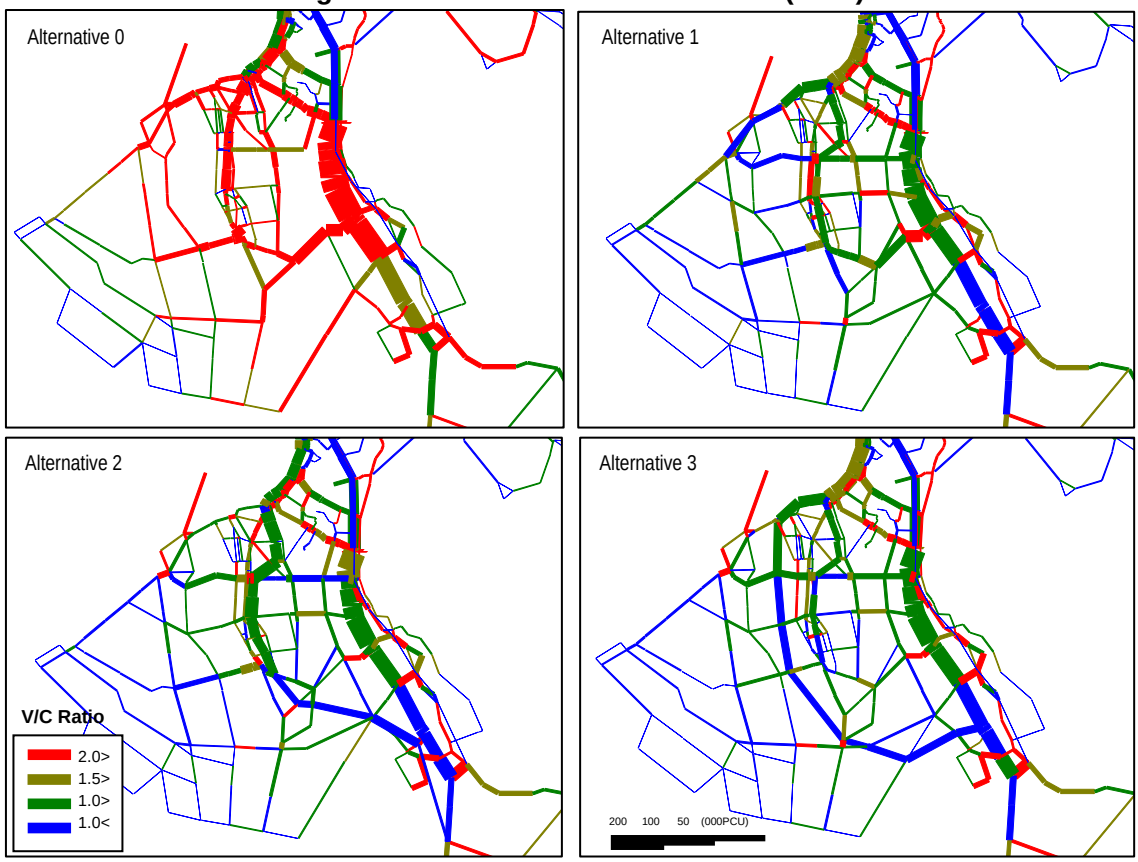


Table 5.1.8 Result of Traffic Assignment (2020)

Alternative	PCU-km (000km)	PCU-Hour (000h)	Capacity - km (000km)	Ave. Speed (km/h)	Ave. V/C Ratio	PCU-km by V/C (%)			
						>1.0	1.0-1.5	1.5-2.0	2.0<
0	43,051	3,280	2588	13.1	2.09	4.9	12.4	16.2	66.4
1	43,582	1,855	38,913	23.5	1.12	21.4	47.2	13.8	17.5
2	44,568	1,824	42,154	24.4	1.06	28.6	42.7	12.0	16.7
3	44,562	1,765	42,266	25.2	1.05	30.3	44.7	10.5	14.6

5.2 Environmental and Social Concerns

5.2.1 Natural Environmental Concerns

For the evaluation of the proposed road network alternatives, air pollution and noise are estimated since these indices are key natural environmental impact factors related to traffic pollution caused by the road development and qualitative evaluations are possible.

(1) Total Discharge Volume of the Air Pollutant

The total discharge volumes of main air pollutants caused by vehicle transportation under the present condition and transport network alternatives are estimated below (Table 5.2.1). As compared with the present condition, future situation of air quality is basically expected to become worse on the whole due to increase of traffic volume. However, the estimated volumes of air pollutants under the Alternatives 1, 2, and 3 are lower than that of the Alternative 0, especially for the Suspended Particulate Matter (SPM) due to improvement of traffic, while marked differences among the Alternatives 1, 2, and 3 are not seen on the discharge volumes of the air pollutants.

Table 5.2.1 Results of Estimate on Total Discharge Volume of the Air Pollutant by Alternative

(Unit: ton/day)

Pollutant	Present	Alternative 0	Alternative 1	Alternative 2	Alternative 3
CO	220	713	624	638	638
NOx	50	136	133	135	136
SOx	0.4	1.2	1.0	1.0	1.0
SPM	2.8	9.8	6.8	6.9	6.8

Note: CO - carbon monoxide, NOx - nitrogen oxide, SOx - sulfur oxide, SPM - suspended particulate matter
Source: Estimated by the JICA study team

As a reference, total discharge volume of the air pollutant from vehicles in Metro Manila in 1990 is shown in Table 5.2.2 below.

Table 5.2.2 Total Discharge Volume of Air Pollutant in Metro Manila

Pollutant	Total Volume (ton/day)
CO	1,569
NOx	181
SOx	28
PM10	31

Source: Philippine Environmental Quality Report 1990-1995, DENR

(2) Total Road Length Required for Mitigation Measure for Traffic Noise

The total road lengths required for mitigation measure for traffic noise for the transport network alternatives are estimated below. The estimate was made for distance passing through existing built-up area by newly developed road under implementation of the alternatives. As a result of the estimate, marked differences among the Alternatives 1, 2, and 3 are not seen on the total road length required for mitigation measure for traffic noise.

Table 5.2.3 Total Road Length Required for Mitigation Measure for Traffic Noise by Scenario

(Unit: km)

Alternative 0	Alternative 1	Alternative 2	Alternative 3
-*	133	126	130

* Note: There is no new road development for the Alternative 0.

5.2.2 Social Concerns

As social indices for evaluation of the proposed transport network alternatives, four indices are examined for proposed alternatives by using GIS data: i) area to be newly acquired in the existing built-up area, ii) number of building/structure to be relocated, iii) area where new road passes through the Strategic Agricultural & Fisheries Planning Zones (SAFs) which were designated as protected agricultural and fishery area, and iv) area where new road passes through informal settlements (squatter areas) and resettlement areas for the past projects. Among the indices, marked differences are seen for the i) and ii) as shown in Table 5.2.4. This is because the road classes differ among the alternatives for new construction and widening sections which pass though existing built-up areas located in the east side of the Cavite-Batangas Road and along the Governor's Drive.

Table 5.2.4 Social Impacts by Alternative

Item	Unit	Alternative 0	Alternative 1	Alternative 2	Alternative 3
i) Area to be newly acquired in the existing built-up area	km^2	-*	3.84	3.18	2.92
ii) Number of building/structure to be relocated	house	-*	4.026	2.956	2.762
iii) Area where new road passes through the SAFs	km^2	-*	1.07	1.12	0.90
iv) Area where new road passes through informal settlements and resettlement areas from past projects	km^2	-*	0.36	0.31	0.32

Note: There is no new road development for the Alternative 0.

5.3 Economic Evaluation of Network Alternatives

5.3.1 Quantitative Evaluation

(1) Investment Scale

Table 5.3.1 represents the road length to be developed. Alternative 1 shows the minimum development amount of roads, especially new construction. According to this, alternative 3 shows the maximum amount to be developed.

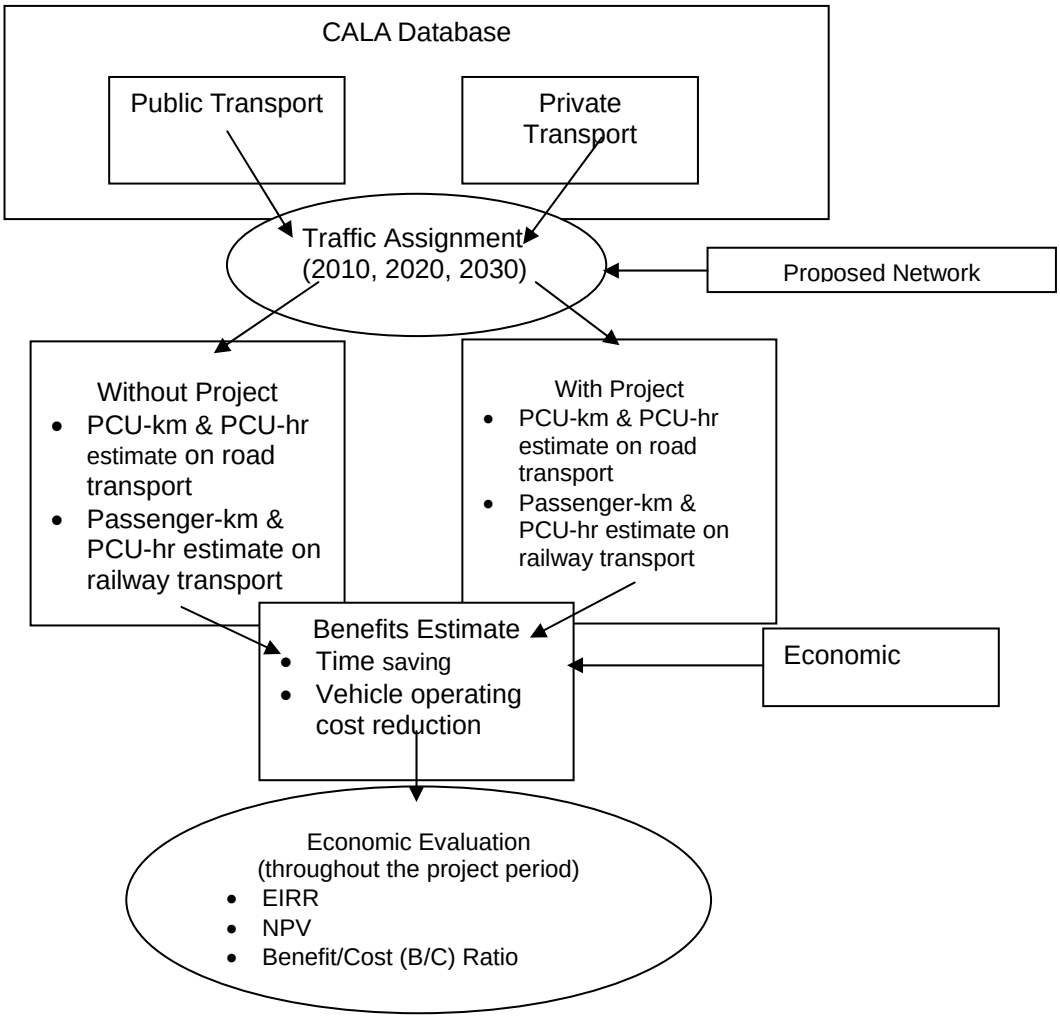
Table 5.3.1 Road Length to be developed by Network Alternative

	No. of lanes		Length (km)		
	Before	After	Alt. 1	Alt. 2	Alt. 3
New Construction					
Expressway	-	6	16.3	70.1	53.3
Ordinary road	-	4	58.1	58.1	58.1
		6	28.0	10.5	28.0
Sub-total	-	-	102.3	138.7	139.3
Widening					
Expressway	6	10	34.7	34.7	34.7
Ordinary road	2	4	80.9	153.4	135.1
	2	6	35.0	3.1	10.0
	4	6	66.7	16.3	45.1
Sub-total	-	-	217.2	207.5	224.9
Total	-	-	319.6	346.2	364.2

(2) Project Cost and Transport Benefit

Table 5.3.2 shows the rough estimate of project cost and the result of initial economic evaluation, counting direct economic benefit. Economic evaluation is done by comparing project benefits and costs, both expressed in terms of economic prices over project life. The estimate of the benefits is limited only to time saving and reduction of operating costs. The first benefit was estimated by comparing the change in passenger-hour with and without the project. On the other hand, the second benefit was measured in terms of the change in vehicle-kilometer and vehicle-hour with and without the project. The procedure taken in making the economic evaluation is outlined in Figure 5.3.1.

Figure 5.3.1 Procedure for Economic Evaluation



The explanation of economic evaluation indices is as follows:

- Economic Internal Rate of Return (EIRR) is the discount rate at which the present value of benefits is equal to the present value of costs.
- Benefit Cost Ratio (B/C) is the number that results when the present value of benefits is divided by the present value of costs. In this case, the

discount rate is the opportunity cost of capital. The latter is approximated by the yield on long-term government bonds.

- Net Present Value (NPV) is the difference between the present value of benefits and the present value of costs, using the opportunity costs of capital as the discount rate. It should be noted that when the EIRR = opportunity cost, the NPV =0.

As shown in Table 5.3.2, three alternatives shows the similar result but alternative 3 shows the highest economical performance (EIRR and NPV).

Table 5.3.2 Project Cost and Economic Evaluation

	Cost (Billion Pesos)			Benefit (Billion Pesos/ year) (2020)	Evaluation		
	Const.	ROW	Total		EIRR (%)	NPV (Billion Pesos)	B/C
Alternative-1	25.8	18.6	44.7	106.3	26.7	72.5	3.0
Alternative-2	30.9	15.3	46.2	106.3	26.9	72.2	3.0
Alternative-3	31.2	15.9	47.1	110.4	27.1	75.6	3.0

5.3.2 Qualitative Evaluation

(1) Industrialization Impact

To promote industrialization, various considerations are requested for a steady, safe and cheap labor forces as well as providing high standard traffic service. The improvement of accessibility to the international transport facilities such as airport and international port in the CALA area, which is located next to Metro Manila, is needed critically and urgently in terms of industrialization of the country. Since it is hard to understand quantitatively the impact on industrialization by road network alternatives, qualitative evaluation such as improvement of accessibility of current industrial parks is to be conducted.

(2) Regional Development Impact (urbanization)

As the theme of regional development, a critical problem is the urbanization policy as well as industrialization. In order to accommodate the urban population, it is needed to develop the urban infrastructure in the outskirts area, and development of strong commercial and business centers as well as industrial parks becomes furthermore an urgent policy. It is forecast that the current 5 million people in the study area will double to 9.5 million, and there is a need to secure residential places for 4.5 million new residents and economic activities for 9.5 million people in 2030. For the evaluation of network alternatives, the qualitative evaluation is to be conducted in relation to an existing urban area and the possibility of new urban development. The framework of regional development plan is based on the WB CALA Study and the present framework of each province.

5.4 Integrated Evaluation of Regional Transport Network Alternatives

Alternative scenarios were evaluated from the following viewpoints:

(1) Whether traffic congestions are alleviated? (Traffic Congestion Alleviation Impact）

(2) Contributing to industrialization or not? (Industrialization Impact)

(3) Realities for implementation

(4) Contributing to the balanced development or not? (Regional development impact)

(Urban development potential in the transport corridors)

(5) Sufficient countermeasures for social environmental impact (Social-environmental Impact)

Based on these viewpoints, the evaluation scores (from 1 to 5) for each criterion are identified in Table 5.4.1.

Using these evaluation scores, the road network alternatives were assessed quantitatively as shown in Table 5.4.2. Results show that Alternative 3 is the most advantageous with the highest total score and Alternative 2 has the 2nd highest score. The difference between Alternative 2 and Alternative 3 is mainly in terms of regional development and environmental impact. Alternative 2 has a large volume of passing through traffic in the study area.

Alternative 1 can be considered as a good choice for the local residents because of its emphasis on local developments; however, the evaluation on industrialization and urbanization in the long term gives it lower priority.

Table 5.4.1 Evaluation Criteria and Standardization

Evaluation Score	1	2	3	4	5
Condition	Very Bad	Bad	So-so	Good	Very Good
Traffic situation	V/C Ratio >2.0		V/C Ratio =1.5		V/C Ratio <1.0
Economic condition	EIRR < 15%		EIRR = 25%		EIRR > 30%
Industrialization	There are intense traffic congestions due to the lack of high-standard roads	There are congestions during peak hours.	There are enough high-standard roads and traffic condition is tolerable.	There are a few congestions and enough accessibility to the high-standard roads	There are very few congestions and very good accessibility to the high-standard roads
Easiness for operation (Finance)	Difficult to prepare the budget	Need to look for additional financial resources	Possible using ODA and domestic funding	Private participation can be considered	Domestic funding or BOT only is enough.
Easiness for operation (ROW)	Difficult to promote due to the large number of affected houses.	A long period for negotiation is needed due to the number of affected houses.	The negotiation can be done; however, there are still some affected houses.	The number of affected houses is few.	There is no problem regarding resettlement.
Regional Development	There is no impact on new development.	There are a few impacts on present economic activities.	There are some impacts on present economic activities and new developments	The development potential is increased significantly by road developments	The study area becomes an urban core for urbanization and industrialization due to road developments
Natural environment	There are serious impacts on ecological system.	Hard to fulfill environmental standard but still manageable.	Fulfilling environmental standard but still need to pay attention on impact.	There is no considerable negative impact.	The good natural environment can be accelerated by the project.
Social environment	There are many affected residents by regional split.	Large number of affected residents and need to have treatment for poor.	There are only a few problems but still manageable.	There is no considerable negative impact.	The good social environment can be accelerated by the project.

Table 5.4.2 Assessment on Road Network Alternatives

	Alternative 0	Alternative 1	Alternative 2	Alternative 3
Traffic situation	1	4	4	4
Economic condition	1	4	4	4
Industrialization	1	3	5	5
Easiness for operation (Finance)	5	3	2	2
Easiness for operation (ROW)	5	2	3	3
Regional Development	1	3	3	5
Natural environment	1	3	2	3
Social environment	5	2	3	4
Total Score	19	24	26	30

Table 5.4.3 shows the summary of preliminary evaluation.

Based on this analysis, Alternative 3 has been selected as the best option.

Table 5.4.3 Summary of Preliminary Evaluation

Scenario	Preliminary Evaluation (Advantages and Disadvantages)
0. Existing Network (widening option)	• Significant magnitude of widening will be required in order to meet the future traffic demand. Significant adverse impact to the existing buildup areas. • New urbanization will be controlled in the existing road corridors and to avoid rapid expansion of urbanization encouraged by the new road network development.. • Control of the rapid urbanization will help control the traffic demand so as to alleviate the traffic congestions. • Regional disparities may be enhanced due to the further concentration of the urban economic activities in the existing urbanizes.
1. Arterial Grid-Pattern	• Sufficient network configuration will provide alternative routes to detour the congested sections; however, it will not play a significant role for long distance trip. • Construction cost for each road sections will be minimized based on the lower road design standards. • Minimize social environmental impact (adverse) • Small and medium commercial and service facilities and industries will be developed along the transport corridors. It will not be sufficient enough to introduce international large scale of investments. • Urbanization pressure widely spread in the region and promote insufficient urbanization. • Easy to invite developers for housing development and contribution of their land for the road network development.
2. MM～Laguna Corridor Enhancement	• Traffic congestions will be improved with the two north-south axis (if C6 expressway would be constructed, the congestion will be further improved). • However, traffic nuisance such as air pollution and noise will be concerned along the north-south axis due to the large volume of through traffic. • Encourage regional economic development in the Metro Manila–Laguna -Batangas corridor including industrialization. • Large scale investment will be required and private investments will be enhanced. • Existing North-South corridor will be further enhanced and less populated areas in the region will be left behind from the development. • Accelerate over concentration of the central functions in Metro Manila • Living environment will be deteriorated. Large adverse impact will be concerned to the existing buildup areas. • Less adverse impact to the existing buildup areas, • But new land acquisition and compensation will be required.
3. East-West and North-South Axis	• Better accessibility for long trip such as inter regional trips will be provided. But for the through traffic, it will be longer detour routes. • Encourage intra-regional traffic not only in the north-south corridors but also in the east-west corridor. • Strategic and balance regional and urbanization development will be promoted. • Higher investment fund for the construction of the high standard highway will be required. • It will be concerned that urban sprawl will be extended to the Agriculture areas in the central and south-west areas in Cavite