JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
NATIONAL ECONOMIC AND DEVELOPMENT AUTHORITY (NEDA)

ROADMAP FOR TRANSPORT INFRASTRUCTURE DEVELOPMENT FOR METRO MANILA AND ITS SURROUNDING AREAS (REGION III & REGION IV-A)

FINAL REPORT

TECHNICAL REPORT NO. 2
TRANSPORT DEMAND ANALYSIS

March 2014

ALMEC CORPORATION

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ABBREVIATIONS

ADB	Asian Development Bank
AFCS	automatic fare collection system
ATI	Asian Terminals Inc.
BCDA	Bases Conversion and Development Authority
BMDS	bus management and dispatch facilities
BOT	build–operate–transfer
BPO	business process outsourcing
BRT	bus rapid transit
CALA	Cavite Laguna
CALABARZON	Cavite, Laguna, Batangas, Rizal and Quezon
CAMANAVA	Caloocan, Malabon, Navotas and Valenzuela
CBD	central business district
CBU	completely built unit
CCW	center/cluster-corridor-wedge
CIAC	Clark International Airport
CLUP	comprehensive land use plans
DBM	Department of Budget and Management
DBP	Development Bank of the Philippines
DMIA	Diosdado Macapagal International Airport
DOF	Department of Finance
DOST	Department of Science and Technology
DOTC	Department of Transportation and Communications
RTPD	Road Transport Planning Division
DPWH	Department of Public Works and Highways
ECC	environmental compliance certificate
EDSA	Epifanio de los Santos Avenue
FTI	Food Terminal, Inc.
GCR	greater capital region
GDP	gross domestic product
GRDP	gross regional domestic product
HCPTI	Harbour Centre Port Terminal Inc.
HLURB	Housing and Land Use Regulatory Board
HUDCC	Housing and Urban Development Coordinating Council
ICTSI	International Container Terminal Service, Inc.
Infracom	infrastructure committee
IRR	internal rate of return
ITS	integrated transport system
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
LGU	local government unit
LRT	Light Rail Transit
LRTA	Light Rail Transit Authority
LTFRB	Land Transportation Franchising & Regulatory Board
MIAA	Manila International Airport Authority
MICT	Manila International Container Terminal
MMDA	Metro Manila Development Authority
MMEIRS	Earthquake Impact Reduction Study for Metro Manila
MMPTS	Mega Manila Public Transport Study
MMUTIS	Metro Manila Urban Transportation Integration Study
MNL	Manila North Line

MNTC	Manila North Tollways Corporation
MNHPI	Manila North Harbour Port Inc.
MPDTC	Metro Pacific Tollways Development Corp.
MPPA	million passengers per annum
MRO	maintenance, repair and overhaul
MRT	Metro Rail Transit
MSL	Manila South Line
MTDP	medium-term development plan
NAIA	Ninoy Aquino International Airport
NCR	National Capital Region
NEDA	National Economic and Development Authority
ICC	Investment Coordination Committee
NLEX	North Luzon Expressway
NSCB	National Statistical Coordination Board
NSO	National Statistics Office
O&M	operations and maintenance
ODA	Official Development Assistance
OTCA	Overseas Technical Cooperation Agency
PDP	Philippine Development Plan
PEZA	Philippine Economic Zone Authority
PIBAS	provincial integrated bus axis system
PNCC	Philippine National Construction Corporation
PNR	Philippine National Railways
PPA	Philippine Port Authority
PPP	public-private-partnership
PUB	public utility bus
PUJ	public utility jeepney
Php	Philippine peso
R&D	research and development
RDA	regional development agenda
RET	rapid exit taxiways
ROW	right-of-way
SBF	Subic Bay Freeport Zone
SBPDP	Subic Bay Port Development Project
SCMB	Subic-Clark-Manila- Batangas
SCTEX	Subic-Clark-Tarlac Expressway
SLEX	South Luzon Expressway
SLTC	South Luzon Tollway Corporation
SOE	state-owned enterprise
STAR	Southern Tagalog Arterial Road
TEAM	traffic engineering and management
TEU	twenty-foot equivalent units
USAID	United States Agency for International Development
USD	US dollar
UV	utility vehicle
VFR	visual flight rules
WB	World Bank

1 INTRODUCTION

1.1 In recent years a number of transport sector studies have been conducted for the Metro Manila (MM) and its adjoining provinces. Most of these studies have been either related to a single transport mode/sector or specifically for a particular project. No study, since MMUTIS (Metro Manila Urban Transportation Integration Study, March 1999) has assessed the changes in land use, population growth and the transportation infrastructure as a whole. One of the key objectives of this study is to assess the performance of the current transport infrastructure in the Greater Capital Region (GCR), particularly in the Mega-Manila area and to formulate the "Roadmap for Transport Infrastructure Development for Metro Manila and Its Surrounding Areas (Region III and Region IV-A)".In the context of this study, detailed travel demand analysis is required to fulfil the following objectives:

(i) To provide magnitude of travel demand within MM and between MM and the adjoining provinces within the GCR;

(ii) Provide information on current and future travel patterns in the GCR for the short, medium, and long term situation, especially by main modes of travel;

(iii) To assist in the identification of network capacity deficiencies, particularly by modes of travel; and

(iv) To assess the performance of the on-going, committed and proposed projects.

1.2 The approach to traffic analysis was to develop and validate a travel demand model that can be used to achieve the above outlined objectives, such that:

(i) The traffic model replicates the current situation well by mode of travel;

(ii) It assists in the analyses and assessment/identification of the short fall/ deficiencies in the performance of the current transport infrastructure;

(iii) Use the model to forecast future travel demand and assess the performance of the current network and with the on-going and committed transport infrastructure projects.

(iv) Prepare/ propose integrated transportation infrastructure development projects, test and assess the performance of the proposed projects using the traffic model, and

(v) Then select and prioritise the development of an integrated network of transport infrastructure that best meets the future travel demand.

1.3 The selected transportation infrastructure projects are then further analysed to be prioritised according to not only the project(s) performance, but also taking into account the available budget constraints and opportunities. This Technical Report 2, following this introduction describes these traffic demand analysis tasks of the study.

2 DEMAND FORECAST METHODOLOGY

2.1 Broad Approach

2.1 The traffic demand analysis methodology has been kept simple and relied mostly on the available data and information from recent studies. The key features of the traffic demand analysis and the forecast methodology used for the development of transportation infrastructure program is depicted in Figure 2.1.1. The key steps involved in the development, validation and use of the traffic model are summarised below and detailed in the remainder of this section.

(i) Convert MMUTIS and HSH study area O/D trip matrices to the project traffic model zone system as detailed in the following section.

(ii) Create 2012 O/D trip matrices for common base year of the project 2012. This aspect is detailed in the model validation section and shows that the traffic model replicates the current situation well by mode of travel;

(iii) Combine 2012 MMUTIS and HSH O/D trip matrices by selecting the whole of MMUTIS area trips for the Mega Manila area, and HSH O/D trips for the remainder of the GCR regions.

(iv) Develop the study area highway and railway network from HSH study and update where necessary.

(v) Validate the 2012 O/D trip matrices by assigning to the 2012 network and comparing the assigned traffic volume against the MUCEP traffic count data collected in 20012.

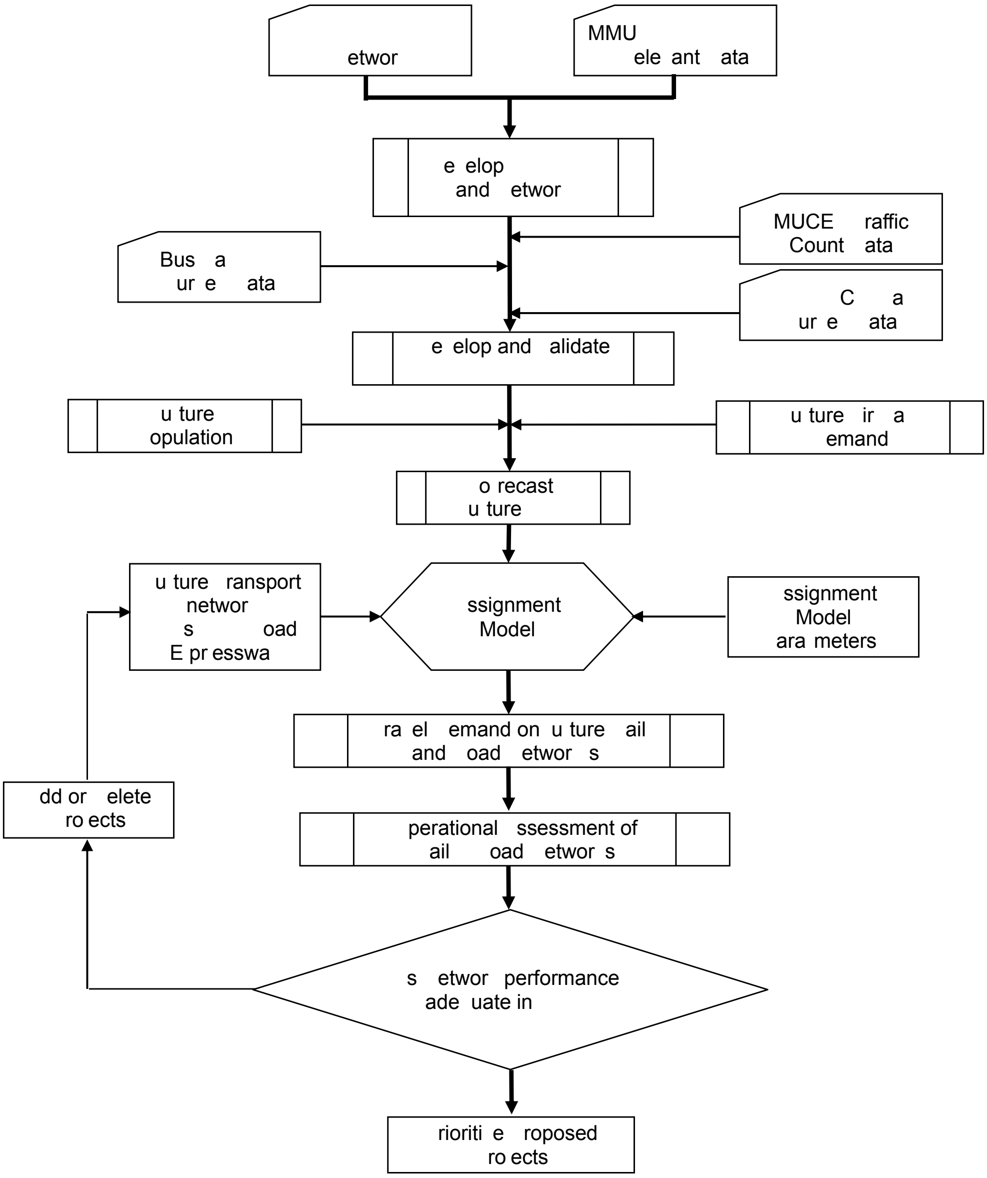
(vi) Prepare future year O/D trip tables and assign to the 2012 network and to the committed/ proposed highway and rail networks.

(vii) Assess the performance of the proposed projects and add/ delete projects until satisfactory integrated network development is achieved.

(viii) Prioritise projects by assessing the performance of each project relative to other projects.

(ix) Economic, financial and environmental evaluation of the proposed candidate projects using traffic model outputs.

(x) State-of-the-art ‘CUBE’ transport planning software was used for traffic modelling tasks.



Source: JICA Study Team.

Figure 2.1.1 Traffic Demand Analysis – Methodology

2.2 Study Area Traffic Zone System

2.2 The initial task in data gathering, manipulation and combining it for the project study area was to develop a new traffic analysis zone system. The new zone system developed for the study is compatible with other studies, mainly MMUTIS, HSH and recently completed study of Airport Express Rail study. The project study area has been defined elsewhere in this report, and the related socio-economic characteristics have been detailed in Chapter 2. The zone system developed for the project and its compatibility with other studies is summarised in Table 2.2.1.

Table 2.2.1 Study Traffic Zone System and its Compatibility with Other Projects

Area Description	Number of Traffic Zones in the Study Area		
	Roadmap[1]	MMUTIS[2]	HSH[3]
Metro Manila (NCR 17 Cities)	94	94	94
Bulacan Province	26	23	26
Laguna Province	14	11	19
Rizal Province	15	19	17
Cavite Province	23	30	25
Rest of Region III	37	1	74
Rest of Region IV-A	18	1	28
Special Zones (Ports & Airports)	8	2	1
Other Areas in Luzon (Externals)	10	-	36
Total Zones	245	181	320

Source: Compiled by JICA Study Team.
1 Roadmap for Transport Infrastructure Development for MM and its Surrounding Areas (Regions III & IV-A)
2 Metro Manila Urban Transport Integration Study 1999, Forecast Model Zone System
3 The Study of High Standard Highway Network Development, 2009.

2.3 For the this project, the traffic zone system was devised such that when converting O/D trip tables to the project area, minimum detail is lost in aggregation of zones within the Greater Metro Manila (GMM) area comprising of NCR, Bulacan, Laguna, Rizal and Cavite provinces. In the outer areas with the Greater Capital Region (comprising of NCR, Region III and Region IV-A) some zones were aggregated to lose the detail that are not necessary for this project. In addition, special airport zones were created for exogenously modelling airport related landside trips. The resultant study area zone system is detailed in Annex A.

2.3 Development of the Study Area Base Year (2012) Travel Demand O/D Tables

2.4 The traffic model was developed for the following four (4) types of O/D trip matrices:

(i) Car person trips O/D (including taxi trips);

(ii) Jeepney passenger trips O/D (including FX and HOV);

(iii) Bus passenger trips O/D (including all buses); and

(iv) All goods vehicles (including delivery vans, pick-up vehicles and trucks).

2.5 All O/D trips matrices represented average number of daily (average weekday) trips. The steps involved in the derivation of the initial 2012 O/D trip matrices were to convert the MMUTIS and HSH study 2012 combine the O/D trips from these O/D tables of the same mode as explained in the following Table 2.3.1.

Table 2.3.1 Formation of Initial 2012 O/D Tables – Sources of O/D Trips

Area	Greater MM Area (Zones 1-172)	Remaining Areas (Zones 173-245, excluding special Zones)
Greater MM Area (Zones 1-172)	O/D Source MMUTIS O/D table	HSH Study O/D table
Remaining Areas (Zones 173-245, excluding special zones)	HSH Study O/D table	HSH Study O/D table

Source: JICA Study Team.
Note: Special Zone trips were estimated exogenously from various O/D surveys and added to the O/D table

2.4 Base Year (2012) Traffic Model Networks

2.6 The traffic model base year network was developed from both MMUTIS and HSH study area networks on the same basis as the O/D table described above. The key characteristics of the two networks are summarised in Table 2.4.1. Both the highway and rail networks as represented in the CUBE model are depicted in the following Figure 2.4.1 and 2.4.2, respectively. The level of detail of the network model was based on the area, i.e., in the MM inner area the network includes all expressways, primary roads (R1-R10 and C1-C5) and most secondary roads. In some cases in small zones, local roads area also included. Whereas outside MM and within Greater Capital Area, all expressways, primary/ national roads are included in the network. Only the secondary roads of strategic importance (those link key conurbations to primary/ national roads) are included.

2.7 The rail network included the three mass transit lines and the PNR Tutuban–Alabang operation. All railways are within Metro Manila. The three mass transit lines run frequent services throughout the day for about 18 hours per day. The PNR operates a limited service between Tutuban and Alabang, while some trains in the morning peak run through to Calamba, but the operation is so limited that it did not warrant inclusion into the traffic model.

Table 2.4.1 Key Characteristics of the Study Area Traffic Model Network

Description	MM Area (km)	Rest of GCR (km)	Total (km)
Expressways	54	244	298
Primary Roads	272	2,517	2,789
Secondary / Local Roads	470	1,968	2,438
Sub-total primary & Secondary Roads	742	4,485	5,227
Total Roads	796	4,729	5,525
Railway Network Metro Manila			
Line/ System	Length (km)		Stations
LRT Line-1	18.1		20
LRT Line-2	12.6		11
MRT Line-3	16.5		13
PNR Tutuban-Alabang	28.0		16
Total Rail Network	75.2		60

Source: JICA Study Team.

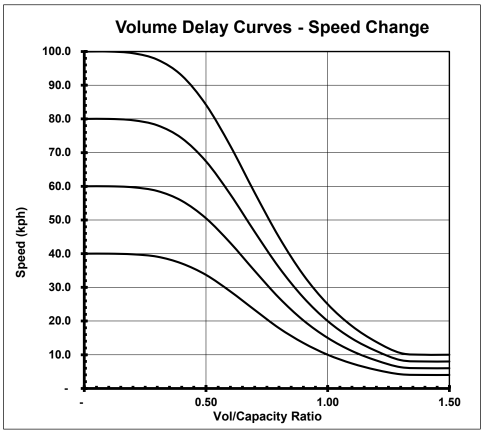
2.8 The traffic model combined road/ rail network was used to assign O/D table. The assignment process used is based on well-known ‘equilibrium’ method, where the traffic from each O/D pair is assigned iteratively to the network until no cheaper/ quicker route could be found. The shortest path building was based on the generalised cots of travel for private mode and public transport fares / wait & walk times were represented for the public modes according to the service on each line. The equilibrium method re-calculates the new travel time based on the road capacity and assigned traffic volume after each assignment iteration. As the travel speed slows down with the addition of more traffic after each successive iteration of assignment adds more traffic to the network. The speed/ flow i.e., volume delay function was calibrated according to the network, and is based on the USA BPR adopted formula.

2.9 The general form of the function is described below and is graphically depicted in Figure 2.4.2, and the road capacities and maximum link speed were adopted from the MMUTIS demand model, however, where necessary the road capacity and maximum speed coded in the network were updated according to the current (2012) conditions. The ‘base’ road capacities and maximum speeds adopted for the study are summarised in

Table 2.4.2.Other assignment model parameters are listed in Table 2.4.3, and the related railway assignment parameters are given in Table 2.4.4.

$$Tx = T0\left\{1 + \alpha\left(\frac{V}{C}\right)^{\beta}\right\}$$

Where: *Tx= Travel Time at a Volume/Capacity Ratio x,T0= Travel Time at Maximum Speed, V=Traffic Volume in PCU, C=Road Capacity in PCU; and*
αandβ are Calibrated Parameters with values: $\alpha = 3.0$, $\beta = 4.0$



Source: MMUTIS Study and Updated by JICA Study Team.

Figure 2.4.1 Volume Delay Function

Table 2.4.2 Road Network Capacities and Maximum Speed

Area	Road Category	Carriageway Type	Capacity 1-way pcu/hr/lane	Maximum Speed
Inside EDSA	Local road	Single	220	30
	Secondary	Single	440	40
	Primary	Single	660	45
Outside EDSA Inside MM (including EDSA)	Secondary	Single	770	50
	Primary	Single	825	60
	Secondary	Divided	1,400	70
	Primary	Divided	1,650	80
Outside MM	Local road	Single	800	30
	Secondary	Single	1,100	55
	Primary	Single	1,540	60
Urban / Inter City	Access / egress	Single	1,500	80
	Expressway	Single	1,700	80
	Expressway	Divided	2,000	100

Source: MMUTIS Study and Updated by JICA Study Team where Appropriate.

Table 2.4.3 Assignment Model Parameters – 2012 Road Transport 2012

Parameter Description	Car	Jeepney	Bus	Truck
Average 24-hour Occupancy (Person)	1.70	10.02	35.28	n/a
PCU Factor	1.00	1.50	2.00	2.00
Value of Time (PHP/min)	1.86	1.30	1.30	n/a
Vehicle Operating Cost (PHP/km)	7.30	n/a	n/a	n/a
Toll Rate Within MM (PHP/km)	10.30	10.30	20.60	30.90
Toll Rate Outside MM (PHP/km)	3.40	3.40	6.80	10.20
Perceived Toll Factor	1.00	0	0	0.50
Public Transport Fare (PHP/km)	n/a	2.00	1.72	n/a

Source: JICA Study Team.

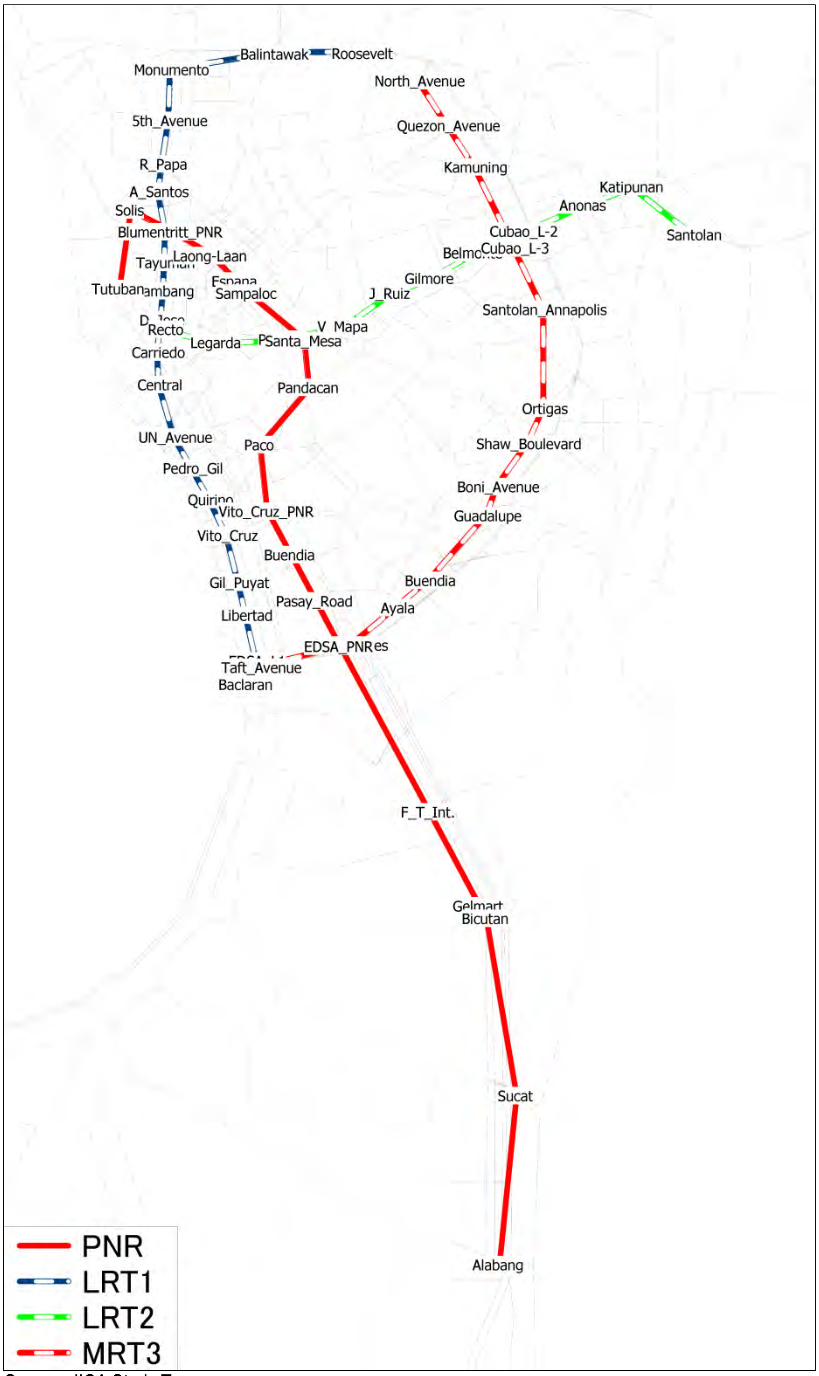
Table 2.4.4 Assignment Model Parameters 2012 - Railways

Parameter Description	LRT-1	LRT-2	MRT-3	PNR
Average Peak Hour Headway (mins)	3.0	5..0	2.5	30.0
Average Speed (km/h)	26.0	29.6	29.5	26.1
Boarding Fare (PHP/boarding)	12.0	12.0	10.0	10.0
Additional Fare (Boarding + PHP/km)	0.45	0.18	0.28	0.30
Perceived Wait Time (Factor)	1.3	1.3	1.3	1.3
Access Walk Speed (km/h)	4.0	4.0	4.0	4.0

Source: JICA Study Team.

Source: Study Area Traffic Model, Network Image from CUBE Software.

Figure 2.4.2 Study Area Base Year Traffic Model – Highway Network



Source: JICA Study Team.

Figure 2.4.3 Study Area Base Year Traffic Model – Rail Network

2.5 Validation of the Base Year (2012) O/D Tables

2.10 The traffic model validation process involved comparison of modelled traffic volume against the traffic counts by vehicle type. For this purpose 2012 MUCEP traffic count data was used. The MUCEP data was available at three levels:

(i) Outer Cordon – Outer boundary of Mega Manila Area (i.e., outer boundary of Bulacan, Cavite, Laguna and Rizal Provinces) almost same area inside the outer cordon as MMUTIS Study area;

(ii) Inner Cordon – Metro Manila Boundary; and

(iii) Three Screenlines within MM–(i) Pasig River; (ii) San Juan River; and (iii) PNR.

2.11 In total there were 16 roads which crossed the outer cordon, 20roads crossed the inner cordon and 46 roads crossed the three screenlines. The comparison was at aggregate level across a combination of roads along a particular corridor like north, south and east. Table 2.5.1 compares the modelled traffic volumes and the observed counts for the two cordons and three screenlines within MM. It can be seen that a good comparison was achieved after a few iterations of adjustments to the O/D trip matrices by each mode at daily level. The overall assessment is that total screenlines and cordon volumes are within 10% of the counts.

Table 2.5.1 Road Network Capacities and Maximum Speed

Description - MM Screenlines	Cars			Truck PCU			Total PCU		
	Count	Model	M/C	Count	Model	M/C	Count	Model	M/C
a sig i er – c reenline	480,000	508,600	1.06	142,600	150,900	1.06	622,600	659,500	1.06
a n Juan i er – c reenline	372,800	379,100	1.02	154,500	144,400	0.93	527,300	523,500	0.99
PNR - Screenline	349,700	388,100	1.11	88,600	85,700	0.97	438,300	473,800	1.08
Total All MM Screenlines	**1,202,500**	**1,275,800**	**1.06**	**385,700**	**381,000**	**0.99**	**1,588,200**	**1,656,800**	**1.04**
Description - MM Screenlines	**Jeepney Pax**			**BUS Pax**			**Total Pax**		
	Count	Model	M/C	Count	Model	M/C	Count	Model	M/C
a sig i er – c reenline	620,217	561,700	0.91	647,104	675,400	1.04	1,267,321	1,237,100	0.98
a n Juan i er – c reenline	870,800	863,400	0.99	733,100	649,900	0.89	1,603,900	1,513,300	0.94
PNR - Screenline	452,900	410,300	0.91	418,000	510,700	1.22	870,900	921,000	1.06
Total All MM Screenlines	**1,943,917**	**1,835,400**	**0.94**	**1,798,204**	**1,836,000**	**1.02**	**3,742,121**	**3,671,400**	**0.98**

Description - MM Cordon	Cars			Truck PCU			Total PCU		
	Count	Model	M/C	Count	Model	M/C	Count	Model	M/C
Inner Cordon - North (GR01-05, EW01)	61,100	87,100	1.4	63,300	64,800	1.0	124,400	151,900	1.22
Inner Cordon - East (GR06-14)	126,900	105,100	0.8	59,400	56,700	1.0	186,300	161,800	0.87
Inner Cordon - South (GR15-18, EW02,03)	142,300	166,200	1.2	68,800	57,500	0.8	211,100	223,700	1.06
Inner (MM) Cordon Total	**330,300**	**358,400**	**1.1**	**191,500**	**179,000**	**0.9**	**521,800**	**537,400**	**1.03**
Description - MM Cordon	**Jeepney Pax**			**BUS Pax**			**Total Pax**		
	Count	Model	M/C	Count	Model	M/C	Count	Model	M/C
Inner Cordon - North (GR01-05, EW01)	166,900	276,500	1.7	337,840	428,100	1.3	504,740	704,600	1.40
Inner Cordon - East (GR06-14)	671,000	536,800	0.8	43,400	88,300	2.0	714,400	625,100	0.88
Inner Cordon - South (GR15-18, EW02,03)	328,000	326,300	1.0	543,700	535,400	1.0	871,700	861,700	0.99
Inner (MM) Cordon Total	**1,165,900**	**1,139,600**	**1.0**	**924,940**	**1,051,800**	**1.1**	**2,090,840**	**2,191,400**	**1.05**

Description - GMM Cordon	Cars			Truck PCU			Total PCU		
	Count	Model	M/C	Count	Model	M/C	Count	Model	M/C
Outer Cordon - North (OC1, 6-8&20)	37,800	37,400	0.99	46,400	46,200	1.00	84,200	83,600	0.99
Outer Cordon - East (OC09)	1,100	1,000	0.91	1,500	8,300	5.53	2,600	9,300	3.58
Outer Cordon - South (OC1, 6-8&20)	53,400	56,127	1.05	36,400	36,800	1.01	89,800	92,927	1.03
Total Outer (GMM) Cordon	**92,300**	**94,527**	**1.02**	**84,300**	**91,300**	**1.08**	**176,600**	**185,827**	**1.05**
Description - GMM Cordon	**Jeepney Pax**			**BUS Pax**			**Total Pax**		
	Count	Model	M/C	Count	Model	M/C	Count	Model	M/C
Outer Cordon - North (OC1, 6-8&20)	42,100	47,800	1.14	153,300	141,100	0.92	195,400	188,900	0.97
Outer Cordon - East (OC09)	1,900	6,300	3.32	1,400	800	0.57	3,300	7,100	2.15
Outer Cordon - South (OC1, 6-8&20)	153,100	142,900	0.93	212,100	226,700	1.07	365,200	369,600	1.01
Total Outer (GMM) Cordon	**197,100**	**197,000**	**1.00**	**366,800**	**368,600**	**1.00**	**563,900**	**565,600**	**1.00**

Source: JICA Study Team.

2.12 Validation of person trips on railways was carried by comparing the modelled patronage with the total daily boarding on each line and the results are summarised in Table 2.5.2. It can be seen that the total modelled rail patronage is within 10% of the average daily volume of all lines. The Line-1 modelled daily demand is 17% higher than the observed volume. This was further analysed and was deemed to be acceptable as the modelling process is set-up to forecast overall demand rather than each station by station volumes, which requires a greater level of detail of rail line access (road and walk) network and finer/ smaller traffic zone system than adopted for this strategic network assessment model. In the case of PNR patronage the actual boarding numbers are small and are not of much concern. As the service provided is erratic and observed volume are also subject to large daily fluctuations.

Table 2.5.2 Comparison of Observed and Modeled Patronage on MM Railways

Description - Railway Line	Daily Railway Pax		
	Count	Model	M/C
Line-1 Baclaran to Roosevelt	518,600	605,100	1.17
Line-2 Recto to Santolan	212,000	206,500	0.97
Line-3 Taft to North Avenue	570,000	577,900	1.01
PNR Tutuban to Alabang	46,700	61,200	1.31
Total MM Railways	**1,347,300**	**1,450,700**	**1.08**

Source: JICA Study Team.

2.13 The model validation process yielded the 2012 O/D trip matrices by four modes of travel. Table2.5.3 summarises the total Inter-Zonal trips in each trip O/D table by region.

Table 2.5.3 Summary of 2012 Inter-Zonal Trips by Study Area Regions

TRSD - 2012 Validated Person Trips by Car					Pax ('000)
No.	City/Province/ Region	1	2	3	Total
1	Metro Manila	4,077.9	73.1	20.3	4,171.4
2	Bulacan+Laguna+Rizal+Cavite	73.1	1,711.6	18.6	1,803.2
3	Rest of GCR	20.3	18.6	156.3	195.2
	Total	4,171.4	1,803.2	195.2	6,169.8
TRSD - 2012 Validated Person Trips by Jeepney					Pax ('000)
No.	City/Province/ Region	1	2	3	Total
1	Metro Manila	5,307.3	318.9	15.0	5,641.3
2	Bulacan+Laguna+Rizal+Cavite	318.9	1,408.4	38.5	1,765.8
3	Rest of GCR	15.0	38.5	160.1	213.5
	Total	5,641.3	1,765.8	213.5	7,620.5
TRSD - 2012 Validated Person Trips by Bus					Pax ('000)
No.	City/Province/ Region	1	2	3	Total
1	Metro Manila	2,692.3	247.0	90.1	3,029.4
2	Bulacan+Laguna+Rizal+Cavite	247.0	2,164.2	14.4	2,425.6
3	Rest of GCR	90.1	14.4	121.1	225.6
	Total	3,029.4	2,425.6	225.6	5,680.5
TRSD - 2012 Validated Goods Vehicle Trips					Vehs('000)
No.	City/Province/ Region	1	2	3	Total
1	Metro Manila	266.6	16.8	15.5	298.9
2	Bulacan+Laguna+Rizal+Cavite	16.8	76.0	10.7	103.6
3	Rest of GCR	15.5	10.7	11.0	37.1
	Total	298.9	103.6	37.1	439.6

Source: JICA Study Team.

3 CHARACTERISTICS OF EXISTING TRAVEL DEMAND

3.1 Characteristics of Road Traffic Demand and Existing Network Performance

3.1 The daily travel demand by main modes of travel in the study area is summarised in Table 3.1.1. ' like with like' comparison of the estimated 2012 travel demand with the MMUTIS 1996 observed person trips within and to and from MM show an increase in trips of15% by car, while trips by public transport (jeepney and bus) declined by about 7%. However, in terms of vehicle trips the increase in car trips has been 69% (on average 3.3% per annum) compared with increase in public vehicle trips of 41% (average growth of 2.2% p.a.) over the last 16 years. The increase in public vehicle trips has been both in terms increase in jeepney (2 times as many as by bus) and bus traffic.

3.2 This high increase in car traffic has been due to ever increasing car ownership as well as decline in car occupancy from 2.5 persons per car in 1996 (MMUTIS Survey) to 1.70 in 2012. In case of public transport the decline in vehicle occupancy has been even more marked, the jeepney occupancy dropped from an average of 15.1 to 10, while the bus occupancy declined from 46.5 to 35.3 passengers per bus over the same period. To some extent the decrease in public vehicle occupancy could be attributed to the use of somewhat smaller vehicles: e.g., introduction of 16-seat jeepneys also in case of buses introduction of more air-conditioned buses which have fewer seats and operate as 'luxury service (all seated passengers compared to 's high capacity buses with many passengers standing.

Table 3.1.1 Travel Demand in the Study Area – Inter-Zonal Trips

Main Mode of Travel	Person Trips		Average Occupancy	PCU Factor	Vehicle Trips (PCU)	
	No.('000)	%			No.('000)	%
Car	6,170	31.7	1.7	1.0	3,629	71.3
Jeepney	7,620	39.1	10.0	1.5	1,141	22.4
Bus	5,680	29.2	35.3	2.0	322	6.3
Sub-Total Public (Jeepney + Bus)	13,300	68.3	-	-	1,463	29.7
Total Person Trips	19,470	100.0	-	-	5,092	100.0

Source: JICA Study Team.

3.3 This marked increase in traffic volume has led to considerable increase in traffic resulting in congestion le el much worst that late 's, in some cases leading to total Grid-lock on key arterial and circumferential roads. The truck traffic has also declined, and as trucks mostly operate at night due to truck traffic ban on some roads during peak or day-light hours. However, the truck volume remains small compared to private and public vehicular traffic.

3.4 The assignment model calibrated for the 2012 matrix validation process is used to assess the current traffic condition on the roads in the study area. The network performance assessment is based on assigning 10% of the daily traffic volume on the hourly network capacity. The assessment of current traffic situation shows that most of the network is either operating at or above capacity. Table 3.1.2 provides a summary of level of traffic demand on the road network by area and key roads in Mega Manila. The impact of network operation at capacity (a measure of congestion) is that road traffic speed tend to drop rapidly once the traffic volume on the road exceeds 50% of capacity (Refer to Figure

3.1.1). Table also shows the traffic volume weighted average speed and also in terms of % of the roads sections (kms) operating at or below 10kph and 20kph.

3.5 It can be seen that (with few exceptions) majority of the traffic in MM on 55% to 76% of the road km travels below 10 kph, and 75% to 92% travel at speeds below 20 kph. This is the result of traffic volumes approaching road capacity which is further illustrated in Figure 3.1.1 in terms of both traffic volume and the Volume Capacity (V/C) ratio of each road section, separately for GCR and MM areas. Colours orange and red show road sections with V/C greater than 0.9 or higher.

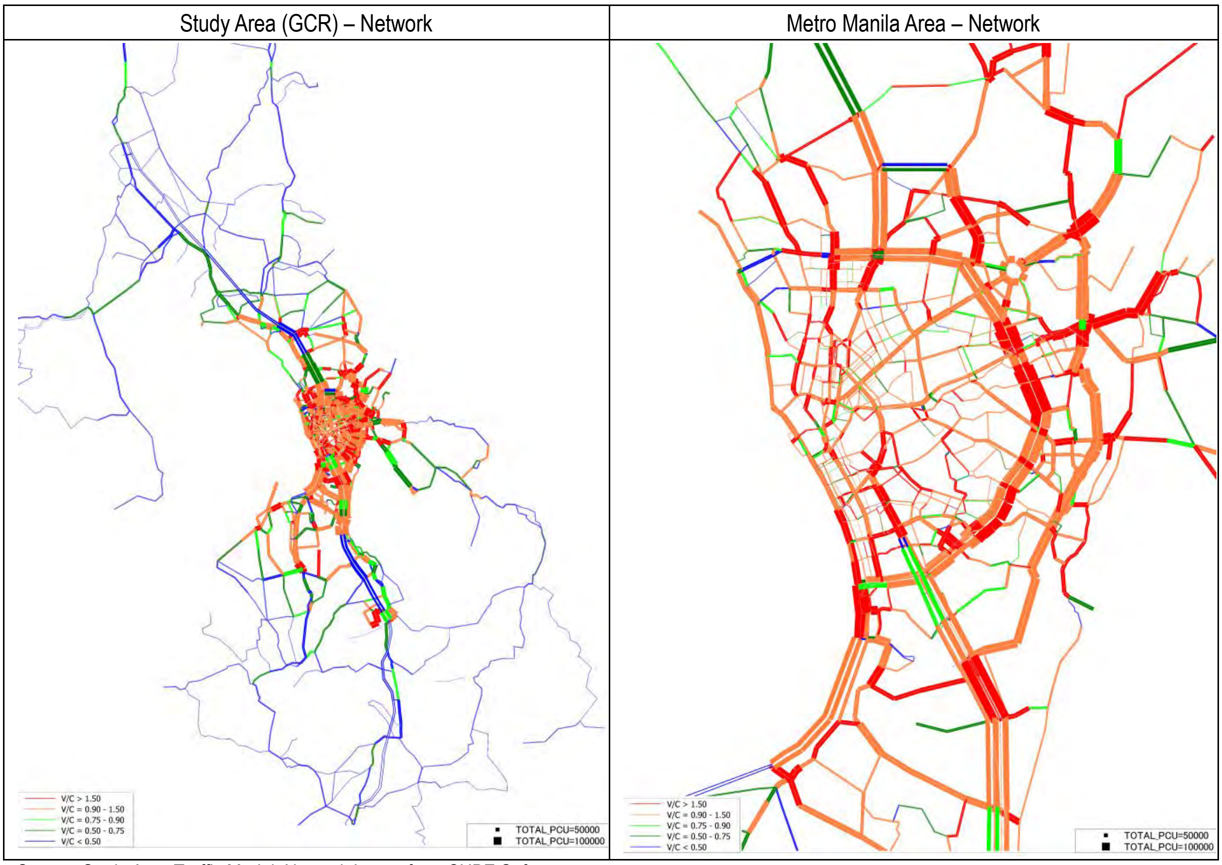
3.6 Among the main arterial (R1 to R10) and circumferential (C1 to C5) roads, EDSA (C4) carries the highest traffic volume, with over 4.8 million PCU-km or 11.3 million person-kms daily. This level of traffic causes the road to reach capacity throughout the day and close to 70% of EDSA operates at speeds below 20 kph. The impact of such high volume of traffic concentration on a single road is not just result in economic losses, but also high level of pollution and poor living environment. The busiest radial road is R7, with traffic exceeding one million PCU-km and person-km in excess of 3.5 million daily. This shows that the person demand in corridor is even higher than on EDSA on per PCU-km basis. As a result traffic speed on R7 is even worse than EDSA, over its entire length of about 12 km operating below 20 kph.

3.7 On area basis, most of MM roads are at capacity, and situation is not much better at Mega Manila level either. Mega Manila road network which represents about 50% of the study area network on average operates at V/C ratio of 0.80, with close to half of the road network operating below 20 kph. This assessment demonstrates that it is about time some serious notice is taken of the current traffic condition in the Mega Manila areas. There has been limited expansion of road network both in terms of new roads or capacity expansion through traffic/ demand management has been realised since MMUTIS study, yet the demand has been allowed to increase unabated.

Table 3.1.2 Summary of Road Traffic Volume and Network Performance

Road Description	Road Length	Av. V/C	Rd. Section (km) with Speed		PCU (000)		Pax (000)	
	km		< 10 kph	< 20 kph	kms	Hrs.	Kms	Hrs.
C-1	6.4	1.14	4.8	5.7	240	36	648	98
C-2	10.2	1.26	6.4	9.7	494	79	1,429	228
C-3	13.8	1.04	7.2	11.0	606	68	2,391	260
C-4	27.1	1.21	13.2	18.6	4,779	462	11,269	1,102
C-5	26.8	1.24	12.5	25.2	3,046	288	9,247	869
R-1	8.8	1.73	8.1	8.8	918	165	2,692	490
R-2	6.7	1.43	6.7	6.7	402	80	1,233	245
R-3	4.7	1.40	3.5	4.7	433	80	1,461	262
R-4	7.5	1.21	6.2	7.2	295	46	975	156
R-5	5.4	1.30	4.3	5.4	294	46	868	133
R-6	10.3	1.35	7.1	9.7	633	86	1,860	255
R-7	11.8	1.16	6.6	11.8	1,065	132	3,579	445
R-8	7.5	1.67	6.4	7.3	534	87	1,871	306
R-9	7.1	1.72	6.5	7.1	424	78	1,196	218
R-10	6.9	1.25	5.6	6.9	418	78	696	134
CAVITEX	10.9	0.81	-	-	903	39	3,434	132
Skyway	17.5	0.90	-	-	1,795	64	8,814	307
SLEX	92.6	0.58	2.7	12.2	5,007	232	20,686	764
NLEX	80.3	0.40	-	2.9	3,330	77	16,538	357
Area	**Road Length**	**Av. V/C**	**Rd. Section (km) with Speed**		**PCU (000)**		**Pax (000)**	
	km		**< 10 kph**	**< 20 kph**	**kms**	**Hrs.**	**Kms**	**Hrs.**
MM Manila City	135	1.31	102.0	124.3	3,870	701	11,023	1,973
MM North	404	1.26	235.6	325.4	20,041	2,450	62,532	7,509
MM Center	135	1.23	84.9	107.8	6,976	898	21,192	2,649
MM South	131	1.21	72.6	98.7	8,380	856	27,600	2,540
Sub-Total MM	**805**	**1.25**	**495.2**	**656.2**	**39,266**	**4,905**	**122,347**	**14,672**
Bulacan	458	0.61	62.8	134.9	9,814	627	31,523	1,888
Laguna	392	0.37	19.3	33.6	5,102	298	15,940	842
Rizal	182	0.68	16.9	49.3	4,056	273	13,365	857
Cavite	447	0.55	56.3	114.6	8,785	606	36,056	2,425
Sub-Total Adj. Prov.	**1,478**	**0.53**	**155.3**	**332.3**	**27,757**	**1,804**	**96,884**	**6,012**
Total - Mega Manila	**2,284**	**0.80**	**650.5**	**988.5**	**67,024**	**6,709**	**219,231**	**20,683**

Source: JICA Team Estimate.



Source: Study Area Traffic Model, Network Image from CUBE Software.

Figure 3.1.1 Traffic Model – Highway Network Traffic Volume and V/C Ratio

3.8 The road based public transport caries bulk of the travel in the study area. In MM, majority of the travel is by jeepneys (36%), where those using the bus services is not far behind at 31%. In the adjoining provinces, the travel by jeepney drops to 28% same as car, and the travel bus share is 44%, mainly because for longer journeys bus is the preferred mode, as summarised in Table 3.1.3. Overall in the Mega Manila area, the car travel accounts for 30% of person-km, but constitutes 72% of the road traffic in terms of PCU-km. The ratio of car usage within MM is similar such that the passenger-km accounts for 33% of travel, yet the car PCU-km are over 72% of traffic. In the adjoining provinces, because of lower car ownership, the travel by car is somewhat lower i.e., car passenger-km are 26% of the total passenger-km against 69% of the total PCU-km.

3.9 The above data on mode share reflects that road based public transport has remained the dominant mode of travel despite high car ownership, albeit the overall share of public transport shows a small drop of about 4~6% when compared to MMUTIS 1996 data. This is despite considerably high growth in car ownership over the same period. This further explains that the ma orit of population does not ha e 'real' mode choice as car available person continue to use the car. The dominance of road based public transport is further illustrated in Figure 3.1.2 where person trips by mode (excluding railways) are shown. It can be seen that there is strong demand for both jeepney and bus travel in all corridors, even in the corridors which are served by railways like EDSA and Taft/ Rizal Avenue. There is also high volume of travel in the east-west corridor, especially east of Santolan (beyond Santolan end of LRT Line-2. In the Mega-Manila areas (Outside MM) bus is the most dominant mode both in the south and north corridors out of MM. The role of jeepney is there, but for short distances around major urban centres.

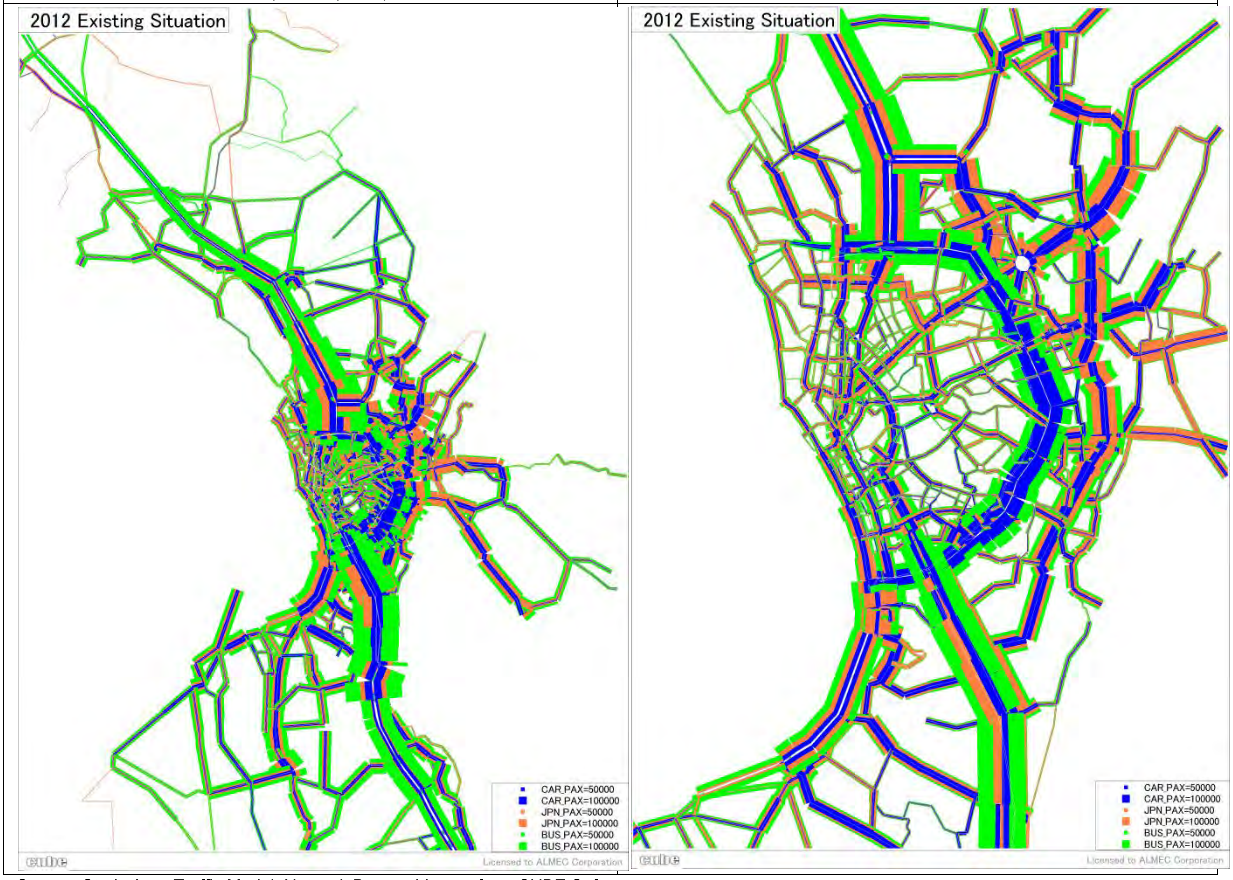
Table 3.1.3 Summary of Road Traffic Volume and Network Performance

Road Description	Pax*km('000)				%Mode Share of Pax*km		
	Car	Jeepney	Bus	Total	Car	Jeepney	Bus
C-1	174	328	145	648	27	51	22
C-2	511	531	387	1,429	36	37	27
C-3	485	1,350	555	2,391	20	56	23
C-4	5,671	-	5,599	11,269	50	-	50
C-5	3,113	3,778	2,357	9,247	34	41	25
R-1	860	1,062	770	2,692	32	39	29
R-2	475	385	374	1,233	38	31	30
R-3	441	607	413	1,461	30	42	28
R-4	220	497	257	975	23	51	26
R-5	296	423	149	868	34	49	17
R-6	610	775	475	1,860	33	42	26
R-7	1,010	1,714	855	3,579	28	48	24
R-8	596	685	590	1,871	32	37	32
R-9	435	480	282	1,196	36	40	24
R-10	201	293	201	696	29	42	29
CAVITEX	848	1,075	1,511	3,434	25	31	44
Skyway	2,436	-	6,378	8,814	28	-	72
SLEX	5,727	4,585	10,373	20,686	28	22	50
NLEX	3,115	2,732	10,691	16,538	19	17	65

Area	Pax*km('000)				%Mode Share of Pax*km		
	Car	Jeepney	Bus	Total	Car	Jeepney	Bus
MM Manila City	3,543	4,596	2,885	11,023	32	42	26
MM North	19,689	24,780	18,062	62,532	31	40	29
MM Center	7,995	6,221	6,976	21,192	38	29	33
MM South	9,496	8,256	9,848	27,600	34	30	36
Sub-Total MM	**40,723**	**43,853**	**37,771**	**122,347**	**33**	**36**	**31**
Bulacan	8,329	8,214	14,980	31,523	26	26	48
Laguna	4,733	3,454	7,753	15,940	30	22	49
Rizal	3,753	5,577	4,034	13,365	28	42	30
Cavite	8,569	10,555	16,932	36,056	24	29	47
Sub-Total Adj. Prov.	**16,815**	**17,245**	**26,768**	**60,828**	**28**	**28**	**44**
Total - Mega Manila	**57,539**	**61,098**	**64,539**	**183,176**	**31**	**33**	**35**

Source: JICA Study Team.

Study Area (GCR)	Metro Manila Area



Source: Study Area Traffic Model, Network Demand Image from CUBE Software

Figure 3.1.2 Travel Demand by Mode –Person Trips by Car, Jeepney and Bus

3.2 Characteristics of Railways in MM

3.10 There are three mass transit urban railway lines in MM, and a commuter mainline railway (PNR) as illustrated in the previous Figure 2.4.2. The key features are:

(i) PNR – a narrow gauge 29 km line from Tutuban to Alabang with 16 stations

(ii) LRT Line-1 18km with 20 stations standard gauge grade-separated mass transit system from Baclaran in the south to Roosevelt on the northern section of EDSA;

(iii) LRT Line-2 16.7 km with 11 stations standard gauge mass transit system from Recto in Manila city to Santolan in the east;

(iv) MRT Line-3 16.5km with 13 stations standard gauge mass transit system along EDSA (C-4) from Taft to North Avenue.

3.11 The three mass transit lines and PNR commuter in MM carried about 1.35 million passengers on an average week-day in 2012 (the PNR carried a small proportion of about 46,000 passengers). The daily demand and line capacity characteristics of each line are summarised in Table 3.2.1. The three mass transit lines combined carry about 10% of the public transport passenger-km of travel within Metro Manila, compared to 48% by jeepney and 42% by buses on about 850km of roads. This is a fairly good performance compared to traffic with just 51.3km of mass transit railways with44 stations (excluding PNR), for a city of over 12 million inhabitants. The PNR system capacity is limited and it is discussed in the next section.

Table 3.2.1 Characteristics of Travel Demand by Railways in MM

Description		PNR[2]	LRT Line-1	LRT Line-2	MRT Line-3	Total Railways
Line Length (km)		28.0	18.1	12.6	16.5	75.2
Stations		16	20	11	13	60
2011 Annual Pax (million)		15.4	156.9	63.8	158.8	394.9
2011 Average Weekday Daily Pax		46,000	476,000	193,000	481,000	1,196,000
2012 Average Weekday Pax[1]		50,000	519,000	212,000	572,000	1,348,000
AM-Peak Hour Boarding Pax/hr		2,000[2]	43,200	18,000	48,100	111,300
Peak Line Volume (Max: Pax/hr/direction=pphpd)		1,000[2]	20,100	11,500	20,300	20,300
Current Operational Headway (mins)		30	3	5	3	-
Current Rolling Stock Crush Capacity (Pax/Train)		~500[2]	1,350	1,600	1,180	-
Current Line Capacity (Pax/hr/direction=pphpd)		1,000[2]	27,100	19,500	23,600	-
Current Load Factor (Line Volume/Capacity)		~100%	74%	59%	86%	-
Maximum Future Capacity[3]: Assuming Extended Trains to Full Platform Length & Modern Connected Car Rolling Stock	Train Length (m)	200	110	110	130	-
	Pax/Train	1,800	1,630	1,630	1,930	-
	Headway	3	2.5	2.5	2.5	-
	Pax/hr/dir=pphpd	36,000	40,000	40,000	46,000	-
Available Capacity @ Current Load and Max-Cap:		97%	50%	71%	56%	-

Source: PNR/ LRTA/ MRT Data &JICA Study Team Analyses.
[1] Lines 1&2 Data is for March 2012, Line-3 Data if for September 2012, and PNR for February 2012.
[2] PNR Data is for Tutuban to Alabang and peak period data is estimated by the study team.
[3] Future Capacities are estimated based on possible capacity expansion program.

3.3 Philippine National Railways (PNR)

3.12 Currently, PNR runs half-hourly service between Tutuban and Alabang. It carries around 40,000 to 50,000 passengers daily. The service is slow, rather erratic as train stop-starts many times. Trains are full to crush-load from Tutuban to Alabang. Passengers at intervening stations some time cannot even get on the train and have to wait 30+ minutes for the next service. h e ser ice could hardl be called a 'commuter' ser ice with half-hour headways and un-predictable travel times. It just acts as a 'social-ser ice' for the poor who need to use the train in that corridor with fairly cheap fare otherwise may have to make a number of jeepney/ bus rides for the same journey.

3.13 All most all intervening stations are open; public can walk from street to train or out without any check/ control. It is not known how many people travel without payment/ ticket. Individual station loadings indicate that 17% of all demand is to/from Alabang. Tutuban and the other four stations (i.e., Blumentritt, Espana, Sta. Mesa and Bicutan) account for majority of the remaining demand. The whole of PNR service needs a major over-haul to be called an efficient commuter service between Tutuban and Alabang. PNR line from labang to Calamba is 'called' as operational, but services are limited to a few trains per day, and no details were available of patronage on this service.

3.4 Metro Manila Urban Mass Transit Lines

3.14 **Line-1** is the oldest of the three mass transit lines. It was built in the mid- 8 ’s. The patronage on the line grew with time, and reached a peak after about a decade to 450,000 passengers per day by 1994. From then on the patronage started to decline due to several operational issues mostly related to rolling stock. This lack of capacity led to decline in patronage to as low as 300,000 passengers per day by 2004/2005. A capacity expansion program was initiated, and the induction of new/ improved rolling stock led to increase in patronage to the current near maximum patronage of around half million passengers per day. The maximum demand is during the morning peak hour in the southbound direction, during which the maximum line volume is over 20,000 passengers per hour per direction (PPHPD). The busiest stations are EDSA in the south and the Monumento in the north where daily boarding and alighting passengers is over 100,000 per day. The line carries 33% of the rail passenger-km in Metro Manila through the most dense corridor of the metropolis.

3.15 Currently, the line is operating at 74% load factor because of rolling stock issues, there are speed restrictions on several sections of the line. The line headways are also affected due to non-availability of rolling stock resulting in unnecessary congestion at stations and in trains – making the system less attractive to passengers. As a result Line-1 is going through its second capacity expansion program to enhance its capacity and image. However, most of the physical infrastructure looks dilapidated. Queues at ticket booths are common, due to many reasons. The integration with Line-2 and Line-3 remain one of the most unattractive way to allow passengers to transfer between lines, further hindering the patronage growth. Most stations have side platforms with a single entry/exit stair case with no escalators. With serious capacity expansion involving the improvement to travel speed, shorter headways by reducing dwell time at stations and state-of-the art modern signalling and other improvements (such as platform screen-doors) could lead almost to doubling its current line capacity to 40,000 PPHPD. Such operational improvements would put more pressure on station infrastructure and facilities which would also need to be enhanced in line with other infrastructure and operational improvements.

3.16 **MRT Line-3** is a circumferential line that carries most rail passengers in MM, some days well in excess of half million passengers. The travel demand on the line accounts for over50% of the total daily rail passenger-km travelled, along one of the busiest transport corridor of MM. It is estimated that Line-3 is operating at near capacity of 85% load factor. The estimation of the load factor as detailed in the above table is calculated using train crush capacity at 8 passengers/m^2. In reality, it is difficult to achieve such loading for every train. Such crush capacity train loading leads to other issues like increased dwell time resulting in delays – in turn reducing system capacity not to mention passenger inconvenience. Currently, it is a well-known fact that patronage on Line-3 is capacity constrained. The travel demand in the corridor far exceeds both the road and rail available capacities. No doubt, enhanced travel time on Line-3 and better passenger handling arrangement and improved station access facilities could bring more patronage, but that would require a serious overhaul of the entire system. With higher capacity rolling stock, better station arrangements and improved accessibility could lead to about 40% increase in peak hour capacity to 46,000 PPHPD, from the current near capacity volume of 24,000PPHPD.

3.17 **LRT Line-2** is a radial line from Santolan in the east to Recto in the heart of Manila City. The Line is a modern mass transit system which opened for revenue service in 2003. The patronage on the line increased rapidly in early years of opening and has now reached over 212,000 passengers per day. Peak line volume analysis revealed that loading on Line-2 is extremely directional compared to Lines 1 and 3, and was estimated to be 11,500 passengers/hr/direction. The service operated at 5 minutes heady, with a load factor of about 60%. This traffic on the line accounts for 16% of the total rail passenger-km of MM, with an average trip length of about 7km. The two terminal stations are busiest, followed by the Cubao station where passengers transfer to Line-3. This passenger interchange facility with Line-3 is the most inconvenient to say the least, involving a walk of well over ¼ km, through a busy shopping area. Similarly the passenger interchange with Line-1 at Recto involves a long walk. However, the station facilities are better than the other two lines. At Santolan, the majority of the patronage is of passengers transferring to LRT from jeepneys, but the interchange facility is poor and inconvenient, involving major road (Marcos Highway) crossing using a pedestrian bridge. The line has major potential and available capacity to increase patronage, but this would require improving multi-modal transfer facilities at Recto, Santolan and Cubao.

3.5 Metro Manila Urban Mass Transit Lines – Capacity Constraints

3.18 Individual line capacity issues are discussed above, and these issues are common to all rail system as outlined next. One major reason for poor rail patronage is the station accessibility. Public footpaths within 1km radius of stations are almost non-existent. In most cases footpaths are occupied by vendors, street furniture, used by shop owners for display of their goods, or by many other activities on the roadside – hindering easy, smooth and convenient walk to/ from the station. h ere are limited or no 'safe' road crossing facilities at stations to access the opposite side, as most stations have side platform and a single side access/ egress arrangements, requiring road crossing at-grade in the street. Similarly, multi-modal interchange facilities between metro lines and with other modes like kiss-n-ride, tricycles, jeepneys, and busses are poor and lack properly designed facilities. These aspects of system improvement need urgent attention, particularly at terminal stations.

3.19 A recent survey for the JICA LRT Lines 1&2 studies showed that less than 5% of all rail passenger walk-in from the origin of their journey and walk-out to their destination. Of the remainder,4~6% of trips are, where car is either the mode of access, or egress, to/ from the rail to destination. These trips are usually at the terminal stations like Santolan/North Avenue, where there are drop-off or park-n-ride facilities available. For the rest of the rail passengers (about 90%+)use other modes of public transport at one or both ends of their rail trip, yet multi-modal interchange facilities are most neglected component of the rail passenger accessibility. In addition, other system integration facilities like common ticketing, fare integration between rail lines and other modes are most desirable features and need urgent attention to relieve the currently overloaded transport infra-structure.

3.6 Traffic Management and Demand Management in Mega Manila

3.20 The current traffic and congestion situation has been explained above in detail. Building new roads to meet the demand is not an easy and only solution. Many cities around the world no longer build or cannot build new roads in dense urban areas. One of the solutions to reduce congestion is to make effective and efficient use of existing road infrastructure through traffic and demand management (TDM). In Metro Manila, considerable effort and resources have been expended to reduce congestion through TDM measures, but results are not so encouraging. Therefore, it is even more important to address the TDM measures to reduce the chronic congestion along some corridors, and improve travel times. Some of the approaches which need immediate attention are outlined next.

(a) **Encroachments: T**he most important reason of reduced road capacity in the inner city areas of MM is the encroachments – not only of the road space but of footpaths. Encroachment of footpath leads to pedestrians walking in the road, causing serious safety issues, and reducing road capacity. Encroachment of road space by adjacent building/ shop owners for parking, and by hawkers/ street vendors is most serious and common cause of loss of road capacity and reduced speed in MM and rest of Mega Manila where ribbon development along the roadside is a common practice. Both fix and transient encroachments should be removed without excuse to release road space for traffic.

(b) **Traffic Signals & Enforcement of Traffic Laws:** There are currently 350 or so signalised intersections in MM. None of these operate in an efficient manner. Reasons are many – long cycle time, no pedestrian phase, right-turn on red without yielding to traffic with priority or to crossing pedestrians, no linkages of signals to get greater throughput. The enforcement of traffic signals sometimes is left to traffic enforcers. On occasions they ignore the traffic signals and manually control traffic, leading to even longer cycle times, longer queues and less efficient use of road space. Right turn on the red signal is inefficient, especially where the turning traffic does not yield take account of the traffic in priority lane. The situation is even worse when the turning traffic ignore the pedestrian phase of traffic signal.

(c) **Non-signalised Intersections:** there are numerous junctions/intersections that would provide better use of road space if signalised. Currently, there is no such program with Metro Manila Development Authority (MMDA) or any other agency to improve traffic condition through improved and wider area traffic signalisation. This is now necessary and efficient intersection operation cannot be left to the whim of traffic enforcers. Non obedience of pedestrian crossing at Zebra crossing or at non-signalised crossings leads to congestion as pedestrian are forced to cross anywhere and to wait in the middle of the road for crossing both side of traffic thus causing unsafe situation and traffic congestion. Installation of pedestrian refuges could help ease traffic congestion.

(d) **Traffic Channelization and Lane Discipline:** Lane hoping is common in Manila traffic, and lane discipline is non-existent. This is particularly true of buses along EDSA, and at times is the main cause of congestion. Physically segregated traffic lanes like service road and main carriageway for through traffic would reduce congestion and instil lane discipline. Physically segregated bus/Jeepney lanes are now essential for efficient use of road space, as the enforcement of bus lanes, with lane markings are not obeyed by drivers of buses/jeepneys and also by the private car drivers alike.

(e) **Pedestrian Facilities:** Good and adequate pedestrian facilities are essential – both for pedestrian safety and to reduce traffic congestion. Inadequate pedestrian side-walk leads to forcing pedestrians into road space causing traffic congestion. This situation is common near bus stops, multi-modal interchanges, and mega-malls. For example, along EDSA pedestrians are almost caged in less than 1m wide footpath, but they still escape at the end of the fences causing major problem for traffic. In addition, a re-think of bus/jeepney stops is essential. Passengers must be dropped off on sidewalks, from where they can easily walk to their destination. However, it is common that passengers are dropped-off in the middle of the road leaving them in unsafe situation and to cross the road causing delays to other vehicles. Such practice is even common at major bus stops like Ayala bus terminal in Makati. Therefore, safe and adequate pedestrian facilities are essential to improve road capacity and reduce congestion.

(f) **Bus/Jeepney/Taxi Stops:** Jeepneys and taxis do not really have any marked stops or lay-over space as terminals. This leads to stray vehicles all over the road space and lead to congestion. Taxis continue to drive around looking for passengers causing unnecessary congestion. Clearly marked jeepney and taxi stops could alleviate some congestion. Bus stops are provided but stopping of buses only at the bus stops is not effectively enforced. In some cases where bus stops are provided, but are without sufficient entry/exit slopes required for the buses to park parallel to the kerbside for convenient passenger boarding/ alighting. This leads to buses over-hanging in the road space outside the bus stop area causing congestion.

(g) **Goods Loading & Unloading:** This goes on at all times without any check along all major roads, with few exceptions. This could be restricted by provision of proper locations for loading/ unloading bays or through time restrictions. Current practices often lead to road space being restricted for through traffic, while loading/ unloading takes place.

(h) **Parking Facilities and Control:** In most major cities around the world parking is a major issue and kerbside parking takes away the scarce/ limited road space. In MM, particularly in inner city areas free kerbside parking is common. In contrast, in some cities of MM (e.g., Makati) and in specific developments parking is well organised and illegal parking is effectively controlled. Sadly, the Makati example is not followed elsewhere in MM and almost not at all in outer urban areas of Mega Manila, leading to loss road space and congestion. An efficient parking control of illegal parking and price controlled parking is essential for efficient traffic circulation and to assists in reduction of traffic congestion.

(i) **Traffic Demand Management:** Transport/ traffic demand management (TDM) measures are used to reduce traffic through road pricing, on the principle 'user pa s' or through other traffic control measures to reduce congestion. Singapore has effectively used road pricing for decades and now many western cities, like London have followed. Road pricing is the best form of congestion reduction, as it not only reduces congestion, but generates revenue that could be used to provide transport infrastructure, and / or to improve public transport. In MM, restrictions are placed on the use of private cars during weekdays, overextended peak periods. The system works by not allowing cars with licence number plates ending with 1 and 2 to be banned on Mondays, those ending with 3 and 4 banned on Tuesday and so on. Initially the scheme had some success in suppressing traffic by about 18% (not by 1/5), but now the scheme has run its useful life, and does not seem to be effective any longer.

3.21 The traffic demand analysis showed that currently major areas and most roads in MM are heavily congested throughout the day. It is costing the nation enormously both in terms of lost time, fuel costs, and unnecessary environmental degradation, not to mention the social costs where urban poor have to travel for long time to / from work, leaving them less time for leisure and family. It is therefore essential to reduce congestion by all means available including TDM. TDM may be invoked to reduce congestion and improve effective use of road space in forms other than to restrict travel, – through measures such as: high occupancy lanes, car-pooling/ road pricing/ parking restrictions through land-use control, / high car ownership taxes/ fuel taxation are a few to mention. But the most efficient of all would be to increase the use of public transport which is efficient and attractive and public must feel that it is a real alternative to car. This would lead to decongestion.

4 CHARACTERISTICS OF FUTURE TRAVEL DEMAND

4.1 Introduction

4.1. The travel demand forecast methodology has been outlined above in Section 4.2. A number of socio-economic development scenarios have been considered for the Mega Manila area, and are described elsewhere in this report. This section describes the travel demand forecast based on the ‘ rend’ scenario – as this scenario is considered to be the most realistic, and in any case the aggregate demand level is quite similar to other socio-economic scenarios.

4.2 Trend’ scenario Based 2030 Travel demand Forecast

4.2. h e tra el demand was estimated b using the ‘ ra tar’ growth factoring techni u e using the traffic zone level growth in population as the growth factor between the base year (2012) and the forecast years of 2020 and 2030. This process yielded O/D trip matrices by private (car) and public modes (Jeepney & Bus) and truck trips. The forecast Trips are summarised in Table 4.2.1 by mode of travel.

Table 4.2.1 Growth in Travel Demand by Mode of Travel (Inter-zonal Trips ‘000)

Description	2012	2020	2030	‘30/‘12
Private Person Trips	6,170	6,863	7,491	1.214
Person Trips by Public Modes	13,301	14,650	15,945	1.199
Total Person Trips	19,471	21,513	23,436	1.204
Truck Trips (vehicles)	440	478	513	1.166

Source: JICA Study Team Estimate.

4.3. It is estimated that the total travel demand in the Study area (GCR) would grow by about 20% by 2030, varying level growth within the study area, while the population growth is forecast to be by about 27% over the same period (from 2012 to 2030). For simplicity, the mode share at this stage of the forecast process was set to be same as in the base year. However, the mode-share between jeepney/ bus and rail is modelled at the assignment stage of the of the demand forecast process. The growth in travel demand by aggregated areas are detailed in Table 4.2.2, and illustrated in Figure 4.2.1.

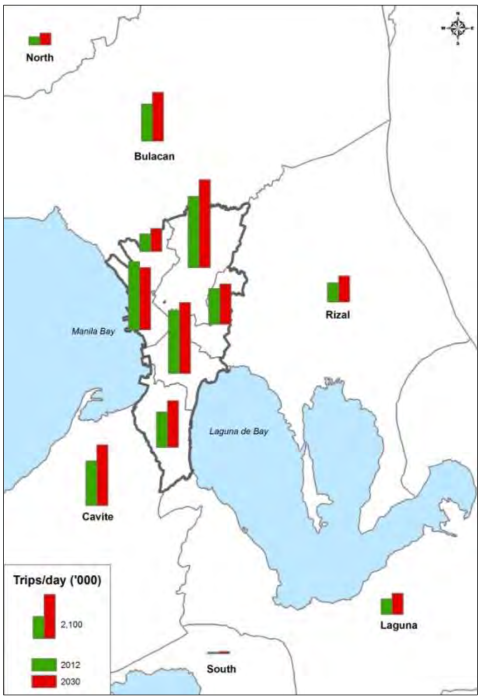
4.4. The above analysis shows that the highest growth areas are the adjoining provinces of MM, averaging about 35% growth over the next 18 years at around 1.67% per annum. The travel demand to/from Manila City is expected to decline as it decentralizes and population moves to other areas and regions. The overall forecast growth in travel in MM is around 13.8% at a rate of about 0.7% per annum.

4.5. h e ‘ rat ar’ trip distribution model tend to produce forecast the same tra el pattern as the base year. However due to different regional growth rates, the average trip length (km) is estimated to increase slightly by about 6% for of the private trips and 5% for public modes to 18.6km and 20.1km respectively by 2030. The trip length distribution of trips for 2012 and 2030 are illustrated below in Figure 4.2.2. It should be noted that the trip length data presented here exclude intra-zonal trips, inclusion of which would show somewhat lower average trip length as intra-zonal trips are of short distance within a traffic zone.

Table 4.2.2 Summary of Growth in Travel (Trip-ends) by Region

City/ Areas/ Province/ Region	2012 Trips ('000)			2030 Trips ('000)			2030/ 2012
	Private	Public	Total	Private	Public	Total	Total
Manila City	835	2,353	3,188	761	2,150	2,912	0.913
MM SE	1,065	1,886	2,950	1,215	2,103	3,319	1.125
MM South	661	983	1,644	868	1,312	2,180	1.326
MM NE	478	1,194	1,671	539	1,345	1,883	1.127
MM North	998	2,329	3,327	1,229	2,885	4,114	1.236
MM NW	229	597	826	298	775	1,073	1.299
Sub-Total MM	**4,265**	**9,342**	**13,606**	**4,910**	**10,571**	**15,481**	**1.138**
Bulacan	605	1,134	1,739	796	1,491	2,287	1.315
Laguna	265	460	725	358	627	985	1.358
Rizal	333	547	880	450	757	1,207	1.373
Cavite	543	1,534	2,078	732	2,093	2,826	1.360
Sub-Total Mega Manila (Excluding MM)	**1,747**	**3,675**	**5,422**	**2,336**	**4,969**	**7,305**	**1.347**
Sub-Total Rest of GCR Regions	**158**	**285**	**442**	**245**	**406**	**651**	**1.471**
Total GCR	**6,170**	**13,301**	**19,471**	**7,491**	**15,945**	**23,437**	**1.204**

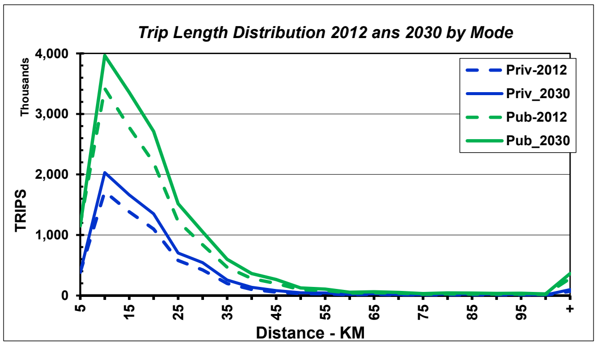
Source: JICA Study Team Estimate.



Source: JICA Study Team Estimate.

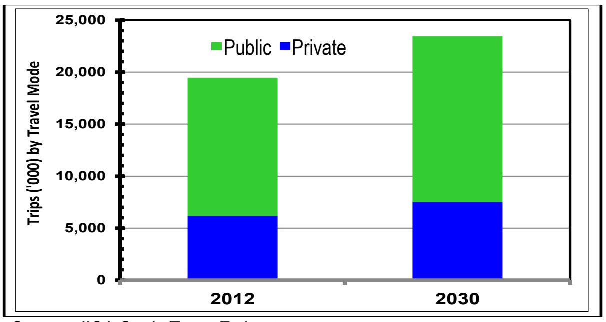
Figure 4.2.1 Travel Demand Comparison by Region for 2012 and 2030

4.6. The number of private and public trips modelled by mode are summarised above, and compared in Figure 4.2.3. Overall mode share is similar to 2012 and is not expected to change (between private & public). Since MMUTIS study the mode share of public transport has declined from around 74% in 1996 to 68% in 2012. It is anticipated that the mode share in the future may not decline in the same way in future, as the car ownership is unlikely to grow at the same rate as it did over the past 15 years. In any case it would be a good practice to sustain the relatively high share of public transport mode rather than to lose it further, as many Asian cities are striving for such high public mode share through massive investment in both road and rail based public transport infrastructure. However, it is intended to carr out 'what-if' sensiti it tests to assess the impact if the mode share does change from the assumed 68%. Such sensitivity test would be carried out at the individual project assessment stage to estimate the impact of changes in mode shift on the project viability and performance.



Source: JICA Study Team Estimate.

Figure 4.2.2 Trip Length Distribution of 2012 and 2030 Private and Public Trips



Source: JICA Study Team Estimate.

Figure 4.2.3 Mode Share 2012 and 2030 Private and Public Trips

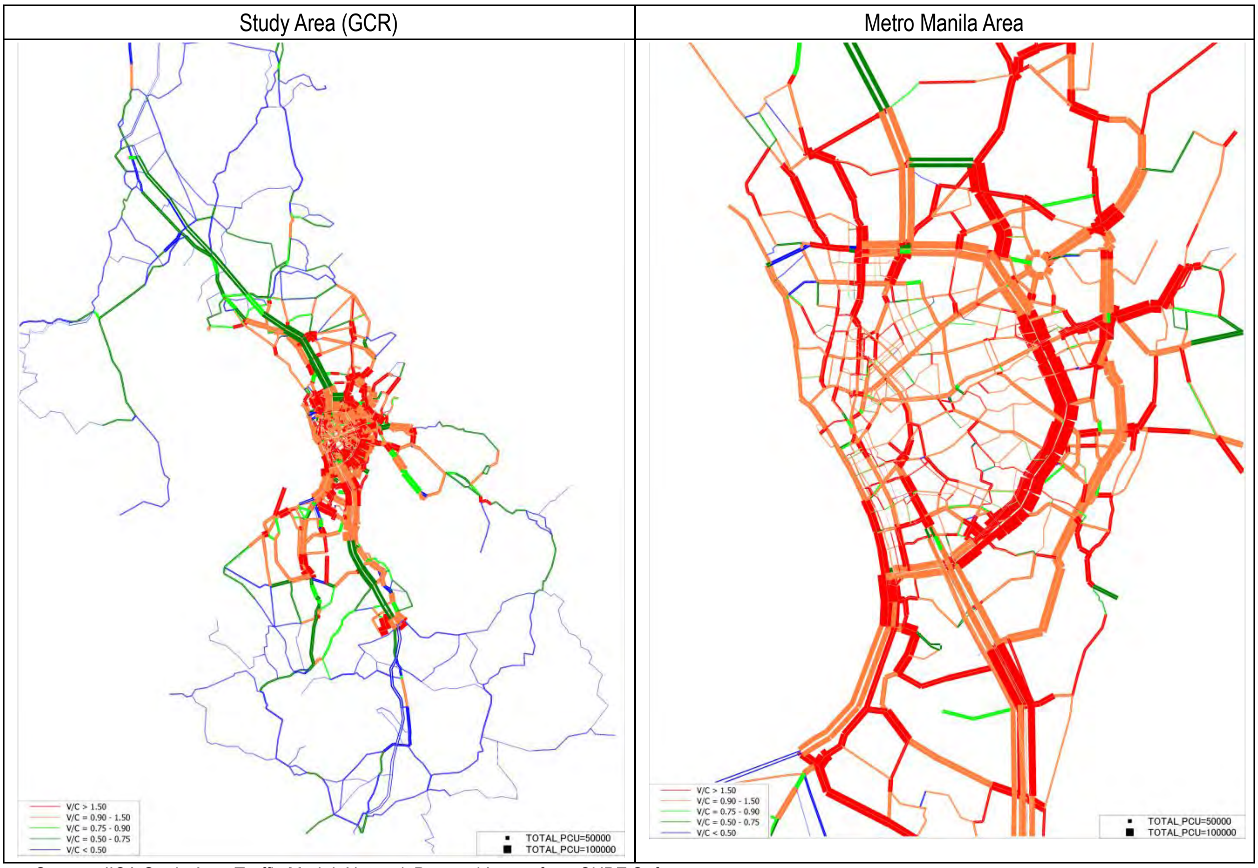
4.3 Impact of 2030 Forecasts Travel Demand – Do-nothing Scenario

4.7. To assess the impact of 2030 travel demand on the current transport infrastructure private and public (O/D) matrices were assigned to the 2012 network. The 2030 assignment model parameters are summarised in Table 4.3.1 for road and rail modes, other calibrated parameter values and vehicle occupancy, PCU factors were retained as for the 2012 model assignment and have been detailed in Tables 4.3.2 and 4.3.3. It is understood that transport infrastructure will be improved/ built between now and 2030, but to realise its impact on the current network this approach of assigning the 2030 O/D table to the 2012 network was adopted. The resultant state of the current network is illustrated in Figure 4.3.1, and summarised in Table 4.3.4.

Table 4.3.1 Assignment Model Parameters 2030

Parameter Description– Roads	Car	Jeepney	Bus	Truck
Value of Time (PHP/min)	4.43	3.10	3.10	n/a
Vehicle Operating Cost (PHP/km)	17.40	n/a	n/a	n/a
Toll Rate Within MM (PHP/km)	24.50	24.53	49.07	73.59
Toll Rate Outside MM (PHP/km)	8.10	8.10	16.20	24.30
Public Transport Fare (PHP/km)	n/a	4.76	4.10	n/a
Parameter Description– Railways	LRT-1	LRT-2	MRT-3	PNR
Average Peak Hour Headway (mins)	3.0	5..0	2.5	30.0
Average Speed (km/h)	26.0	29.6	29.5	26.1
Boarding Fare (PHP/boarding)	28.6	28.6	23.8	23.8
Additional Fare (Boarding + PHP/km)	1.07	0.43	0.67	0.71

Source: JICA Study Team.



Source: JICA Study Area Traffic Model, Network Demand Image from CUBE Software.

Figure 4.3.1 2030 Travel Demand Impact on 2012 (Do-Nothing) Network

4.8. It can be seen that in MM almost all the network operates at V/C ratio in excess of 1.5, as the PCU-km on the network increased by 17% with much increase in travel time, causing PCU-hours to increase by about 30%. As result of increased congestion the total travel cost in MM would increase by more than 2.57 times, with vehicle operating cost going up by more than threefold for 17% increase in trips. The key road sections of circumferential and radial roads would be most affected, as shown in the following table. Almost 90% of all radial roads (R1-R10) would be operating at below 10kph, compared to about 80% in 2012, and all will be below 20kph by 2030 under the do-nothing situation. The circumferential roads would not perform much better as V/C ratio increases from 1.2 to 1.4, speed on 67% of the circumferential road sections would drop to below 10kph, compared with 52% in 2012. The rail passenger trips would go up by 20%, slightly higher than the growth in demand due to increased congestion.

Table 4.3.2 Comparison of 2030 Do-Nothing and 2012 Assignments – Metro Manila

Indicator Description		2012	2030 Do-Nothing	'30/12
Travel Demand Person Trip Generations (million)		12.8	14.5	1.13
Number of Rail Passengers		1.45	1.70	1.20
Volume Capacity (V/C) Ratio		1.25	1.47	1.18
Circumferential Roads (C1-C5=84km) % km <10kph		52%	67%	1.28
Circumferential Roads (C1-C5=84km) % km <20kph		83%	91%	1.09
Radial Roads (R1-R10=77km) % km <10kph		80%	89%	1.12
Radial Roads (R1-R10=77km) % km <20kph		98%	99%	1.01
All Roads (MM = 796km) % km <10kph		61%	71%	1.15
All Roads (MM = 796km) % km <20kph		81%	90%	1.10
Person-km ('000)	Car	40,723	47,836	1.17
	Public (Road)	81,624	95,032	1.16
	Rail	9,616	10,047	1.04
	Total	131,963	152,915	1.16
Person-Hours ('000)	Car	5,124	6,537	1.28
	Public (Road)	9,548	12,386	1.30
	Rail	341	356	1.05
	Total	15,013	19,279	1.28
PCU-KM ('000)	Car	30,560	35,791	1.17
	Public (Road)	8,706	10,247	1.18
	Total	39,266	46,038	1.17
PCU-Hrs('000)	Car	3,834	4,974	1.30
	Public (Road)	1,071	1,394	1.30
	Total	4,905	6,368	1.30
Travel Cost (PHP million/day)	VOC	1,016	3,261	3.21
	Time	1,345	2,819	2.10
	Total	2,361	6,079	2.57
Total Cost (USD) million/ annum	All Modes	21,548	55,474	2.57
Total Revenue (USD) million/ annum	Rail	167	456	2.73
	Bus/ Jeepney	1,393	3,889	2.79
	Expressway	634	1,579	2.49
	Total	2,194	5,924	2.70

Source: JICA Study Team.
Note: Annualisation Factor Used=365, and USD1.00=PHP40.00

4.9. In the provinces adjoining MM (i.e. Mega Manila less MM) the impact would be even more severe as the number trip would increase by about 33% from 2012 to 2030. This would increase the partially congested network at overall V/C ratio 0.53 to close to level of service C or worst to V/C ratio of 0.72. Total travel cost of the network would increase by about 3.5 times whereas operating cost would increase by almost four fold. The results for Mega Manila (excluding MM) are summarised in Table 4.3.3. Table 4.3.4 gives the results for whole for Mega Manila, whereas outer region results are presented in Table 4.3.5 and study area total results are compiled in Table 4.3.6.

4.10. The transport infrastructure in the study area (GCR) as whole would need comprehensive upgrade and new roads and railways to sustain the anticipated growth in travel demand, otherwise the city would grind to halt within the next few years. This would have dire impact on the economic growth of the Greater Capital Region the economic engine of the Philippines, with tremendous degradation of quality of life, which is already barely acceptable by poor masses. What needs to be done is presented in the following section.

Table 4.3.3 Comparison of 2012 and 2030 Traffic Impacts of Do-Nothing, in Mega Manila (Excluding MM)

Indicator Description		2012	2030 Do-Nothing	'30/12
Travel Demand Person Trip Generations (million)		6.0	8.0	1.33
Volume Capacity (V/C) Ratio		0.53	0.72	1.35
Roads (Total=1,478km) % km <10kph		11%	22%	2.09
Roads (Total=1,478km) % km <20kph		22%	33%	1.48
Person-km ('000)	Car	25,384	35,035	1.38
	Public (Road)	71,500	94,458	1.32
	Rail	-	-	-
	Total	96,884	129,493	1.34
Person-Hours ('000)	Car	1,843	3,360	1.82
	Public (Road)	4,169	7,656	1.84
	Rail	-	-	-
	Total	6,012	11,016	1.83
PCU-KM ('000)	Car	21,118	28,777	1.36
	Public (Road)	6,639	8,781	1.32
	Total	27,757	37,557	1.35
PCU-Hrs('000)	Car	1,403	2,602	1.86
	Public (Road)	401	735	1.83
	Total	1,804	3,337	1.85
Travel Cost (PHP million/day)	VOC	462	1,887	4.08
	Time	532	1,590	2.99
	Total	994	3,477	3.50
Total Cost (USD) million/ annum	All Modes	9,069	31,725	3.50
Total Revenue (USD) million/ annum	Rail	-	-	-
	Bus/ Jeepney	1,193	3,769	3.16
	Expressway	104	351	3.37
	Total	1,297	4,120	3.18

Source: JICA Study Team.
Note: Annualisation Factor Used=365, and USD1.00=PHP40.00

Table 4.3.4 Comparison of 2012 and 2030 Traffic Impacts Do-Nothing, Mega Manila

Indicator Description		2012	2030 Do-Nothing	'30/12
Travel Demand Person Trip Generations (million)		18.8	22.5	1.20
Volume Capacity (V/C) Ratio		0.80	1.00	1.25
Roads (Total=2,284km) % km <10kph		28%	39%	1.38
Roads (Total=2,284km) % km <20kph		43%	53%	1.23
Person-km ('000)	Car	66,107	82,871	1.25
	Public (Road)	153,124	189,490	1.24
	Rail	9,616	10,047	1.04
	Total	228,847	282,408	1.23
Person-Hours ('000)	Car	6,967	9,897	1.42
	Public (Road)	13,717	20,042	1.46
	Rail	341	356	1.05
	Total	21,024	30,295	1.44
PCU-KM ('000)	Car	51,679	64,568	1.25
	Public (Road)	15,345	19,028	1.24
	Total	67,024	83,596	1.25
PCU-Hrs('000)	Car	5,237	7,576	1.45
	Public (Road)	1,472	2,129	1.45
	Total	6,709	9,706	1.45
Travel Cost (PHP million/day)	VOC	1,478	5,148	3.48
	Time	1,877	4,408	2.35
	Total	3,355	9,556	2.85
Total Cost (USD) million/ annum	All Modes	30,616	87,199	2.85
Total Revenue (USD) million/ annum	Rail	167	456	2.73
	Bus/ Jeepney	2,586	7,658	2.96
	Expressway	738	1,930	2.61
	Total	3,492	10,044	2.88

Source: JICA Study Team
Note: Annualisation Factor Used=365, and USD1.00=PHP40.00

Table 4.3.5 Comparison of 2012 and 2030 Traffic Impacts of Do-Nothing, in Rest of Regions III and IV-A

Indicator Description		2012	2030 Do-Nothing	'30/12
Travel Demand Person Trip Generations (million)		0.60	0.9	1.50
Volume Capacity (V/C) Ratio		0.14	.21	1.46
Roads (Total=3,241km) % km <10kph		0%	0%	-
Roads (Total=3,241km) % km <20kph		0%	1%	-
Person-km ('000)	Car	10,903	17,322	1.59
	Public (Road)	34,874	48,811	1.40
	Rail	-	-	-
	Total	45,777	66,134	1.44
Person-Hours ('000)	Car	198	342	1.73
	Public (Road)	615	914	1.49
	Rail	-	-	-
	Total	812	1,256	1.55
PCU-KM ('000)	Car	11,203	16,458	1.47
	Public (Road)	2,971	4,200	1.41
	Total	14,174	20,658	1.46
PCU-Hrs('000)	Car	211	341	1.61
	Public (Road)	55	84	1.54
	Total	265	424	1.60
Travel Cost (PHP million/day)	VOC	150	534	3.57
	Time	70	179	2.55
	Total	220	713	3.24
Total Cost (USD) million/ annum	All Modes	2,006	6,508	3.24
Total Revenue (USD) million/ annum	Rail	-	-	-
	Bus/ Jeepney	575	1,925	3.35
	Expressway	33	191	5.73
	Total	608	2,116	3.48

Source: JICA Study Team.
Note: Annualisation Factor Used=365, and USD1.00=PHP40.00

Table 4.3.6 Comparison of 2012 and 2030 Traffic Impacts of Do-Nothing, in GCR

Indicator Description		2012	2030 Do-Nothing	'30/12
Travel Demand Person Trip Generations (million)		19.5	23.4	1.20
Volume Capacity (V/C) Ratio		0.44	0.57	1.28
Roads (Total=5,525km) % km <10kph		12%	16%	1.38
Roads (Total=5,525km) % km <20kph		18%	22%	1.25
Person-km ('000)	Car	77,010	100,193	1.30
	Public (Road)	187,998	238,301	1.27
	Rail	9,616	10,047	1.04
	Total	274,624	348,542	1.27
Person-Hours ('000)	Car	7,164	10,239	1.43
	Public (Road)	14,331	20,956	1.46
	Rail	341	356	1.05
	Total	21,836	31,551	1.44
PCU-KM ('000)	Car	62,882	81,026	1.29
	Public (Road)	18,316	23,228	1.27
	Total	81,198	104,254	1.28
PCU-Hrs('000)	Car	5,448	7,917	1.45
	Public (Road)	1,526	2,213	1.45
	Total	6,974	10,130	1.45
Travel Cost (PHP million/day)	VOC	1,628	5,682	3.49
	Time	1,947	4,587	2.36
	Total	3,575	10,269	2.87
Total Cost (USD) million/ annum	All Modes	32,622	93,707	2.87
Total Revenue (USD) million/ annum	Rail	167	456	2.73
	Bus/ Jeepney	3,161	9,583	3.03
	Expressway	772	2,121	2.75
	Total	4,100	12,160	2.97

Source: JICA Study Team.
Note: Annualisation Factor Used=365, and USD1.00=PHP40.00

5 ASSESSMENT OF PROPOSED RAIL/ ROAD NETWORK

5.1 Development of 2030 'Do-maximum' Highway/ Rail Networks

5.1 The impact of forecast 2030 travel demand on the existing transport network, as discussed in the previous section shows that the entire road and rail network would need drastic level of upgrade. This involved improving existing roads/ expressways and Railways to provide additional capacity. Initial comparison of demand/ supply revealed that adding capacities by upgrade existing facilities alone would not be sufficient – new roads/ expressways and railways would be required to meet the 2030 demand for the sustained development of the GCR region. The proposed, a hierarchical roads/ expressway and an integrated rail network was developed through in iterative process, whereby at the end the final network provides a congestion free environment in the Mega-Manila area with relief to most road users and retains high share of public transport.

5.2 The proposed rail network 'do-ma imum' consists of north/south commuter heavy rail line as the backbone of the north-south corridor public transport demand corridor. The demand within Metro Manila is supported by numerous primary LRT/MRT lines supplemented by secondary rail (e.g. monorail, AGT, etc.) network acting as feeders to the primary lines. Parallel with the rail network, the proposed highway network provides high capacity high speed network of urban and inter-urban expressways supplemented by provision of primary and secondary roads. In the development of highway network full consideration was given to the improved use of existing infrastructure through upgrading the existing roads and where necessary new road sections are proposed.

5.3 The proposed 'do-ma i mum' networ full ta es account of the transport projects being undertaken by various government agencies in the GCR – these projects are:

(i) On-going transport projects due for completion in the near future,

(ii) Committed transport projects at various stages of implementation; and

(iii) Proposed transport projects at various stages of study/ approval etc.

5.4 Initial assessment of the impact of all above (on-going, committed and proposed) Government projects revealed that these projects alone would not be sufficient at all to relieve congestion, and congestion would remain prevalent and sever in most of MM areas, particularly along the major north/south axis in the mega-manila area. As a result additional transport infrastructure pro ects were de eloped under the guidelines of the 'transport de elopment strateg ' described elsewhere in this report.

5.5 Other infrastructure projects such as intersection improvement through construction of multi-level flyovers, better traffic management through improved/ modern traffic signal arrangements or soft projects like introduction of integrated fare system or institutional reforms etc. have also been studied, their impact taken into account and reported elsewhere in this report. The following sections report on the operational performance of the proposed transport infrastructure 'do-ma i mum' case in . The 2030 'do-ma i mum' networ would need se eral ears to implement. h e implementation schedule was prepared based on growth in transport demand, available budget, and giving priority to Government on-going, committed and proposed projects. In view of the staged implementation assessment of transport network performance were made for the intermediate years of 2016 and 2020.

5.2 Highway Network

5.6 The proposed road network includes urban and inter-urban expressways, primary and secondary arterial roads in Mega-Manila area and primary (national) roads in the rest of the Regions III and IV-A. The existing expressways are proposed to be upgraded (widened), and new ones are proposed to form a network of integrated expressways from north to south in the GCR. The expressway network is supported by both new and upgraded primary and secondary roads in the entire GCR to provide seamless connectivity between major GCR regional, sub-regional centres and cities. The proposed highway network is illustrated in Figure 5.2.1 and key features are summarised in Table 5.2.1. Report Volume Roadmap Projects Profile provides a detailed list of all projects included in 2030 Do-maximum plan.

Table 5.2.1 Key Characteristics of Do-maximum Highway Network - 2030

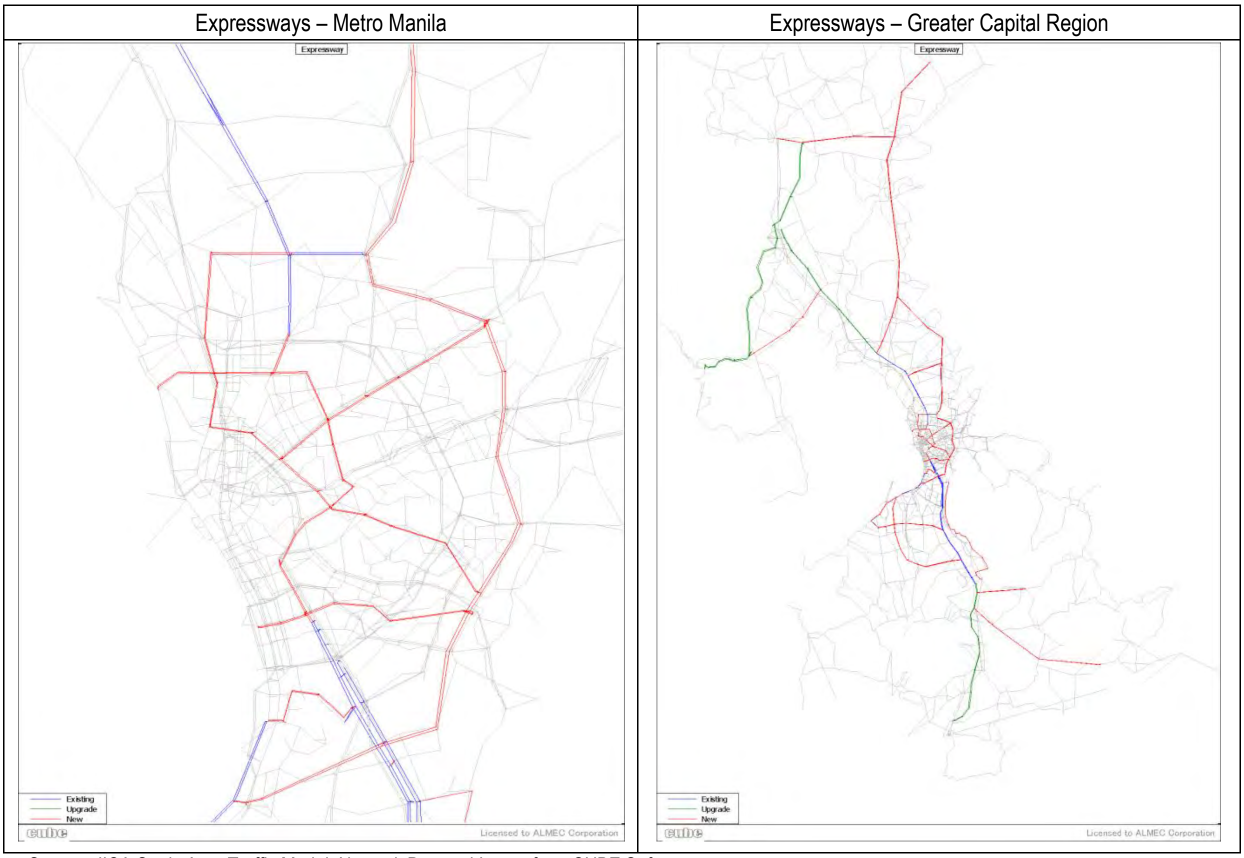
Road Type and Area		Length (km)		
		Metro Manila	Rest of GCR	Total
Expressways	Existing No Upgrade	54	47	101
	Existing – Upgrade	0	197	197
	Sub-Total Existing	54	244	298
	New - Expressways	119	386	505
	Total Expressways	173	630	803
Primary & Secondary Roads	Existing No Upgrade	577	4,102	4,679
	Existing – Upgrade	165	383	548
	Sub-Total Existing	742	4485	5227
	New – Roads	43	94	137
	Total Primary & Sec. Roads	785	4,579	5,364
Highway Network Expressways & Roads	Existing No Upgrade	631	4,149	4,780
	Existing – Upgrade	165	580	745
	Sub-Total Existing	796	4729	5525
	New - Proposed	162	480	642
	Total X-way & Roads	958	5,209	6,167

Source: JICA Study Team.

5.7 The proposed network requires more than 170% increase in the current expressway network both in MM and in the rest of the GCR study area region to ensure reasonable level of service on the expressway system. The proposed network of expressways is shown in Figure 5.2.1 for MM and whole of GCR. The Do-maximum scenario would extend the current network of 300km to over 800 km, which will provide high standard expressway from Batangas to San Jose (Nova Ecija) on the east side of GCR, and from Cavite to Tarlac on the west of GCR, thus providing two high standard north/south roads both passing through MM, with numerous east-west links between the two expressways. The proposed expressway would strengthen the north-south corridor with a completely new expressway from CAVITEX in the west over the existing C-5 circumferential road to San Jose del Monte in Bulacan, and north to Cabanatuan, and up to San Jose in Nova Ecija.

5.8 It is also proposed to make the best use of existing available Right of Way (ROW) of the existing expressways through widening (adding additional lanes) from the current single two lane (Part of Star & SCTEX) or dual 2 lane (NLEX & other) to dual 3 lanes (i.e. divided six lanes).Similarly it is proposed to improve SLEX/ Star to dual 3 lane standard wherever the existing expressways are dual 2lanes. In the south east it is also proposed to extend SLEX to Lucena City. In the north-west it is proposed to provide an expressway between

San Fernando (Pampanga) and Subic port – this providing a much shorter expressway route between Subic and Metro Manila.



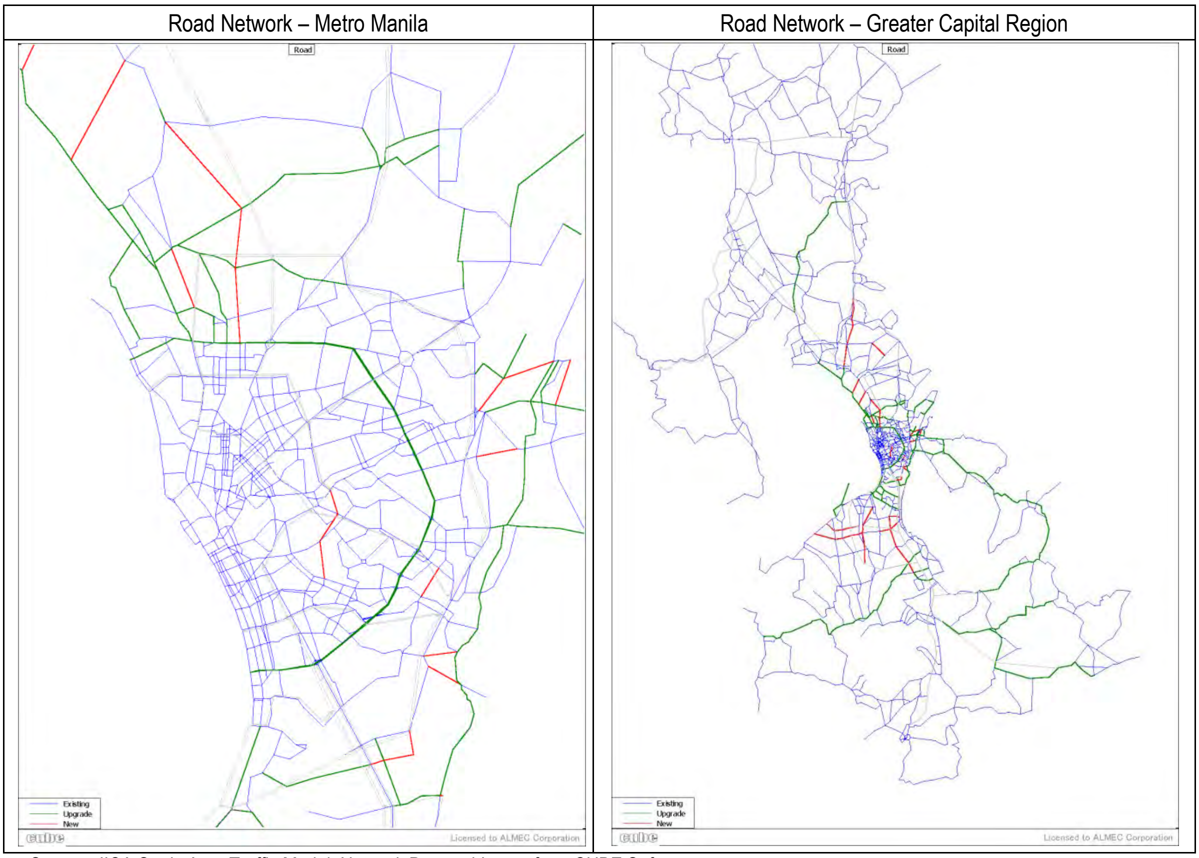
Source: JICA Study Area Traffic Model, Network Demand Image from CUBE Software.

Figure 5.2.1 2030 Do-maximum Highway Network Expressways

5.9 Under the do-maximum the expressway network in MM would increase by almost threefold from the current 54 km to 173 km. Within MM the committed expressways (SLEX-NLEX connector, Skyway stage 3, NAIA expressway) would provide adequate capacity in major north/south corridor. The radial corridor specially R-4 & R-7 corridors would need additional capacity and need to have elevated expressways. In addition extension of skyway-3 to the north harbour, and NAIA Phase-II would enhance the expressway connectivity to the key traffic nodes in MM.

5.10 Parallel with the (toll) expressway network, the local area primary/ secondary road network has also been enhanced mostly through capacity expansion and where necessary through new roads both in MM urban areas and in the GCR provinces. The road network enhancement is summarised above in Table 5.2.1. The new roads proposed would increase the network in much needed areas by about 140km, including completion/ construction of several missing links in MM, thus increasing the road network by 6% in MM.

5.11 Greater emphasis is placed increasing capacity of the existing network through traffic & demand management measures. However, in some areas such as Marikina, Navotas and Malabon would require road widening from current single carriageway to at least dual carriageway of two lanes on each side. The provision of divided carriageway enhances the road capacity considerably, particularly on primary routes. About 550 km of road network has been identified for capacity expansion, almost one third of the 548km is in MM, and rest of the upgrade of roads is mostly in the surrounding provinces.

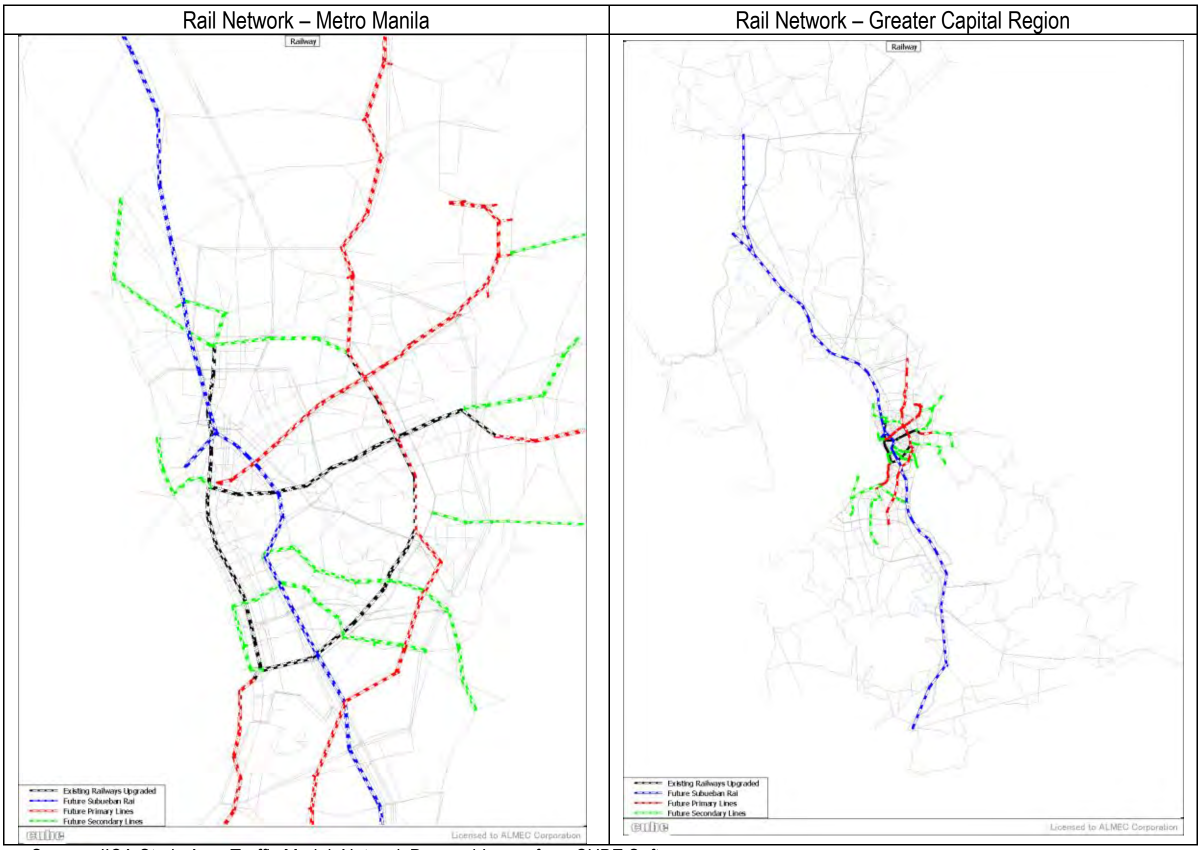


Source: JICA Study Area Traffic Model, Network Demand Image from CUBE Software.

Figure 5.2.2 2030 Do-maximum – Road Network Existing, Upgrades & New Roads

5.3 Railway Network

5.12 Based on the north/ south corridor development strategy, it is proposed to provide two major north-south rail systems. The western N/S corridor is based on the philosophy to make best and most effective use of the existing PNR ROW and provide a high capacity modern suburban railway. On the east side of the N/S corridor it is proposed to provide a high capacity mass transit system from Cavite to Bulacan, through the densest part of MM along the busiest transport corridor of MM. The proposed railway network is illustrated in Figure 5.3.1 and key features are summarised in Table 5.3.1. Annex B provides a detailed list of all proposed rail lines included in 2030 Do-maximum plan.



Source: JICA Study Area Traffic Model, Network Demand Image from CUBE Software.

Figure 5.3.1 2030 Do-maximum – Rail Network Current and New Lines

5.13 The north/south corridor lines are supported by primary network lines of LRT/MRT lines within MM, supplemented by five secondary lines acting as feeder lines. It is also proposed that the existing three lines should go through major overhaul and capacity expansion programme so that full extent of the infrastructure is utilised. The above table illustrates these features. The current rail network (excluding PNR which carries minimal passengers) would increase by almost 10 fold from the current 47km to 494km with 285 stations by 2030.

5.14 It should be noted that the future line lengths are approximate and station numbers are also an estimate based on possible location accessibility and station spacing. Exact line lengths and number of stations may be revised/ determined/ confirmed at the feasibility study stage of each line. The above network fully supports the current GoP committed/approved rail lines and the JICA study team proposals further enhances the performance of the GoP proposed lines. It can be seen, that the proposed hierarchical rail network (refer Figure 5.3.1) is a well-integrated rail system with higher density of stations inside and along EDSA, and all secondary lines on the outskirts acting as local transit railways as well as feeder to the primary lines.

Table 5.3.1 2030 Do-maximum Proposed Railway Network – Key Characteristics

Code	Project	Section/ Description	Line Characteristics	
			Length (km)	Stations (Approx.)
LRT-1	**LRT-1 Existing Capex**	**Baclaran - Monumento**	**18.1**	**20**
LRT-1-1	LRT-1 South Ext. - Ph-I	Baclaran - Niyog	11.8	8
LRT-1-2	LRT-1 South Ext. - Ph-II	Niyog - Dasmarinas	18.4	13
LRT-1-3	LRT-1 North Ext.	Monumento - Malabon	2.7	2
LRT-1	**Sub**	**Total**	**51.0**	**43**
LRT-2	**LRT-2 Existing Capex**	**Recto-Santolan**	**12.6**	**11**
LRT-2-1	LRT-2 East Ext. Ph-I	Santolan - Masinag	4.2	2
LRT-2-2	LRT-2 East Ext. Ph-II	Masinag - Antipolo (U-Ground)	3.0	1
LRT-2-2	LRT-2 East Ext. Ph-II	Masinag - Antipolo	6.0	5
LRT-2-3	LRT-2 West Ext.	Recto - MM North Harbour	4.7	3
LRT-2	**Sub**	**Total**	**30.5**	**22**
MRT-3	**Existing Capex**	**Taft - North Avenue**	**16.5**	**13**
MRT-3-1	MRT-3 Ext. - South	Taft - Mall of Asia (Underground)	2.2	2
MRT-3-2	MRT-3 Ext. - West	Monumento - Malabon/ Navotas	7.2	5
MRT-3	**Sub**	**Total**	**25.9**	**20**
MRT-7-1	MRT-7 (Underground)	Recto - Blumentritt	2.1	3
MRT-7-2	MRT-7 (Elevated)	Blumentritt - Comm. Av - Banaba	24.0	18
MRT-7	**Sub**	**Total**	**26.1**	**21**
MRT-NS-1	NS Line (Underground)	MM - BGC - Makati	43.5	30
MRT-NS-2	NS Line (Elevated)	North & South - Sections	25.1	18
MRT-NS	**Sub**	**Total**	**68.6**	**48**
	Sub-total - Upgrade/ Capex	**Existing Lines (Excl. PNR)**	**47.2**	**44**
	Sub-Total LRT/MRT	**Extensions + New**	**154.9**	**110**
Monorail-1	Ortigas	Ortigas - Angono	13.7	14
Monorail-2	Paco	Paco - Pateros	11.3	12
Monorail-4	Marikina Line	Marikina Area	16.8	15
Monorail-5	Alabang	Alabang - Zapote	9.3	8
Monorail-6	Cavite	Zapote - Cavite - Gen. Trias	20.6	18
	Sub-Total Secondary Lines	**Monorail Lines**	**71.7**	**67**
PNRC-1	**PNR Commuter**	**Malolos - Calamba**	**91.3**	32
PNRC-2	PNR South Ext.	Calamba - Batangas	47.7	12
PNRC-3	PNRC North Ext.	Malolos - Angeles - Tarlac	81.1	20
	Sub-Total Main Railways	**Commuter & Suburban**	**220.1**	**64**
	Grand Total	**All Railways**	**493.9**	**285**

Source: JICA Study Team.

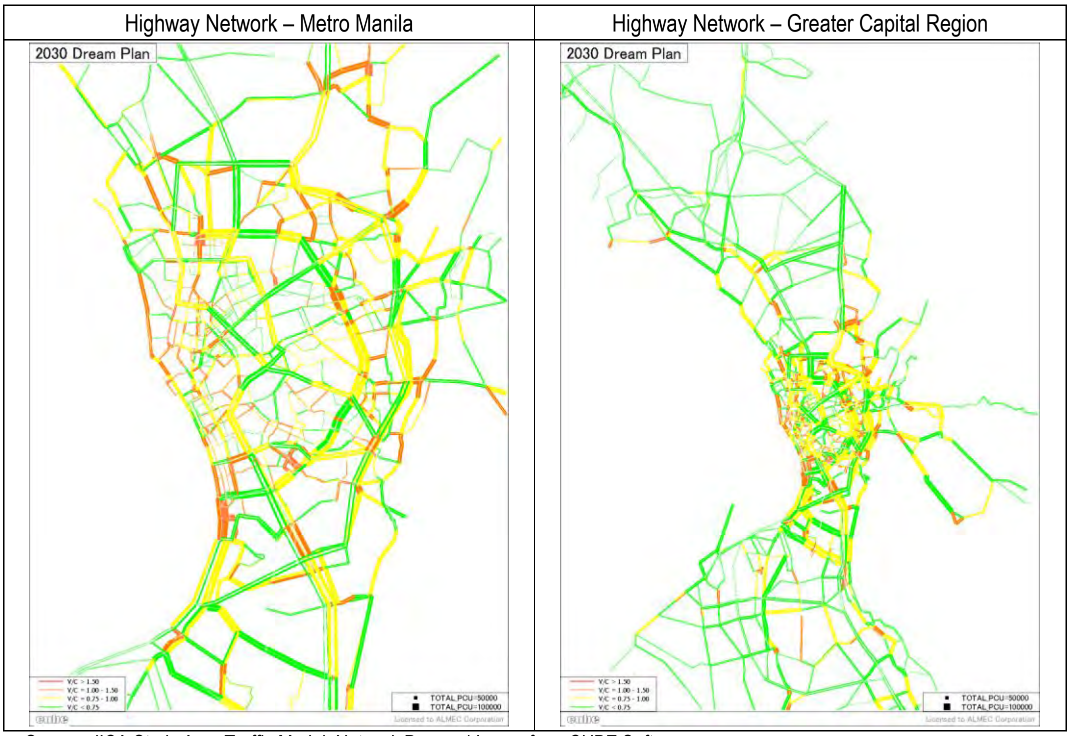
5.4 Proposed Do-maximum Network Performance

5.15 The 2030 future travel demand O/D was assigned to the proposed do-maximum highway and rail network. The assignment results and the performance of the network is summarised and discussed in the following tables by region. Table 5.4.1presents the results for the Metro Manila Area and assigned volumes are shown in Figure 5.4.1.

Table 5.4.1 2030 Do-Maximum Network Performance – Metro Manila Area

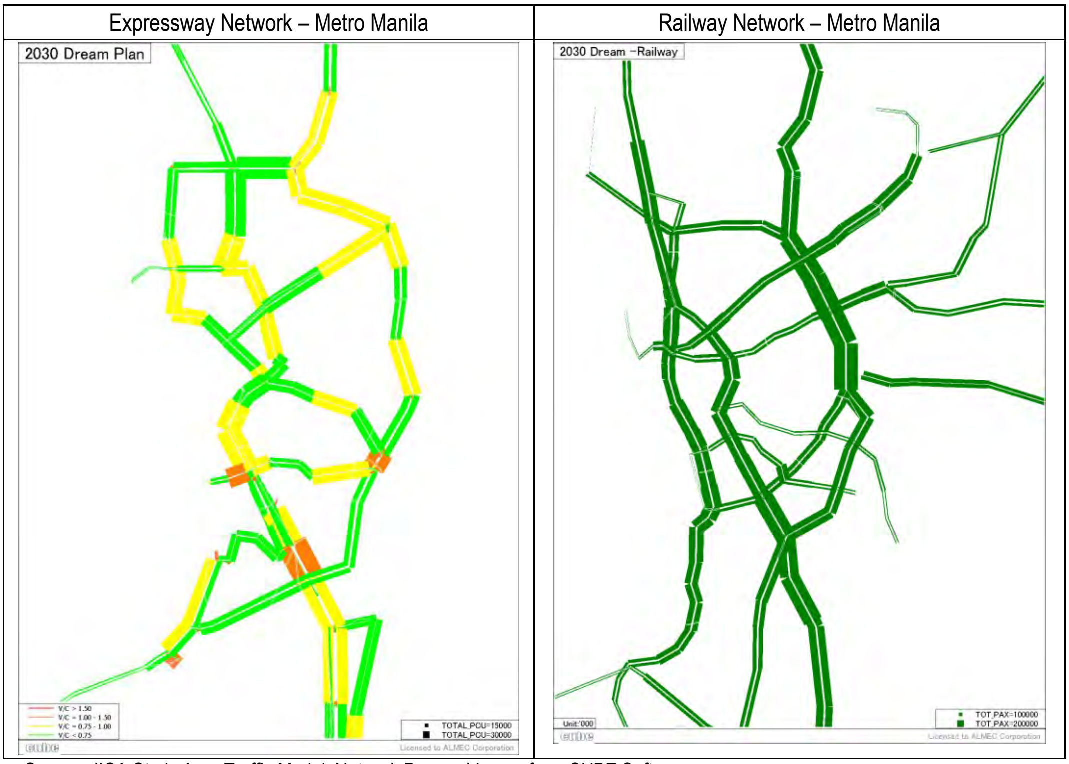
Indicator Description		2030 Do-Nothing	2030 Do-Max	Impact DM/DN
Travel Demand Person Trip Generations (million)		14.5	14.5	1.00
Expressway Network (119km of new expressways) km		54.0	173.0	3.20
Primary & Secondary Roads (43km new roads) km		742.0	785.0	1.06
Total Highway Network (km)		796.0	958.0	1.20
Volume Capacity (V/C) Ratio		1.47	0.72	0.49
Circumferential Roads (C1-C5=84km) % km <10kph		67%	6%	0.09
Circumferential Roads (C1-C5=84km) % km <20kph		91%	21%	0.23
Radial Roads (R1-R10=77km) % km <10kph		89%	28%	0.31
Radial Roads (R1-R10=77km) % km <20kph		99%	61%	0.62
All Roads (DN 796km; DM=958) % km <10kph		71%	15%	0.21
All Roads (DN= 796km; DM=958) % km <20kph		90%	36%	0.40
Rail Network (DN=47km; DM~300km) Pax (million)		1.45	7.45	5.14
Person-km ('000)	Car	47,836	40,091	0.84
	Public (Road)	95,032	50,733	0.53
	Rail	10,047	61,517	6.12
	Total	152,915	152,341	1.00
Person-Hours ('000)	Car	6,537	2,089	0.32
	Public (Road)	12,386	2,172	0.18
	Rail	357	1,790	5.01
	Total	19,279	6,051	0.31
PCU-KM ('000)	Car	35,791	31,598	0.88
	Public (Road)	10,247	4,979	0.49
	Total	46,038	36,577	0.79
PCU-Hrs. ('000)	Car	4,974	1,660	0.33
	Public (Road)	1,394	228	0.16
	Total	6,368	1,888	0.30
Travel Cost (PHP million/day)	VOC	3,261	1,156	0.35
	Time	2,819	897	0.32
	Total	6,079	2,053	0.34
Total Cost (USD) million/ annum	All Modes	55,474	18,737	0.34
Total Revenue (USD) million/ annum	Rail	456	1,635	3.59
	Bus/ Jeepney	3,889	2,042	0.53
	Expressway	1,579	1,993	1.26
	Total	5,924	5,670	0.96

Study Team.
Note: Annualisation Factor Used=365, and USD1.00=PHP40.00.



Source: JICA Study Area Traffic Model, Network Demand Image from CUBE Software

Figure 5.4.1 2030 Do-maximum – Highway Network Performance



Source: JICA Study Area Traffic Model, Network Demand Image from CUBE Software

Figure 5.4.2 2030 Do-maximum – Expressway and Railway Network Performance

Table 5.4.2 2030 Do-Maximum Network Performance – GCR Study Area

Indicator Description		2030 Do-Nothing	2030 Do-Max	Impact DM/DN
Travel Demand Person Trip Generations (million)		23.4	23.4	1.00
Expressway Network (505km of new expressways) km		298	803	2.69
Primary & Secondary Roads (137km new roads) km		5,227	5,364	1.03
Total Highway Network (km)		5,525	6,167	1.12
Volume Capacity (V/C) Ratio		0.57	0.31	0.54
All Roads % km <10kph		16%	3%	0.19
All Roads % km <20kph		22%	7%	0.32
Rail Network (km)		75	494	6.59
Rail Network Patronage - Pax (million)		1.74	9.44	5.43
Person-km (‘000)	Car	100,193	80,130	0.80
	Public (Road)	238,301	145,956	0.61
	Rail	10,047	105,025	10.45
	Total	348,542	331,111	0.95
Person-Hours (‘000)	Car	10,239	3,380	0.33
	Public (Road)	20,956	4,639	0.22
	Rail	356	2,828	7.94
	Total	31,551	10,848	0.34
PCU-KM (‘000)	Car	81,026	68,407	0.84
	Public (Road)	23,228	13,349	0.57
	Total	104,254	81,755	0.78
PCU-Hrs. (‘000)	Car	7,917	1,660	0.21
	Public (Road)	2,213	228	0.10
	Total	10,130	1,888	0.19
Travel Cost (PHP million/day)	VOC	5,682	2,329	0.41
	Time	4,587	1,590	0.35
	Total	10,269	3,919	0.38
Total Cost (USD) million/ annum	All Modes	93,707	35,761	0.38
Total Revenue (USD) million/ annum	Rail	456	2,591	5.68
	Bus/ Jeepney	9,583	5,809	0.61
	Expressway	2,121	2,775	1.31
	Total	12,160	11,155	0.80

Source: JICA Study Team.
Note: Annualisation Factor Used=365, and USD1.00=PHP40.00.

5.5 Proposed Short Term 2016 Network Performance

5.16 The short term network development was proposed to alleviate the dire traffic conditions in MM and also in the adjoining provinces. The impact of some of the minor projects will be localised, like with the addition of flyovers at junctions. Whereas the major improvements of road sections (e.g. C-4 ‘E ’ rehabilitation and building and completion of new road/ expressway sections over the next three years (2013~2016) would have considerable impact in reducing the traffic congestion. The impact of the completion of the proposed Short Term projects was assessed using the travel demand forecast model by comparing the 2016 do-nothing situation with the completion of Short Term plan projects by 2016. The details of the Short Term projects are presented and discussed in the Main Report and its appendices; however, a summary list of Short Term projects is given in Table 5.5.1; and depicted in Figure 5.5.1.

Table 5.5.1 Highway, Expressway, Other Roads, Railways Short Term Projects

	Name of Project		Region	Status	New/ Upgrade	Length (km)	Existing Lanes	Proposed Lanes
A. Roads	2. Global City to Ortigas Center Link Road		NCR	Proposed	New	1.2		3-3
A. Roads	3. Skyway – FTI - C5 Connector		NCR	Committed	New	6.8		2-2
A. Roads	4. C3 Missing Links (San Juan to Makati)		NCR	Proposed	New	5.2		3-3
A. Roads	5. Rehabilitation of EDSA (C-4)		NCR	Committed	Improve	Improved traffic Channelization		
A. Roads	6. Arterial Road Bypass Project Phase II, Plaridel Bypass		BRLC	Committed	New	Various		
B. EXPRESSWAYS	1. Daang Hari-SLEX Link Toll Road		BRLC	Committed	New	4.0	-	2-2
B. EXPRESSWAYS	2. NLEX-SLEX Connectors Project	a. Link Expressway	NCR	Committed	New	13.5	-	2-2
B. EXPRESSWAYS		b. Skyway Stage3	NCR	Committed	New	14.8	-	2-2
B. EXPRESSWAYS		d. Seg. 9&10, and connection to R10	NCR	Committed	New	8.0	-	3-3
B. EXPRESSWAYS	3. NAIA Expressway, Phase II		NCR	Committed	New	7.2	-	2-2
B. EXPRESSWAYS	4. Cavite – Laguna Expressway Project		BRLC	Committed	New	47.0	-	3-3
B. EXPRESSWAYS	5. CLLEX Phase I		GCR	Committed	New	30.7	-	2-2
B. EXPRESSWAYS	6. Calamba–Los Banos Expressway		BRLC	Proposed	New	15.5	-	2-2
B. EXPRESSWAYS	7. C6 extension–Flood Control Dike Expressway		BRLC	Committed	New	39.8	-	2-2
B. EXPRESSWAYS	8. Segment 8.2 of NLEx to Commonwealth		NCR	Proposed	New	8.0	-	2-2
B. EXPRESSWAYS	9. Southern Tagalog Arterial Roads (STAR)		GCR	Committed	Upgrade	22.0	1x1	2-2
C. OTHER ROADS	1. Secondary Road Packages for Metro Manila, Bulacan and Cavite	a. Bulacan Road Package 1 and 2	BRLC	Proposed	New/ Upgrade	65.4	1x1	2-2
C. OTHER ROADS		c. Cavite Secondary Roads	BRLC	Proposed	New/ Upgrade	75.3	1x1	2x2/3x3
C. OTHER ROADS		c. Sucat Road Upgrade	NCR	Proposed	Upgrade	7.7	1x1/4x4	4-4
C. OTHER ROADS		d. Quirino Road (Paranaque)	NCR	Proposed	Upgrade	7.3	2x2	4-4
C. OTHER ROADS		e. Paranague Road Package	NCR	Proposed	Upgrade	13.0	1x1/2x2	3-3
C. OTHER ROADS	7. Preparatory studies for several projects		GCR	Proposed	-	-	-	-
C. OTHER ROADS	8. Other Central Luzon Road Projects		GCR	Committed	-	233.3	-	-
C. OTHER ROADS	9. Other Southern Luzon Road Projects		GCR	Committed	-	206.0	-	-
D. Railways	1. LRT Line1 Cavite Extension and O&M		NCR/BRLC	Committed	New	11.7	10 stations +2 Future	
D. Railways	2. LRT Line2 East Extension		NCR/BRLC	Committed	New	4.2	2 Stations	
D. Railways	3. MRT3 Capacity Expansion		NCR	Committed	Existing	16.5	Upgrade/ Stations	
D. Railways	4. MRT 7 stage1 (Quezon Ave. – Comm. Ave.)		NCR/BRLC	Committed	New	22.8	Common Station	
D. Railways	5. Contactless Automatic Fare Collection System (AFCS)		NCR	Committed	New	All Rail & Possibly Bus System		
D. Railways	6. Line1 and Line2 System Rehabilitations		NCR	Committed	Existing	18.1	Upgrade/ Stations	

Source: JICA Study Team.

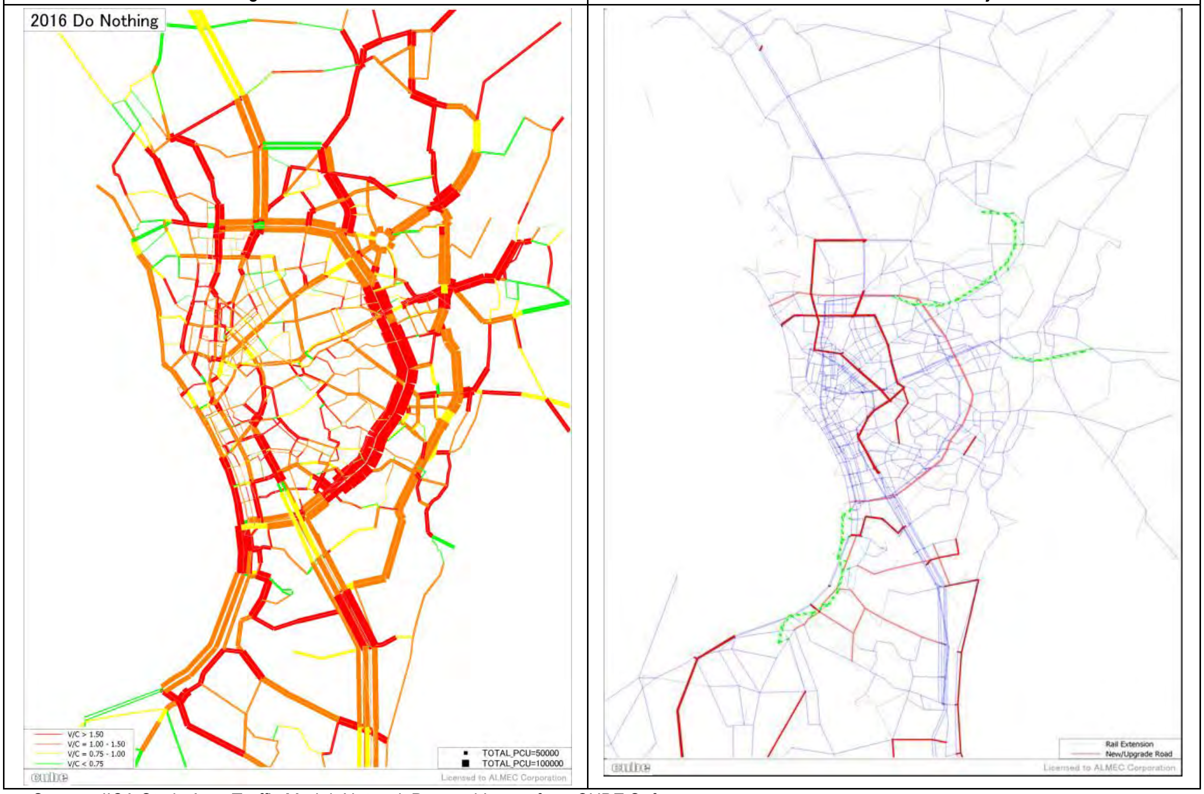
5.17 The impact of implementing the Short Term plan is compared with the do-nothing scenario in Table 5.5.2 for the study area as whole, and reflected in Figure 5.5.1.The figure illustrates how even limited upgrades (e.g. EDSA) could have major impact in reducing congestion in MM areas. Congestion in the south of MM would also reduce due to extension of Line-1 to Niyog. The overall railway patronage would go up by almost three fold due to capacity expansion of existing Line-1 and Line-3 and extension of Line-1 to south, extension of Line-2 to Masinag and completion of MRT-7 to Common Station. This increase of about 2.9million Pax would reduce congestion in their respective corridor of operation. On the roads speeds would increase, albeit not substantially, some 24% of MM network will no longer operate below 20kph. Substantial economic benefit resulting in total Vehicle Operating Cost (VOC) going down by 29% and time savings of about 36% would accrue, resulting in annual benefit of about USD14.5billion annually.

Table 5.5.2 Short Term (ST) Plan Performance – GCR Study Area

Indicator Description		2016 Do-Nothing	2016 Short Term	Impact ST/DN
Travel Demand Person Trip Generations 2012 & 2016 (million)		(2012) 19.47	(2016) 20.46	('16/12) +5.1%
Total Highway Network Roads & Expressways (km)		5525	5,673	+238km
Volume Capacity (V/C) Ratio		0.50	0.40	0.80
Circumferential Roads (C1-C5=84km) % km <10kph		64%	20%	-44%
Circumferential Roads (C1-C5=84km) % km <20kph		90%	50%	-44%
Radial Roads (R1-R10=77km) % km <10kph		83%	52%	-31%
Radial Roads (R1-R10=77km) % km <20kph		99%	89%	-11%
All Roads MM (DN 805km;ST=844km) % km <10kph		67%	36%	-34%
All Roads MM (DN= 805km; ST=844km) % km <20kph		87%	63%	-24%
Rail Network – Metro Manila (DN=47km; DM~75km) Pax (million)		1.45	4.39	+2.94
Person-km ('000)	Car	90,089	87,331	0.97
	Public (Road)	206,341	185,120	0.90
	Rail	9,940	32,301	3.25
	Total	306,370	304,752	0.99
Person-Hours ('000)	Car	8,430	5,698	0.68
	Public (Road)	16,555	9,265	0.56
	Rail	353	1,078	3.06
	Total	25,338	16,041	0.63
PCU-KM ('000)	Car	71,980	70,036	0.97
	Public (Road)	20,131	17,840	0.89
	Total	92,111	87,876	0.95
PCU-Hrs. ('000)	Car	6,403	4,358	0.68
	Public (Road)	1,753	958	0.55
	Total	8,156	5,316	0.65
Travel Cost (PHP million/day) (VOC=Vehicle Operating Cost)	VOC	2,293	1,630	0.71
	Time	2,564	1,638	0.64
	Total	4,858	3,269	0.67
Total Cost (USD) million/ annum	All Modes	44,325	29,825	0.67
Total Revenue (USD) million/ annum	Rail	206	591	2.87
	Bus/ Jeepney	4,139	3,705	0.90
	Expressway	1,075	1,297	1.21
	Total	5,420	5,594	1.03

Source: JICA Study Team.
Note: Annualisation Factor Used=365, and USD1.00=PHP40.00

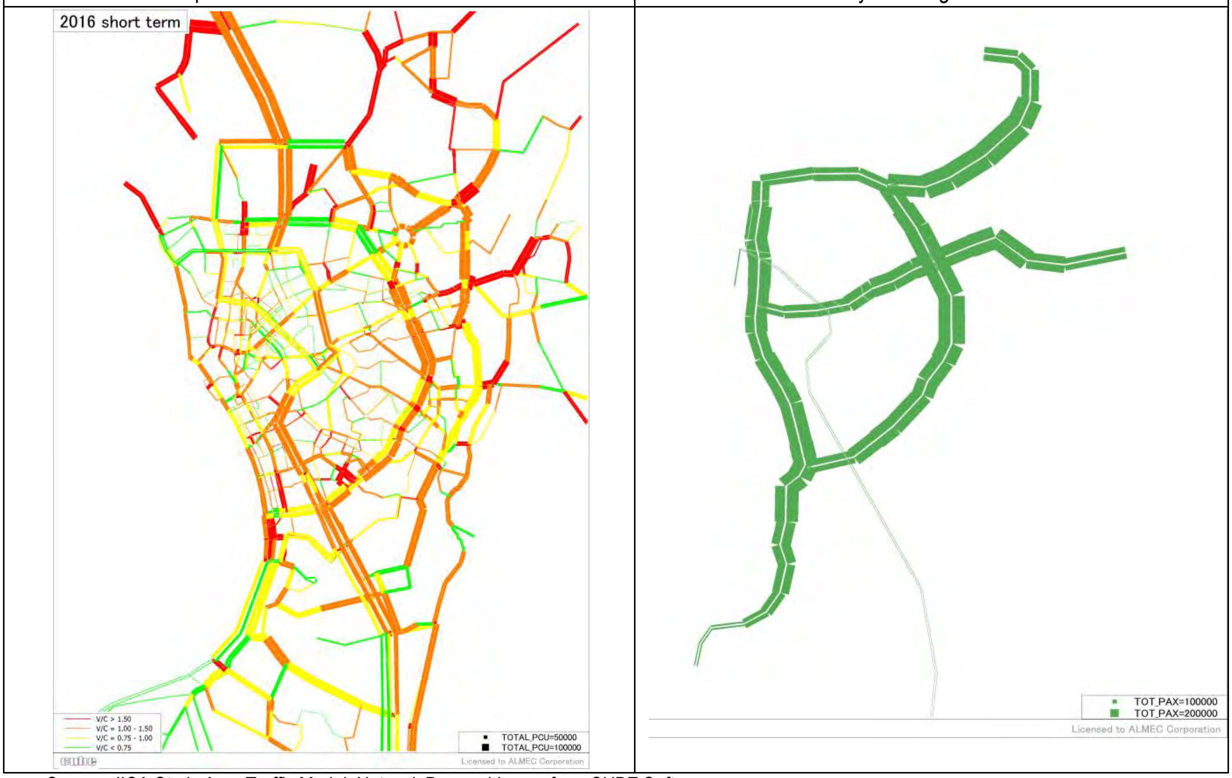
2016 Do-nothing Scenario – Metro Manila	2016 Short Term Plan Projects



Source: JICA Study Area Traffic Model, Network Demand Image from CUBE Software

Figure 5.5.1 Do-Nothing Network Performance and Short Term Plan Projects

2016 Impact Short Term Plan – Metro Manila	2016 Railway Passengers – Metro Manila



Source: JICA Study Area Traffic Model, Network Demand Image from CUBE Software.

Figure 5.5.2 2016 Network Performance and Railway Demand

ANNEXES

ANNEX A

Study Area Zone System

Zone	Area	Province	Region
1	Manila	Metro Manila	NCR
2	Manila	Metro Manila	NCR
3	Manila	Metro Manila	NCR
4	Manila	Metro Manila	NCR
5	Manila	Metro Manila	NCR
6	Manila	Metro Manila	NCR
7	Manila	Metro Manila	NCR
8	Manila	Metro Manila	NCR
9	Manila	Metro Manila	NCR
10	Manila	Metro Manila	NCR
11	Manila	Metro Manila	NCR
12	Manila	Metro Manila	NCR
13	Manila	Metro Manila	NCR
14	Manila	Metro Manila	NCR
15	Manila	Metro Manila	NCR
16	Manila	Metro Manila	NCR
17	Manila	Metro Manila	NCR
18	Manila	Metro Manila	NCR
19	Manila	Metro Manila	NCR
20	Pasay	Metro Manila	NCR
21	Pasay	Metro Manila	NCR
22	Pasay	Metro Manila	NCR
23	Pasay	Metro Manila	NCR
24	Pasay	Metro Manila	NCR
25	Makati	Metro Manila	NCR
26	Makati	Metro Manila	NCR
27	Makati	Metro Manila	NCR
28	Makati	Metro Manila	NCR
29	Makati	Metro Manila	NCR
30	Makati	Metro Manila	NCR
31	Makati	Metro Manila	NCR
32	Mandaluyong_W	Metro Manila	NCR
33	Mandaluyong_C	Metro Manila	NCR
34	Mandaluyong_SE	Metro Manila	NCR
35	Mandaluyong_NE	Metro Manila	NCR
36	San-Juan_E	Metro Manila	NCR
37	San-Juan_W	Metro Manila	NCR
38	Quezon	Metro Manila	NCR
39	Quezon	Metro Manila	NCR
40	Quezon	Metro Manila	NCR
41	Quezon	Metro Manila	NCR
42	Quezon	Metro Manila	NCR
43	Quezon	Metro Manila	NCR
44	Quezon	Metro Manila	NCR
45	Quezon	Metro Manila	NCR
46	Quezon	Metro Manila	NCR
47	Quezon	Metro Manila	NCR
48	Quezon	Metro Manila	NCR
49	Quezon	Metro Manila	NCR

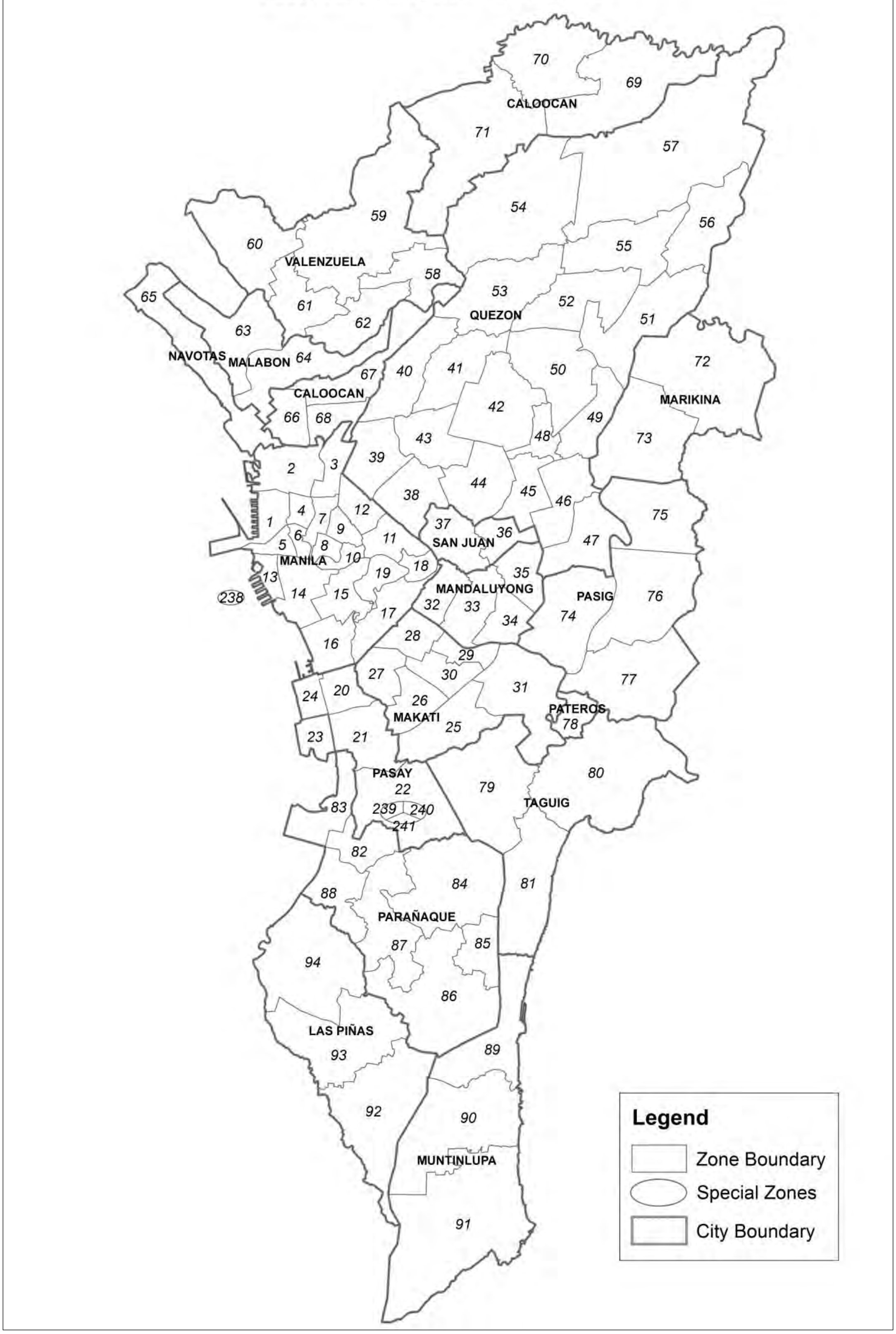
Zone	Area	Province	Region
50	Quezon	Metro Manila	NCR
51	Quezon	Metro Manila	NCR
52	Quezon	Metro Manila	NCR
53	Quezon	Metro Manila	NCR
54	Quezon	Metro Manila	NCR
55	Quezon	Metro Manila	NCR
56	Quezon	Metro Manila	NCR
57	Quezon	Metro Manila	NCR
58	Valenzuela	Metro Manila	NCR
59	Valenzuela	Metro Manila	NCR
60	Valenzuela	Metro Manila	NCR
61	Valenzuela	Metro Manila	NCR
62	Valenzuela	Metro Manila	NCR
63	Malabon_W	Metro Manila	NCR
64	Malabon_E	Metro Manila	NCR
65	Navotas	Metro Manila	NCR
66	Caloocan_S_W	Metro Manila	NCR
67	Caloocan_S_NE	Metro Manila	NCR
68	Caloocan_S_SE	Metro Manila	NCR
69	Caloocan_NE	Metro Manila	NCR
70	Caloocan_N	Metro Manila	NCR
71	Caloocan_NW	Metro Manila	NCR
72	Marikina_N	Metro Manila	NCR
73	Marikina_S	Metro Manila	NCR
74	Pasig_W	Metro Manila	NCR
75	Pasig_N	Metro Manila	NCR
76	Pasig_C	Metro Manila	NCR
77	Pasig_S	Metro Manila	NCR
78	Pateros	Metro Manila	NCR
79	Taguig_W	Metro Manila	NCR
80	Taguig_N	Metro Manila	NCR
81	Taguig_S	Metro Manila	NCR
82	PRNQ_Santos	Metro Manila	NCR
83	PRNQ_RCLM	Metro Manila	NCR
84	PRNQ_NE	Metro Manila	NCR
85	PRNQ_E	Metro Manila	NCR
86	PRNQ_S	Metro Manila	NCR
87	PRNQ_C	Metro Manila	NCR
88	PRNQ_W	Metro Manila	NCR
89	Muntinlupa_N	Metro Manila	NCR
90	Muntinlupa_C	Metro Manila	NCR
91	Muntinlupa_S	Metro Manila	NCR
92	Las_Pinas_SE	Metro Manila	NCR
93	Las_Pinas_C	Metro Manila	NCR
94	Las_Pinas_NW	Metro Manila	NCR
95	Bacoor	Cavite	IV-A
96	Imus	Cavite	IV-A
97	Cavite_City	Cavite	IV-A
98	Kawit	Cavite	IV-A
99	Noveleta	Cavite	IV-A
100	Rosario	Cavite	IV-A
101	Gen_Trias_N	Cavite	IV-A
102	Gen_Trias_C	Cavite	IV-A

Zone	Area	Province	Region
103	Gen_Trias_S	Cavite	IV-A
104	Tanza	Cavite	IV-A
105	Trece_Martires_City	Cavite	IV-A
106	Dasmarinas_W	Cavite	IV-A
107	Dasmarinas_E	Cavite	IV-A
108	Dasmarinas_S	Cavite	IV-A
109	Gen_Alvarez	Cavite	IV-A
110	Carmona	Cavite	IV-A
111	Naic_W	Cavite	IV-A
112	Naic_E	Cavite	IV-A
113	Silang	Cavite	IV-A
114	Aguinaldo_Magallanes	Cavite	IV-A
115	Amadeo_Indang	Cavite	IV-A
116	Alfonso_Indang	Cavite	IV-A
117	Tagaytay_City	Cavite	IV-A
118	San Pedro	Laguna	IV-A
119	Binan	Laguna	IV-A
120	Santa_Rosa_City	Laguna	IV-A
121	Cabuya	Laguna	IV-A
122	Calamba_City	Laguna	IV-A
123	Calamba_W	Laguna	IV-A
124	Bay	Laguna	IV-A
125	Alaminos	Laguna	IV-A
126	San_Pablo_City	Laguna	IV-A
127	Santa Maria	Laguna	IV-A
128	Kalayaan	Laguna	IV-A
129	Cavinti	Laguna	IV-A
130	Liliw	Laguna	IV-A
131	Pagsanjan	Laguna	IV-A
132	San_Jose	Rizal	IV-A
133	Burgos	Rizal	IV-A
134	San Mateo	Rizal	IV-A
135	Antipolo_City	Rizal	IV-A
136	Cainta	Rizal	IV-A
137	Taytay	Rizal	IV-A
138	Angono	Rizal	IV-A
139	Binangonan	Rizal	IV-A
140	Teresa	Rizal	IV-A
141	Morong	Rizal	IV-A
142	Cardona	Rizal	IV-A
143	Baras	Rizal	IV-A
144	Tanay	Rizal	IV-A
145	Pililla	Rizal	IV-A
146	Jalajala	Rizal	IV-A
147	Balayan	Batangas	IV-A
148	Agoncillo	Batangas	IV-A
149	Laurel	Batangas	IV-A
150	Tanauan_City	Batangas	IV-A
151	Santo_Tomas	Batangas	IV-A
152	Balete	Batangas	IV-A
153	Lipa_City	Batangas	IV-A
154	Cuenca	Batangas	IV-A
155	Alitagtag	Batangas	IV-A

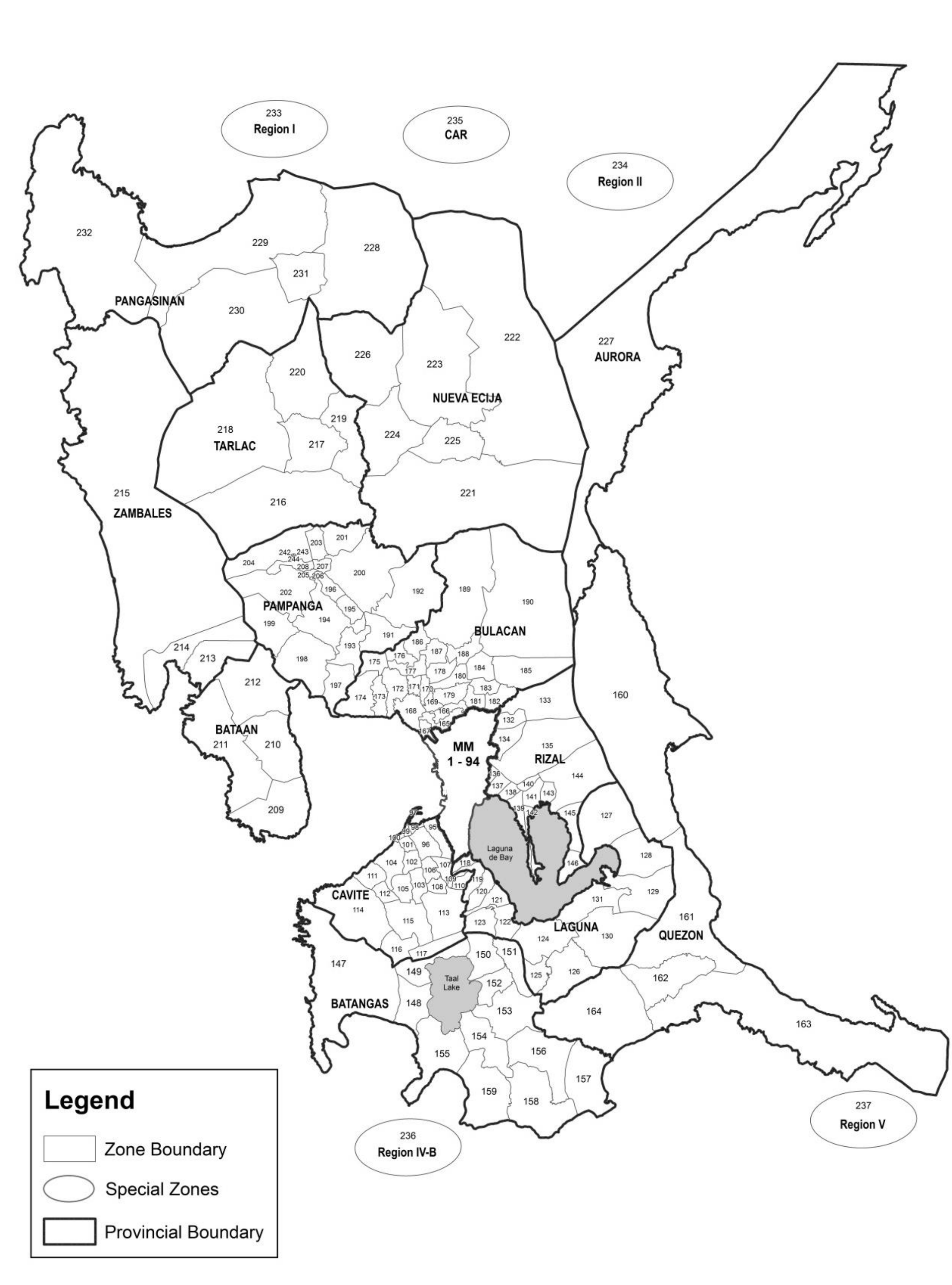
Zone	Area	Province	Region
156	Padre_Garcia	Batangas	IV-A
157	San_Juan	Batangas	IV-A
158	Lobo	Batangas	IV-A
159	Batangas_City	Batangas	IV-A
160	Gen_Nakar	Quezon	IV-A
161	Lucban	Quezon	IV-A
162	Tayabas_City	Quezon	IV-A
163	Lucena_City_SE	Quezon	IV-A
164	Quezon_SW	Quezon	IV-A
165	Meycauayan	Bulacan	III
166	Marilao	Bulacan	III
167	Obando	Bulacan	III
168	Bulacan	Bulacan	III
169	Bocaue	Bulacan	III
170	Balagtas	Bulacan	III
171	Guiguinto	Bulacan	III
172	Malolos	Bulacan	III
173	Paombong	Bulacan	III
174	Hagonoy	Bulacan	III
175	Calumpit	Bulacan	III
176	Pulilan	Bulacan	III
177	Plaridel	Bulacan	III
178	Pandi	Bulacan	III
179	Santa_Maria_S	Bulacan	III
180	Santa_Maria_N	Bulacan	III
181	San_Jose_Del_Monte_W	Bulacan	III
182	San_Jose_Del_Monte_E	Bulacan	III
183	San_Jose_Del_Monte_N	Bulacan	III
184	Norzagaray_W	Bulacan	III
185	Norzagaray_E	Bulacan	III
186	Baliuag	Bulacan	III
187	Bustos	Bulacan	III
188	Angat	Bulacan	III
189	San_Ildefonso_Miguel_Rafael	Bulacan	III
190	Dona_Remedios_Trinidad	Bulacan	III
191	Apalit_SanSimon	Pampanga	III
192	Candaba_SanLuis	Pampanga	III
193	Minalin_Macabebe	Pampanga	III
194	Bacolor_Guagua_S-R_S-T	Pampanga	III
195	San_Fernando_S	Pampanga	III
196	San_Fernando_N	Pampanga	III
197	Masantol	Pampanga	III
198	Lubao_Sasmuan	Pampanga	III
199	Floridablanca	Pampanga	III
200	Arayat_Mexico_Santa_Ana	Pampanga	III
201	Magalang	Pampanga	III
202	Porac	Pampanga	III
203	Mabalacat_E	Pampanga	III
204	Mabalacat_W	Pampanga	III
205	Angeles_C	Pampanga	III
206	Angeles_S	Pampanga	III
207	Angeles_E	Pampanga	III
208	Angeles_W	Pampanga	III

Zone	Area	Province	Region
209	Mariveles_Limay	Bataan	III
210	Balanga	Bataan	III
211	Bagac	Bataan	III
212	Dinalupihan	Bataan	III
213	Olongapo_City	Zambales	III
214	Subic	Zambales	III
215	Zambales_NW	Zambales	III
216	Tarlac_SW	Tarlac	III
217	Tarlac_City	Tarlac	III
218	Tarlac_W	Tarlac	III
219	Tarlac_E	Tarlac	III
220	Tarlac_N	Tarlac	III
221	Nueva_Ecija_S	Nueva Ecija	III
222	Nueva_Ecija_E	Nueva Ecija	III
223	Nueva_Ecija_NC	Nueva Ecija	III
224	Nueva_Ecija_W	Nueva Ecija	III
225	Cabanatuan_City	Nueva Ecija	III
226	Nueva_Ecija_NW	Nueva Ecija	III
227	Aurora	Aurora	III
228	Pangasinan_E	Pangasinan	I
229	Pangasinan_N	Pangasinan	I
230	Pangasinan_SW	Pangasinan	I
231	Pangasinan_C	Pangasinan	I
232	Pangasinan_NW	Pangasinan	I
233	La Union	La Union	I
234	Nueva Vizcaya	Nueva Vizcaya	II
235	Benguet	Benguet	CAR
236	ALL_IV-B	ALL_IV-B	IV-B
237	ALL_V	ALL_V	V
238	Manila Port	Special_Ext	NCR
239	NAIA (I)	Special_Ext	NCR
240	NAIA (D)	Special_Ext	NCR
241	NAIA (W)	Special_Ext	NCR
242	CIA (I)	Special_Ext	III
243	CIA (D)	Special_Ext	III
244	CIA (W)	Special_Ext	III
245	Spare	Special	?

Study Area Zone System - Metro Manila



Study Area Zone System - Outer Provinces



ANNEX B

Vehicle Operating Cost and Value of Time

1 B.1 Calculation of Vehicle Operating Cost (VOC)

Network wide vehicle operating cost was estimated using the exogenously calculated VOC for each of the four (1. Car, 2.Jeepney, 3.Bus 4. Truck) vehicle types modelled for the study. Vehicle operating cost is estimated for each link in the network and summed up for the entire network for any scenario. The VOC calculation method is same for each scenario.

Vehicle Operating Cost for each link in the model network was calculated by using link speed associated with the total assigned volume to the link and its capacity. The volume, capacity and speed relationship is defined in the main text of Technical Report 2.

$$\mathrm{VOC} = (\mathrm{a} \times \mathrm{link\ speed(kph)} + \mathrm{b}) \times \mathrm{link}\frac{\mathrm{distance(km)}}{1000} \times \mathrm{No. of\ assigned\ vehicles}$$

Where “a” and “b” are coefficient as define in Table B.1 to B.3 for 2012, 2016 and 2030 respectively below, and link length, link travel speed and assigned volume for each vehicle type are taken from the assigned network.

Table B.1 Coefficient for VOC- 2012

Link Speed (kph)	Car		Jeepney		Bus		Truck	
	a	b	a	b	a	b	a	b
0<Speed<=10	-2,117.4	37,920	-3,700.4	62,746	-7,295.2	122,275	-15,787.6	257,116
10<Speed<=20	-560.1	22,347	-943.4	35,176	-1,849.6	67,819	-3,970.7	138,947
20<Speed<=30	-195.7	15,059	-294.7	22,202	-588.6	42,599	-1,642.6	92,385
30<Speed<=40	-100.6	12,206	-169.8	18,455	-305.3	34,100	-783.3	66,606
40<Speed<=50	-52.4	10,278	-0.5	11,683	-41.5	23,548	-357.2	49,562
50<Speed<=60	8.6	7,228	92.2	7,048	104.6	16,243	-194.0	41,402
60<Speed<=70	28.0	6,064	139.3	4,222	179.7	11,737	-45.4	32,486
70<Speed<=80	43.0	5,014	155.4	3,095	217.5	9,091	111.5	21,503
Speed>80	62.9	3,422	132.7	4,911	195.8	10,827	211.0	13,543

Source: JICA Study Team.

Table B.2 Coefficient for VOC- 2016

Link Speed(kph)	Car		Jeepney		Bus		Truck	
	a	b	a	b	a	b	a	b
0<Speed<=10	-2,515.5	45,049	-4,396.1	74,542	-8,666.7	145,263	-18,755.7	305,454
10<Speed<=20	-665.4	26,548	-1,120.8	41,789	-2,197.3	80,569	-4,717.2	165,069
20<Speed<=30	-232.5	17,890	-350.1	26,376	-699.3	50,608	-1,951.4	109,753
30<Speed<=40	-119.5	14,501	-201.7	21,925	-362.7	40,511	-930.6	79,128
40<Speed<=50	-62.3	12,210	-0.6	13,879	-49.3	27,975	-424.4	58,880
50<Speed<=60	10.2	8,587	109.5	8,373	124.3	19,297	-230.5	49,186
70<Speed<=80	33.3	7,204	165.5	5,016	213.5	13,944	-53.9	38,593
80<Speed<=90	51.1	5,957	184.6	3,677	258.4	10,800	132.4	25,546
Speed>90	74.7	4,065	157.6	5,834	232.6	12,863	250.7	16,089

Source: JICA Study Team.

Table B.3 Coefficient for VOC- 2030

Link Speed(kph)	Car		Jeepney		Bus		Truck	
	a	b	a	b	a	b	a	b
0<Speed<=10	-5043.7	90,325	-8814.4	149,461	-17,377.2	291,259	-37,606.1	612,450
10<Speed<=20	-1334.7	53,231	-2247.4	83,789	-4,405.8	161,545	-9,458.2	330,972
20<Speed<=30	-466.7	35,871	-702.0	52,885	-1,402.1	101,471	-3,912.7	220,061
30<Speed<=40	-239.6	29,075	-404.4	43,960	-727.2	81,226	-1,865.8	158,656
40<Speed<=50	-124.8	24,482	-1.2	27,829	-98.9	56,091	-850.9	118,057
50<Speed<=60	20.5	17,217	219.6	16,788	249.2	38,691	-462.1	98,620
60<Speed<=70	66.7	14,444	331.8	10,057	428.0	27,958	-108.1	77,382
70<Speed<=80	102.4	11,943	370.2	7,372	518.1	21,655	265.6	51,220
Speed>80	149.8	8,151	316.1	11,698	466.4	25,790	502.6	32,259

Source: JICA Study Team.

Table B.4 Fares and Toll Used in Travel Demand Modelling

Year	Rail	Jeepney	Bus	Toll	
				Metro Manila	Outside of Metro Manila
2016	11.9+0.7/km	2.3/km	2.0/km	12.2/km	4.0/km
2030	23.8+1.3/km	4.8/km	4.1/km	24.5/km	8.1/km

Source: JICA Study Team.
2012 Actual 2012 Prevailing Fares were used for each mode.

Table B.5 Values of Time (VoT)

Year	Car	Jeepney/ Bus Passengers
2012	111.8	78.1
2016	126.7	88.5
2030	182.6	127.5

Source: JICA Study Team.