Session 3C: Assoc. Prof. Dr. Alexis M. Fillone

Presentation entitled:
Low Carbon Society Policy in Philippines

Biographic Data of Speaker

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Dr. Alexis M. Fillone earned his PhD in Urban and Regional Planning from the School of Urban and Regional Planning (SURP), University of the Philippines in 2005. He has a Master of Engineering Degree in Transportation from Asian Institute of Technology, Bangkok, Thailand. He is currently an Associate Professor in Civil Engineering at De La Salle University-Manila. His research interests are in public transportation planning, travel demand modeling, behavioral analysis as well as environmental issues in transportation.

CLEAN AIR INITIATIVES IN TRANSPORTATION, THE CASE OF THE PHILIPPINES

Some of the initiatives being pursued in transportation in the Philippines towards cleaner air are discussed. The national government as well as local governments has been initiating programs and projects in transportation for a cleaner environment.

The application of an improved method by the IGES in measuring co-benefits from a proposed transportation project in Metro Manila is also discussed. The measurement of co-benefit has become very important to estimate the acceptability of a transport project from the view point of not only greenhouse gas (GHG) emission reduction but also roadside emission reduction and other effects. The application of this method is presented as applied to the proposed BRT introduction in Metro Manila. In this study, traffic demand was estimated using demand forecasting model based on the Metro Manila Urban Transportation Integration Study (1998) and micro simulation model which was developed to estimate the impact of BRT introduction on Circumferential Road 5 (C-5) which is a ring road in Metro Manila. Based on the estimated demand, benefit from reduction of CO2, NOx, CO, PM were estimated as well as benefit from reduction of total travel time, total operating cost and damage cost by traffic accident.

CLEAN AIR INITIATIVES IN TRANSPORTATION, THE CASE OF THE PHILIPPINES

By

Alexis M. Fillone
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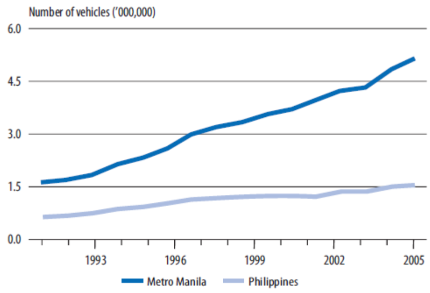
Summary of Presentation

A. Background
B. Transport-related Clean Air Initiatives in the Philippines
C. Proposed BRT Projects in the Philippines
D. Application of the Co-Benefit Analysis of a Transport Project using IGES Guideline
 - Application of Co-Benefit Analysis to a proposed BRT Project
E. Summary of Findings

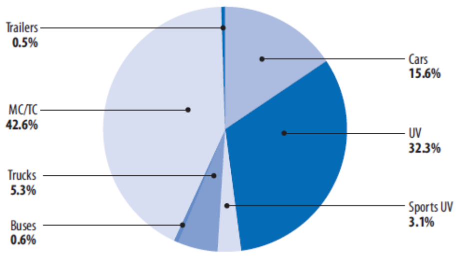
Background

Registered Motor Vehicles in the Philippines and Metro Manila, 1990–2005



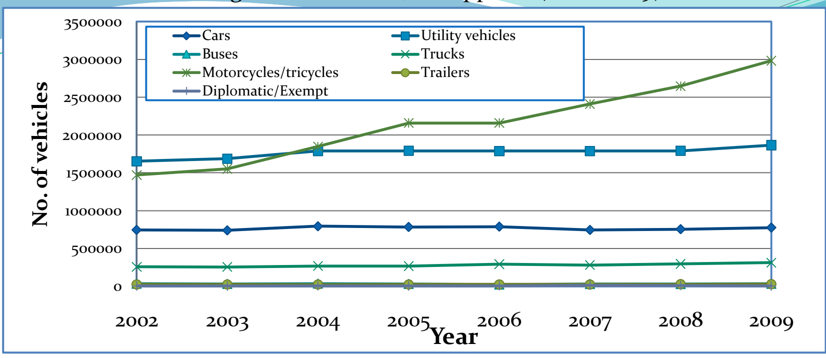
Source: Land Transportation Office, 2006 graphed by Clean Air Initiative-Asia.

% Share of Vehicle Types in the Overall Fleet, 2005

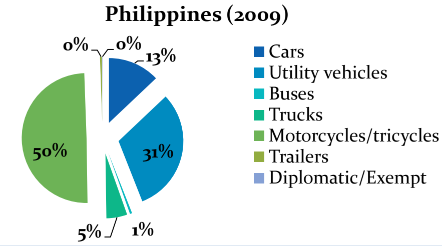


CAI = Clean Air Initiative; LTO = Land Transportation Office; MC/TC = motorcycle/tricycle; NCR = National Capital Region; UV = utility vehicle; % = percent
Source: LTO, 2006 and graph by CAI-Asia.

No. of Registered Vehicles, Philippines (2002-2009)



Percent of registered vehicles, Philippines (2009)



National Capital Region Emissions Inventory, 2005

Item	Area (%)	Mobile (%)	Stationary (%)
PM	90.80	4.23	4.88
SOx	0.05	0.00	57.51
NOx	1.15	7.89	31.57
CO	1.12	71.32	4.92
VOC/TOG	6.88	16.57	1.11
Total (tons per year)	**161,631.00**	**1,544,664.00**	**14,336,347.00**

CO = carbon monoxide, EMB = Environmental Management Bureau, NOx = nitrogen oxide, PM = particulate matter, SOx = sulfur oxide, t = tons, TOG = total organic gases, VOC = volatile organic compound, % = percent
Source: EMB, 2006.

- CO is the main pollutant emitted by mobile sources

Management of Mobile Sources

1. Improved Emission Standards – the Environmental Management Bureau (EMB) set the maximum HC emissions from motorcycles and tricycles at 7800 ppm for those operating in urban centers and 10,000 ppm for thos operating in rural areas or outside urban centers

2. Fuel Quality – leaded gasoline was phased out in December 2000. There was a reduction of aromatics and benzene in gasoline to 35% and 2% by volume, respectively in 2003, and a reduction of sulfur content of automotive diesel fuel to 0.05% by weight in 2004. By July 2007, fuel quality with respect to sulfur limits and the standards for new vehicles will be EURO II compliant

3. Fuel Additive registration – permanent registration is granted to fuel additives after screening their chemical contents and ensuring that these chemicals do not contribute harmful emissions

4. Use of Coco-Methyl Ether (CME) – beginning July 2004 government vehicles were required to use diesel fuel blended with 1% CME.

5. Compressed Natural Gas (CNG) – the Natural Gas Vehicle Program for Public Transport was launched in 2002. A mother-daughter fueling system was set up in Region IV and in Metro Manila to promote the use of CNG by 100 public buses.

6. Liquefied Petroleum Gas (LPG) – initiatives on the use of LPG as automotive fuel are private sector-led. Most taxis are already running on LPG . The price of conversion is the biggest obstacle for a more widespread use.

   The conversion kit for carburator engines costs Php25,000 ($500) while for a fuel injection engine costs Php50.000 ($1,000). Also limited number of refilling stations.

7. Ethanol in Fuels – Widespread use of 10% ethanol blended gasoline

8. Anti-Smoke Belching Campaign – In 2004 and 2005, a total of 16,250 and 21,141 diesel vehicles, respectively, were apprehended for smoke emissions

9. Motor Vehicle Inspection System – Aimed at improving the operation and maintenance of vehicles to ensure that their emissions meet national standards

10. Tricycle Improvement Strategy – Motorized tricycle operators and drivers usually have very low incomes and have low capacities to accommodate regulatory requirements, making it difficult for them to maintain their tricycles properly and avoid contributing to the air pollution problem. There are local government initiatives to introduce battery-powered tricycles.

11. Pilot Testing of Eletric Jeepneys - Several cities in the Philippines have experimented with e-jeepneys with support of international funding agencies (ADB) and private institutions/individuals

12. Introduction of BRT Projects – feasibility/pre-feasibility studies of BRT projects in major cities of the Philippines

- Experimentation/field testing of E-tricycles

E-tricycles in Taguig City
-Capacity is six people including the driver
-Being rented to tricycle drivers

Standard motorcycle-powered tricycle

E-tricycle

E-tricycles in Mandaluyong City
-Capacity is six people including the driver
-Being rented to tricycle drivers

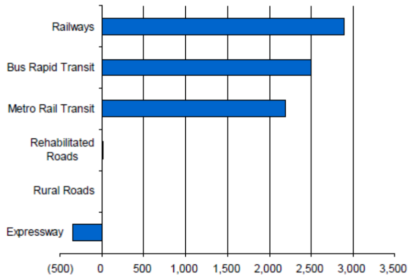
- Experimentation with E-Jeepneys
  - Several cities in the Philippines have experimented with e-jeepneys with support of international funding agencies (ADB) and private institutions/individuals
  - E-jeepneys in the city of Makati with ADB support

Capacity – 12 including driver

- E-jeepneys (10 units)of Iloilo City provided by a private individual
- to provide free rides to students and old people around Iloilo City
- Capacity – 12 including the driver

Carbon Dioxide Emissions vs. Type of Transport Infrastructure

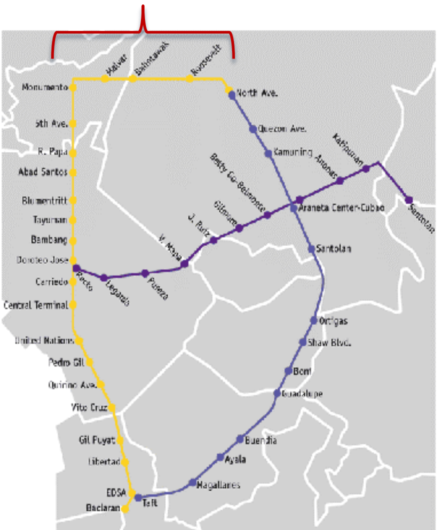
Figure 4: Savings in the Intensity of Carbon Dioxide Emissions
(CO_2 tons saved per kilometer per lane per year)



CO_2 = carbon dioxide.
Source: Independent Evaluation Department estimate based on review of Asian Development Bank project documents and reports.

• Revival of Philippine National Railways (PNR) operation from Metro Manila to the Bicol Region (*The Bicol Express*)

LRT 1 North Extension – Connecting Monumento Station to North Avenue Station (end of MRT 3)



Update of BRT Projects in the Philippines

• Feasibility study of a proposed BRT project in CEBU City, Central Visayas, Philippines
  - World Bank Funded feasibility study (Cost of study - $ 1 million) in the finishing stage
  - Estimated cost of BRT - $350 million

• Pre-feasibility study of an LRT system in Davao City, Mindanao, Philippines
  - ADB commissioned feasibility study
  - Expert estimates the City is still 10-15 years away for an LRT system
  - Another expert recommends a BRT system for Davao City

• Pre-feasibility study of proposed BRT projects in Metro Manila
  - USAID and National Center for Transportation Studies (NCTS)

ESTIMATION OF CO-BENEFIT FROM BUS RAPID TRANSIT INTRODUCTION IN METRO MANILA USING IGES' CO-BENEFIT GUIDELINE

by

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Potential BRT Projects for Metro Manila

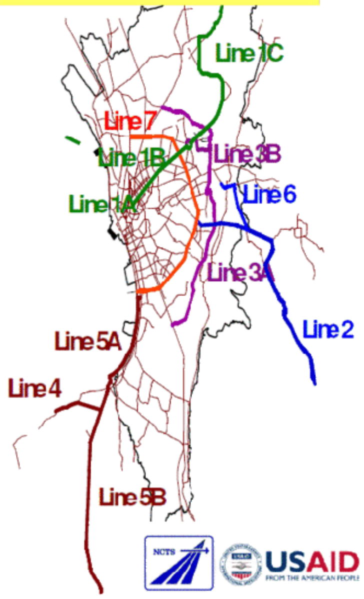
Source: USAID and NCTS Study

- 426-km of Bus Rapid Transit routes
- Estimated Total Cost is P55 Billion
- Typical characteristics/design of proposed BRT lines

  - segregated median busways with median stations, pre-boarding fare collection and fare verification, free transfers between corridors, competitively-bid concessions, high-frequency service and low-station dwell times, clean bus technologies and modal integration

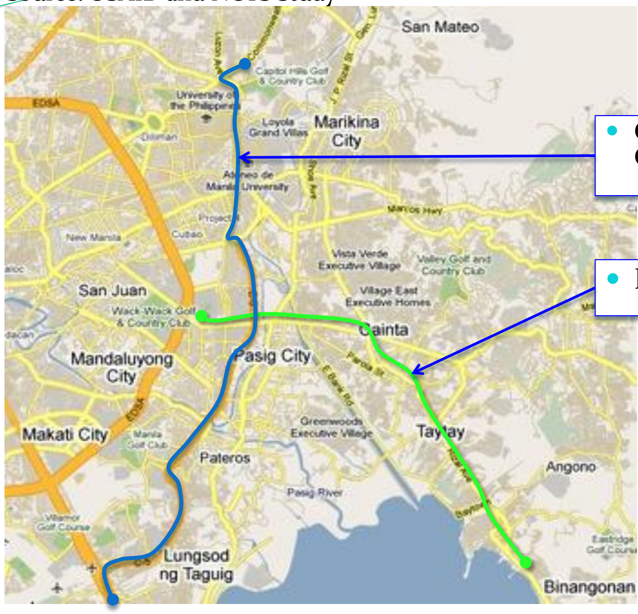
	Corridor/s	LGUs involved	Configuration
1a)	Lerma-SM Fairview	Q.C., Manila	Intersects MRT3 at EDSA ; close to LRT2 at Lerma; intersects BRT3
1b)	Welcome Rotonda-SM Fairview	Q.C.	Intersects MRT3; intersects BRT3
1c)	SM North-SM Tala	Q.C., Caloocan	Connects to MRT3; intersects BRT3
7)	EDSA	Caloocan, Q.C., Pasig, Makati, Pasay	Complements/ Competes? w/ MRT3; intersects BRT1
5b)	Bacoor-Dasmarinas	Cavite Province	Connects to LRT1 Extension
2)	EDSA-Binangonan	Pasig, Rizal Province (Cainta, Taytay, Angono, Binangonan)	Connects to MRT3; (Intersects BRT3)
6)	Santolan-Binangonan	Pasig, Rizal Province	Connects to LRT2
5a)	Baclaran-Dasmarinas	Paranaque, Las Pinas, Cavite	Connects to LRT1
4)	Baclaran-Kawit	Paranaque, Las Pinas, Cavite	Connects to LRT1
3a)	C-5 (SLEX-Commonwealth)	Taguig, Pasig, Makati, Q.C.	Intersects LRT2; intersects BRT1/MRT7
3b)	C5 (SLEX-Elliptical)	Taguig, Makati, Pasig, Q.C.	Intersects LRT2; intersects BRT1

Potential BRT Corridors



Proposed BRT Routes (2 Pilot Projects)

Source: USAID and NCTS Study



- C-5 (SLEX–Commonwealth Ave.)
- EDSA-Binangonan

BRT Project Proposal

Source: USAID and NCTS Study

- Two Pilot Routes
  - 21-km C-5 (South Luzon Expressway – Commonwealth Avenue in Quezon City) route
  - 24-km Edsa – Binangonan (Rizal) route
- No. of Stations
  - 16 stations (C-5 BRT)
  - 18 stations (Edsa-Binangonan BRT)
- Estimated Cost (per kilometer) in Construction
  - P129.33 million (C-5)
  - P139.07 million (Edsa-Binangonan)

Case Study Focused on C-5 BRT

Proposed C-5 BRT (in EMME 3)

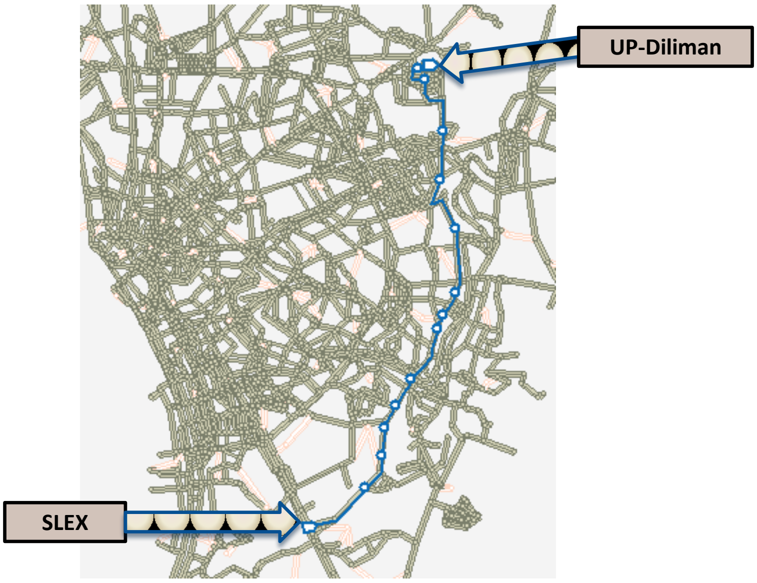
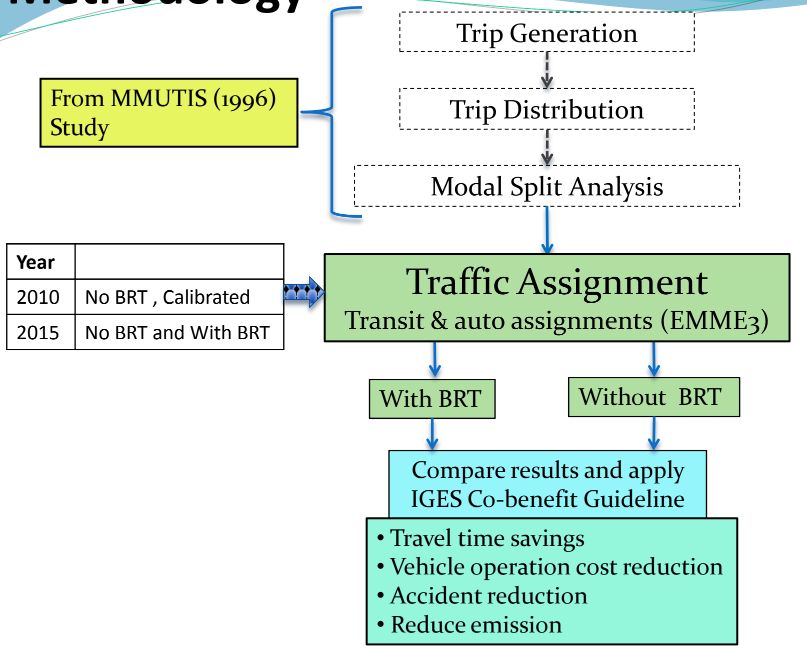


Table 5 Basic Service Characteristics of the Proposed C-5 BRT System

Characteristics	
Capacity	Seating = 100, Full = 200
Headway (min)	3
Average speed (kph)	20
No. of Stops	15
Estimated length (km), one direction	20.59

Articulated bus

Methodology



- Used the MMUTIS (1996) Person-Trips OD Matrix and its estimates for design year 2010 and 2015

Table 1 Percent of Public and Private Daily Trip Estimates for Metro Manila, MMUTIS, 1996

	Base Year	Design Periods	
	1996	2010	2015
Percent Public Trips	77.9	69.3	66.2
Percent Private Trips	22.1	30.7	33.8

Table 2 Trip Generation Percent Growth Estimates for Metro Manila, MMUTIS, 1996

	Base Year	Design Periods	
	1996	2010	2015
Percent Growth	1.00	1.62	1.84

Table 3 OD Trip Matrix Estimates

Year 2010	Total Daily OD Trips	Peak Hour OD Trips	Median Hour OD Trips
Public	27,021,338	3,391,233	1,153,695
Private	11,970,490	1,142,033	556,568
Year 2015			
Public	29,317,998	3,679,313	1,251,803
Private	14,969,010	1,427,984	695,967

Median Hour OD Trips – is the middle value of all hourly person trips in a day (24 hours)

Estimated Boardings and Alightings along the Proposed C-5 BRT

SLEX to UP (Commonwealth)

UP (Commonwealth) to SLEX

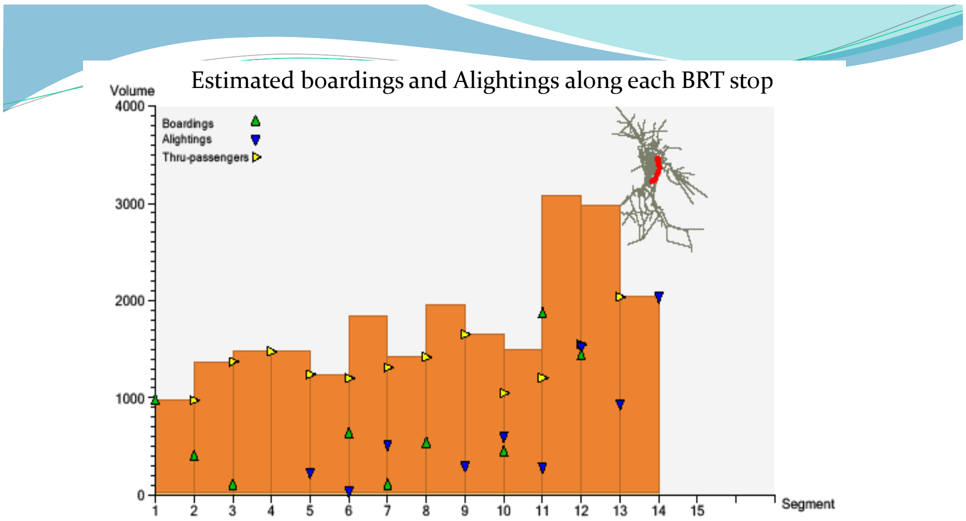


Table 7 Estimates of trip characteristics in Metro Manila

		Daily Estimate	
		Pass-hr	Pass-km
2010 (W/out BRT)	Public	10,570,888.8	177,806,448
2015 (W/out BRT)	Public	11,405,366.4	192,693,048
2015(With BRT)	Public	11,374,452	192,650,016
Reduction 2015(W/out BRT – With BRT)		30914.4	43032
Reduction rate (W/out BRT – With BRT)/W/out BRT		0.27%	0.02%
		Veh-hr	Veh-km
2010 (No BRT)	Private+Public	2,503,185.6	48,995,448
2015 (No BRT)	Private+Public	3,563,637.6	61,720,968
2015(With BRT)	Private+Public	3,559,233.6	61,683,576
Reduction 2015(W/out BRT – With BRT)		4404	37392
Reduction rate (W/out BRT – With BRT)/W/out BRT		0.12%	0.06%

Co-Benefit Analysis of the Proposed C-5 BRT Project Using IGES Guideline

1. Travel time savings
2. Vehicle operating cost reduction
3. Traffic accident cost reduction
4. Cost of emissions

Equation for Travel Time Savings

Benefit of travel time saving $BT = BT_o - BT_w$

Total Travel time cost $BT_i = \sum_j \sum_l \left(Q_{ijl} \times T_{ijl} \times \alpha_j\right) \times 365$

where,

BT : Benefit of travel time saving

BT_i : Total travel time cost with/without project

Q_{ijl} : traffic volume for j vehicle type on link l, with/without project (vehicle/day)

T_{ijl} : average travel time for j vehicle type on link l, with/without project (minute)

α_j : value of time for j vehicle type (Yen/minute*vehicle)

i : $i = w$ with project, $i = o$ without project,

j : vehicle type

l : link

Vehicle Operating Cost Reduction

Benefit of vehicle operating cost reduction $BR = BR_o - BR_w$

Total Travel time cost $BR_i = \sum_j \sum_l (Q_{ijl} \times L_l \times \beta_j) \times 365$

where,

BR : Benefit of vehicle operating cost reduction

BR_i : Total vehicle operating cost with/without project

Q_{ijl} : traffic volume for j vehicle type on link l, with/without project (vehicle/day)

L_l : Link length of link l (km)

β_j : value of vehicle operating cost for j vehicle type (Yen/minute*vehicle)

i : $i = w$ with project, $i = o$ without project,

j : vehicle type

l : link

Formulas for calculating number of human accidents (Japan)

Road section	Intersection
$Z_1 = aX_1$	$Z_2 = bX_2$

Notations:

Z1 : number of accidents (per year)

Z2 : number of traffic accidents at a major intersection (per year)

X1 : vehicle･kilometer (1,000 vehicles･km/day)
= daily traffic volume (1,000 vehicles/day) × link length (km)

X2 : traffic volume multiplied by number of major intersections :
vehicle-intersection (1,000 vehicles･intersection/day)
= daily traffic volume (1,000 vehicles/day) × number of major intersections

a,b: derived parameters per type of road

Estimating Emission Factors (Bangkok Estimates)

Air pollutants = travel distance (veh-km) x emission factor at running speed (g/veh-km)

Table 5-1 Emission factors of passenger car

Speed (km/h)	NOx (g/km)	CO (g/km)	CO_2 (g/km)
7.5	1.161	10.759	319.5
14.7	1.042	9.139	211.7
23.4	1.011	9.351	166.2
33.3	0.908	7.766	150.2
42.9	0.884	8.893	141.2
70.0	0.698	4.727	117.3
90.0	1.058	3.890	128.7

Table 5-3 Emission factors of buses

Speed (km/h)	NOx (g/km/ton)	CO (g/km/ton)	CO_2 (g/km/ton)	PM (g/km/ton)
4.966	2.994	2.213	178.160	0.135
9.231	2.162	1.341	128.640	
15.045	1.770	1.039	108.450	
22.831	1.500	1.046	101.180	
35.465	1.236	0.848	84.380	
60.104	1.041	0.185	58.823	
78.513	1.195	0.332	74.525	

Table 5-4 Emission factors of light duty trucks

Speed (km/h)	NOx (g/km)	CO (g/km)	CO_2 (g/km)	PM (g/km)
7.830	2.691	1.345	415.713	0.126
14.707	1.869	0.945	308.830	
23.213	1.410	0.739	249.250	
34.033	1.174	0.582	217.810	
46.887	1.054	0.506	204.093	
70.110	0.976	0.433	162.337	
90.173	1.053	0.374	185.133	

Table 8 The value of time (Php/hr) of urban transport users (MMUTIS, 1996)

	Design Year		
	1996	2010	2015
Private Mode	74.4	101.20	123.50
Public Mode	60.0	81.6	99.6
Growth Rate (1996 = 1.00)	1.00	1.36	1.66

Table 10 Estimated user's benefit in Metro Manila given the scenarios

	2010 Present Situation Scenario	2015 Without BRT Scenario	2015 With BRT Scenario	Difference Between (Without BRT – With BRT)
Time Cost (Php/year)	107,056,811,528.06	166,293,592,161.26	165,027,449,933.67	1,266,142,200

Table 5-31 Vehicle operating cost (VOC) of public and private transport modes (MMUTIS, 1996)

Speed (km/hr)	Public		Private	
	Php/km	Php/hr	Php/km	Php/hr
0	4.757	25.35	3.268	16.98
10	4.197	40.25	2.849	23.68
20	3.197	47.70	2.640	27.08
30	3.730	50.84	2.284	26.96
40	3.632	52.13	2.379	25.93
50	3.670	52.78	2.342	24.70
60	3.842	53.16	2.352	23.90
70	4.103	53.61	2.422	22.39
80	4.558	54.50	2.562	21.43
90	5.339	56.33	2.805	21.66

Table 5-32 Vehicle Operating Cost Estimates for Metro Manila

Item	Vehicle Operating Cost in Php (24-hr period)	Vehicle Operating Cost in Php(Annually)
Japanese Values from Tables 2-2		
2010(w/out BRT)	461,198,152.80	168,337,325,700
2015(w/out BRT)	591,025,000.00	215,724,125,000
2015(with BRT)	590,629,228.50	215,579,668,400
Reduction rate ((Without –With BRT)/Without BRT)	0.07 %	
Using MMUTIS VOC Estimates in Table 5-31		
2010(w/out BRT)	48,920,401.68	17,855,946,610
2015(w/out BRT)	61,720,969.44	22,528,153,840
2012(with BRT)	61,683,584.16	22,514,508,210
Reduction rate ((Without –With BRT)/Without BRT)	0.06 %	

Table 5-33 Estimated Traffic Accident Costs in Metro Manila, with and without BRT

	2010 Present Situation Scenario	2015 Without BRT Scenario	2015 With BRT Scenario	Difference Between (Without BRT – With BRT)
Loss by Traffic Accident (Php/year)	56,489,004,000	70,494,002,500	70,444,534,500	49,468,000

- less vehicles on the road, hence less accidents

Table 5-39 Modeling of the Emissions

Emission Type	Specific Types	Modeling period	Representative Hourly Emission Estimates (kgs)	Daily Emission Estimates (kgs)
Air pollutants	NOx	2010 base year 2015 (without BRT) 2015 (with BRT)	6,804.14 8,349.73 8,343.09	163,299.38 200,393.55 200,234.20
		Reduction (Without – With BRT)	6.64	159.35
		Reduction rate ((Without – With BRT)/Without BRT)	0.08 %	
	CO	2010 base year 2015 (without BRT) 2015 (with BRT)	41,403.38 54,172.78 53,757.66	993,681.11 1,300,146.77 1,290,183.75
		Reduction (Without – With BRT)	415.12	9,963.02
		Reduction rate ((Without – With BRT)/Without BRT)	0.77 %	
	PM	2010 base year 2015 (without BRT) 2015 (with BRT)	243.30 279.22 277.53	5,839.22 6,701.20 6,660.62
		Reduction (Without – With BRT)	1.69	40.58
		Reduction rate ((Without – With BRT)/Without BRT)	0.61 %	
Greenhouse Gas	CO_2	2010 base year 2015 (without BRT) 2015 (with BRT)	390,111.04 516,293.86 515,875.73	9,362,665.04 12,391,052.54 12,381,017.52
		Reduction (Without – With BRT)	418.13	10,035.02
		Reduction rate ((Without – With BRT)/Without BRT)	0.08 %	

Results of Co-Benefit Estimation in Metro Manila (unit : million Php)

	2015 (Without BRT)	2015 (With BRT)	Reduction (Without-With BRT)
Time Cost (PHP/year)	166,293.6	165,027.5	1,266.1
Vehicle Operating Cost (PHP/year)	22,528.2	22,514.5	13.7
Loss by Traffic Accidents (PHP/year)	70,494.0	70,444.5	49.5
NOx (PHP/year)	284,306.1	284,080.0	226.1
CO (PHP/year)	791.7	785.7	6.1
PM (PHP/year)	471,306.2	468,452.2	2,854.1
CO2 (PHP/year)	3,889.6	3,886.4	3.1

USD 1.00= PHP 43.0
*1 t CO2= USD 20.00

Summary of Findings

- Clean air initiatives in transportation are limited and projects are experimental in nature
- Limited and inadequate efforts to monitor air quality
- Lack of technical capacity to evaluate environmentally-related transport programs and projects

- Demonstrated the applicability of the IGES Co-benefit Guideline for a proposed transportation project (C-5 BRT) in Metro Manila
- Although, more studies (data and research information) are needed to get satisfactory results

References:

1. Country Synthesis Report on Urban Air Quality Management, Philippines, published by the Asian Development Bank (ADB) and Clean Air Initiatives for Asian Cities,(CAI-Asia) Discussion Draft, December 2006
2. Estimation of Co-Benefit from Bus Rapid Transit Introduction in Metro Manila using IGE's Co-Benefit Guidelines

Thank you for listening!

THE END