PORT DEVELOPMENT PROJECTS AND THEIR TRAFFIC IMPACT

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Abstract: The Port District of Manila drafted a 25-year port development plan that will cover the South Harbor, the North Harbor and the Manila International Container Terminal. The objectives of that master plan are urgent port extensions for coping with growing container cargo and passenger traffic. There is a particular problem in the port strategy for the Port of Manila. It is the dominant source of and market for port traffic. However, the port's land operations are severely hampered by Metro Manila's traffic congestion, to which they also contribute. This study aims to assess the adequacy of the present road network and its capability to handle future road traffic considering the numerous port development projects through traffic simulation. Since these port projects will generate mostly freight/cargo traffic, the focus of this study would be on truck traffic and will incorporate related issues like the truck ban scheme and the utilization of railroad as an alternative to trucks in cargo handling and distribution.

1. INTRODUCTION

The Port of Manila is the center of the Philippine port system. It is composed of the South Harbor, North Harbor and the Manila International Container Terminal (MICT). Renamed as "Port District Office of Manila" (PDO-Manila), the port serves as the country's link to major cities of the world and the junction of domestic and international trade. Its economic importance is reflected on employment generation, business opportunities in shipping, cargo handling and other services related to the shipping industry.

From 1978 to 1996, the total cargo throughput in the Port of Manila increased some 200%, with an accelerating annual growth rate. In the later years, from 1987 to 1996, the growth rate was at 14%. At the MICT, the growth rate has been very high since its privatization in 1978, with an annual growth averaging 15% in the last few years. Total sea-borne cargo for the Port of Manila is expected to grow at 10% per annum, so that in 2010 it is expected to be four times the 1995 throughput.

The increasing demand for port services prompted the Philippine Ports Authority (PPA) to draft the Port District of Manila's 25-year port development plan that will cover the South Harbor, the North Harbor and the Manila International Container Terminal.

At the Port of Manila, the port's land operations are severely hampered by Metro Manila's traffic congestion, to which they also contribute. Basically, land transport to and from the Port of Manila is undertaken by road transport. Numerous studies in the past recommended that port development projects should be evaluated considering their traffic impact. This particular study aims to assess the traffic impact of the proposed port developments through traffic simulation. The forecasted port traffic will be converted to the number of trucks that would be necessary for hauling and distribution of these cargoes. The impact of these trucks to the traffic environment will be evaluated through simulation.

Five cases will be simulated to represent the different scenarios prior and upon completion of the said development projects. Case 0 depicts the present condition that is, present traffic volume on the existing roadway facilities. Case 1 represents the scenario for the year 2015 assuming that the proposed port development projects will not materialize. Case 2 will simulate the "do nothing" scenario for the year 2015 wherein forecasted traffic volume as per the MMUTIS Study plus the forecasted truck traffic to be generated by the port development will be tested on the existing roadway facilities. Case 3 considers the effect of propose infrastructures of the MMUTIS Study on the existing road network in simulating the forecasted traffic volume for year 2015 and the forecasted truck traffic. Case 4 considers the effect of the railway system in cargo handling in addition to the scenario in Case 3. **Figure 1** shows flow of this study.

2. REVIEW OF RELATED LITERATURE

The trend of maritime traffic indicates that the west Pacific region will become a center of maritime development in the 21st century. Numerous ports in the region underwent rehabilitation and expansion projects to cope up with the growing port traffic. Land access to ports was also improved considering that ports, functioning as intermodal interfaces, perform a strategic function in providing adequate capacity for the efficient movement of persons and goods in the international marketplace. In the Asian region, the successful ports credit their accessibility to their hinterland as a major factor in ensuring the efficiency of the port.

There are studies regarding the development of the Port of Manila, for example, The Greater Capital Region Integrated Port Development Study in the Philippines by JICA-DOTC (October 1994) tried to grasp the present port operations and it discussed the future development of the port considering the need for decentralization of some port activities away from the Port of Manila. The MMUTIS and MMURTRIP studies reviewed the needs of freight vehicles in Metro Manila with a view in identifying policy changes and investment requirements. The studies concentrated on rationalizing the existing system of truck routes leading to and from the Port of Manila.

This study will assess the traffic impacts of the proposed development projects as per the Master Plan of the Port of Manila and MMUTIS considering forecasted traffic to be generated up to year 2015.

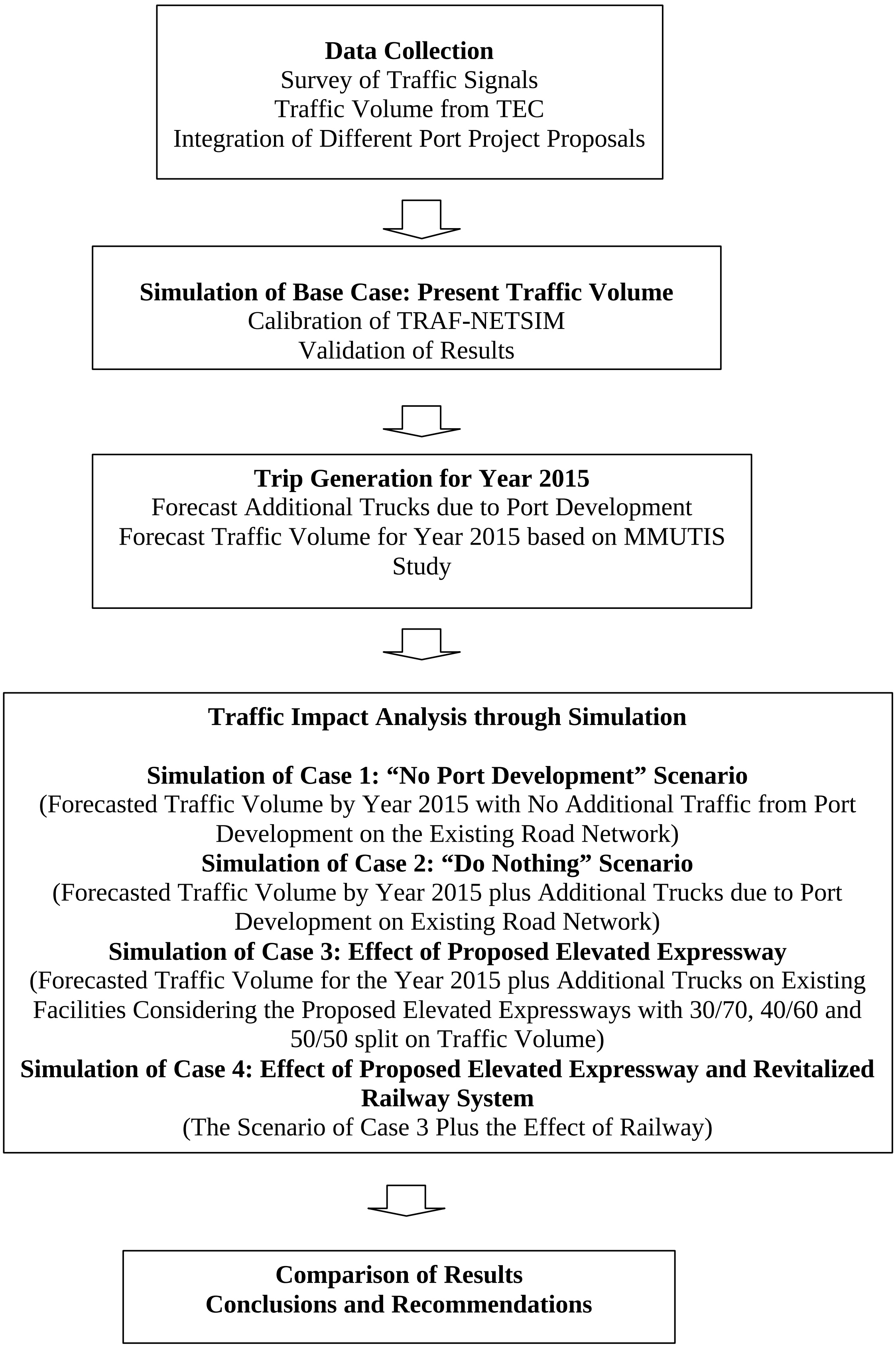


Figure 1. Study Flow

3. DATA COLLECTION AND ANALYSIS

A traffic impact study is basically a before and after type of analysis. It is important to identify the existing traffic operational conditions of the intersections and roadway segments in the study area to allow comparison with future conditions with the proposed developments in place.

In this study, because of the complexity of the road network, the analyses would be performed through traffic simulation using the TRAF-NETSIM software. Data necessary for the simulation run are topology and geometrics of each roadway component (in the form of link node diagram), channelization of traffic, traffic signal timing, traffic volumes, turning volumes, specification of transportation modes and designated vehicle routes.

3.1 Data Gathering for Simulation of Base Case

3.1.1 Survey of Traffic Signals and Roadway Geometrics

The study area for simulation (**Figure 2**) is bounded by R-10, Tayuman St. (C-2), A. H. Lacson St. (Gov. Forbes St.) and P. Burgos St. The area is within the Old City of Manila and is considered the downtown area.

The study area consists of 73 signalized intersection as reflected on the Map of Traffic Signal Locations furnished by the Traffic Engineering Center. Survey was conducted last February 8 – 12, 1999 during morning and afternoon peak hours to gather data for actual green time, phasing of traffic flow, physical attributes (number of lanes, lane width, left-turning bay) of the roads and to observe intersection conflicts, parking and pedestrian activities. Of the 73 intersections, 5 signals were out of order. Ten signal cycle times per intersection were observed to check the stability of the count. The recorded cycle time of the intersections varied from 80 seconds to 180 seconds. The allocated green time per phase for left-turners varied from 10 seconds to 80 seconds. Allocated green time for through traffic per phase ranged from 35 seconds to 110 seconds. The observed amber time is 3 seconds. The traffic signals along Rizal Ave., Gov. Forbes and portion of P. Burgos are now linked to the SCATS system. The traffic signals were not yet linked to the SCATS system during the survey so the traffic signals were then functioning as pre-timed signals. A follow-up survey was conducted in October 6-8, 1999 to check the stability of the signal timing and phasing of traffic flow. Although some of the signals are now linked to the SCATS system, minimal discrepancies were noted; difference of 2 to 5 seconds in green time per phase. This is because the encoded initial cycle time and phasing for the SCATS system were the previous values of the pre-timed signals.

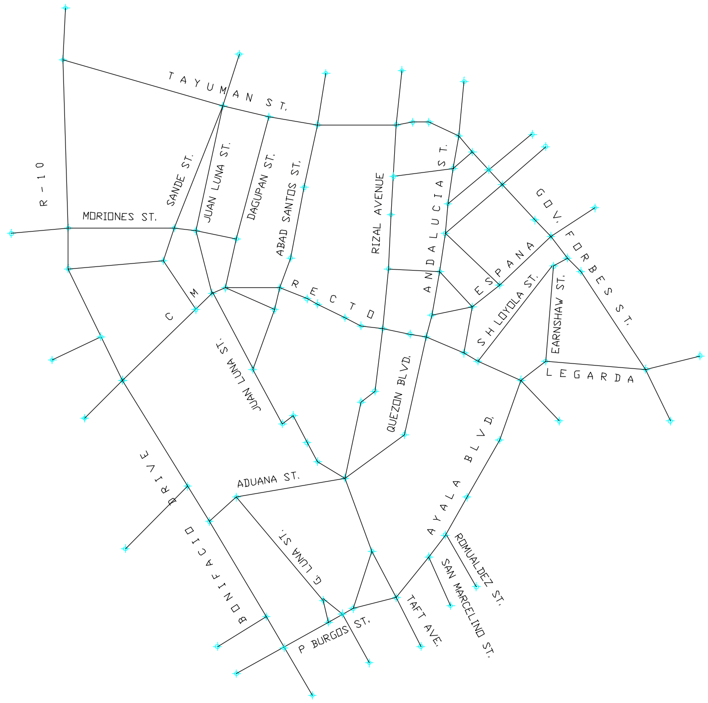


Figure 2. Map of Simulated Study Area

3.1.2 Traffic Volume Data

The study area is quite extensive such that it would be very expensive and time consuming to conduct a traffic volume survey for this study. The Traffic Engineering Center (TEC) conducts periodic traffic volume surveys along major intersections and their data for 1998 were adopted. The traffic count is from 7:00 am to 8:00 pm. Although truck ban is imposed during peak hours (6:00 to 9:00 am and 5:00 to 9:00 pm), the designated truck routes to and from the port are not included. The morning peak volume was used in the simulation.

Extensive ocular inspections within the study area were conducted to observe the prevailing traffic conditions. These were necessary to validate the secondary traffic volume data obtained from the Traffic Engineering Center (TEC).

3.1.3 Identification of Truck Routes

Metro Manila experiences traffic congestion on major routes throughout the day prompting the imposition of the truck ban scheme, which limits cargo movements within, to and from Manila. Truck routes and other prohibitions of truck movement have been in force in Metro Manila since 1978. The designated truck routes to and from the Port defined by MMC Ordinance No. 5, S.1994 that are not included in the truck ban scheme are used in this study.

3.2 Trip Generation for the Year 2015

One basic factor needed to evaluate site traffic impacts is an estimate of the amount of traffic generation associated with the development. For the year 2015, the increase of traffic volume in the study area is based on the factors generated by the MMUTIS Study. The estimate of the amount of freight traffic to be generated by the port development was based on the projected cargo to be handled by the port.

3.2.1 Factors Used in Forecasting Traffic Volume by Year 2015

Metro Manila's population increased from 5.9 million in 1980 to 9.5 million in 1995 posting a 3.2% increase per year. Based on the MMUTIS Study, it estimated to likely reach 13 million by 2015. Although the increase is not so significant in the central part of Metro Manila, the roads in the area have already been saturated that any increase in the future should be subjected to a careful study.

There are three (3) major factors identified by the MMUTIS Study which will contribute to the increase of traffic load on the roads in the future:

a.)	population growth	1.58 times
b.)	relative increase of private mode	1.35 times
c.)	increase in average trip length	1.40 times

The combined effect of these three factors is about 3 times the present traffic volume.

3.2.2 Forecasting of Additional Trucks to be Generated by Port Development

The Port of Manila's 25-Year Development Plan has projections of future port traffic statistics and facility requirements up to the year 2020. However, only projections up to the year 2015 for the South harbor, year 2005 for the North Harbor and year 2010 for MICT will be evaluated reflecting the optimum development of the port. To evaluate the traffic impact on the road network, the projected port cargoes were converted to the number of trucks that would be used for hauling and transport of these cargoes. The result of the O/D survey conducted by JICA in 1994 was adopted to locate the destination of the cargoes. Enumerated below are the other assumptions:

- *number of working days a year = 360 days*
- *average truck load = 1.75 TEU*
- *all inward/outward cargo will enter the study area*
- *inward cargo is equal to outward cargo*
- *uniform flow of trucks per hour*
- *destination of north bound trucks are the provinces linked by the North Expressway*
- *destination of south bound trucks are the provinces linked by the South Expressway*
- *destination of eastbound trucks is Metro Manila*

Table 1 shows the additional trucks to be generated by the proposed development projects.

Table 1. Forecasted Average Truck Traffic (Truck/Hour)

	1996[1]	2015	2015/1996
South Harbor	83	345	4.15
North Harbor	88	145	1.65
MICT	126	440	3.50
Total	297	930	3.13

Source: MMUTIS

The present truck traffic generated by the port is expected to increase 3 times after the completion of the port development plan.

Table 2. Distribution of Forecasted Truck Traffic

Destination	Number of Trucks/Hour
Southbound	345
Northbound	145
Eastbound	440
Total	930

Metro Manila will remain as the major hinterland of the Port of Manila. Metro Manila (including Rizal and other underlying areas) has a share of 47% from the additional trucks to be generated by the port development.

4. TRAFFIC IMPACT ANALYSIS USING SIMULATION

4.1 Simulation Using TRAF-NETSIM

TRAF-NETSIM is a simulation model that allows the traffic engineer to evaluate complex strategies on a real-time basis for a given network. It is a microscopic stochastic simulation model, which is a detailed simulation model that involves the use of probability.

The traffic environment must be specified to exercise the TRAF-NETSIM model. It consists of the following:

- topology of the roadway system (in the form of link-node diagram)
- geometrics of each roadway component
- channelization of traffic (left, thru, right, buses, carpool, etc)
- motorists behavior which determines the operational performance of vehicles in the system (acceleration, deceleration, yellow light response, etc.)
- traffic control devices (stop, yield, signal timing and detector)
- traffic volumes entering the roadway system
- turning movements or origin-destination data
- transportation modes: cars, carpools, trucks and buses
- specification of bus system (routes, stations, and frequency of service)

There are other methods to calculate traffic impact scenarios like the conventional computation of V/C Ratio based on the Highway Capacity Manual (HCM). However, this has limitations because the procedure in large part depends on look-up tables. The values from these look-up tables usually represent an average situation, which may be different from the situation being analyzed. The procedure cannot represent situations wherein there are cases of over-saturation, double parking, lane obstructions, etc. Users have to exercise judgement under such circumstances. TRAF-NETSIM has several advantages when compared to HCM:

- graphics capability
- comprehensiveness
- adaptability
- interaction of traffic factors

4.2 Building of Simulation Network

The model network is composed of 79 internal nodes, 23 entry/exit nodes and 32 signalized intersections. Although data for 68 traffic signals are available, only 32 signals were used because the network was modified to conform within the limits of the TRAF-NETSIM software.

4.2.1 Calibrating TRAF-NETSIM

The following parameters, which reflect the local conditions, were adjusted to calibrate the model. In links wherein the signal timing was not used, the free flow speed was reduced to reflect the stopping at the intersection. The free flow speed is equal to 15 mph (24 kph) based on actual average speed of jeepneys during off-peak hours. This value is low for cars but is reasonable to reflect the behavior of jeepneys (indiscriminate stopping to load and unload passengers) that also hampers the speed of other vehicles and the performance of jeepney engines which are second-hand engines. **Table 3** shows the summary of traffic parameters used for the calibration.

Table 3. Traffic Parameters for Calibration

mean value of start-up lost time for 1st vehicle	3.0 sec
mean queue discharge headway	2.0 sec[1]
desired free flow speed	15 mph/24 kph
start-up acceleration rate	
passenger cars	5.5 mph/sec[2]
jeepneys (carpools)	3.0 mph/sec[3]
trucks	2.0 mph/sec[4]

Note: [1] Analysis of Road Traffic Flow and Traffic Environment in Metro Manila. (Vergel, 1999)
[2] default value (2.44 m/s^2)
[3] slow moving vehicles (1.33 m/s^2)
[4] default value for buses (0.9 m/s^2)

The truck routes were modeled using the record types for bus routes. There were 5 entry/exit nodes for trucks at the Port Area (2 at South Harbor, 1 at MICT and 2 at North Harbor). There were 6 streets that are considered as entry/exit nodes (Romualdez, San Marcelino, R-10, Abad Santos, Andalucia and Gov. Forbes) for trucks going to and from the Port Area. Separate route identifications are necessary for entry and exit. However, the bus/truck routes available in the software are limited to 25 routes only. The initial bus/truck headway is 90 seconds or equivalent to 40 trucks per hour. In cases where the actual number of trucks exceeds 40 trucks/hour, the remaining volume of trucks is added to the source volume.

The jeepney was treated as carpool vehicle in the simulation to distinguish it from cars. The vehicle length used was 25 feet. The load factor carpool was limited to 6 persons per vehicle so this value was adopted instead of the actual average of 14 passengers per jeepney. Jeepney routes are defined in the Study Area but were not reflected on the simulation because there was no provision for carpool routes. Jeepney stops were not modeled. Therefore, short-term events were used although only effective on outer lane.

4.2.2 Checking of Stability of Simulation

After calibration, there is a need to check the stability of the simulation model. The initialization process affects initial simulation cycles so stability of the simulation should be validated. An initialization of 11 minutes was necessary as "fill-up time" prior to simulation. The base data was simulated for 30 minutes. The flow rate of vehicles entering the network was graphed relative to cycle time. Two (2) entry nodes were evaluated: nodes 701 (R-10) and 714 (Taft Ave.). From **Figure 3** and **Figure 4**, after 10 cycles, the flow rates were already stable.

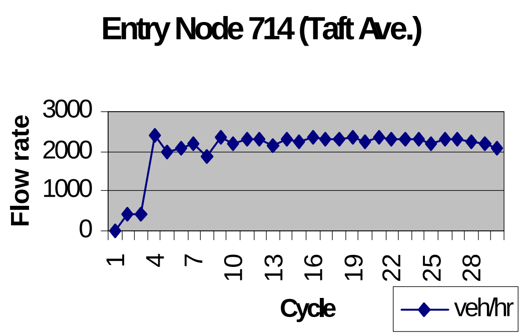


Figure 3. Stability Check at Node 714 (Taft Ave.)

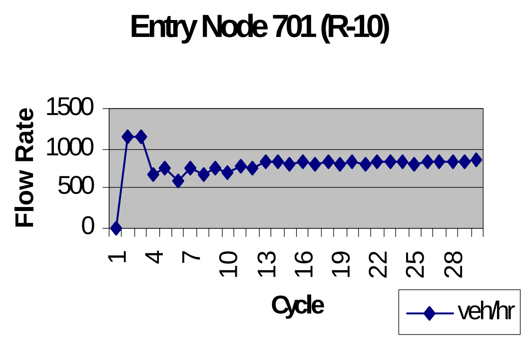
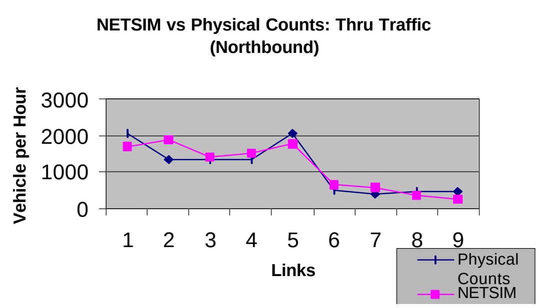


Figure 4. Stability Check at Node 701 (R-10)

4.2.3 Validation of Results

To validate the results of the simulation, the actual flow rates through the links are compared with the simulated flow rates. To illustrate, values for the stretch fronting the Port Area (between P. Burgos and Tayuman St.) were used. The variation between the physical count and the simulation model output on the northbound direction is 1.5 % while at the southbound direction, 27%.



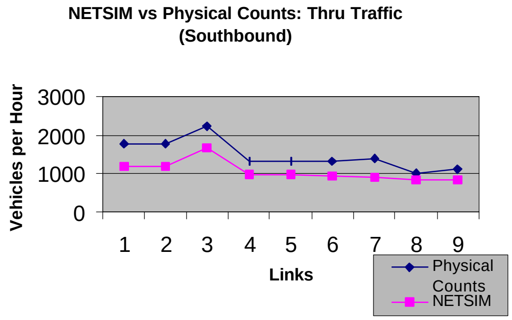


Figure 6. Comparison Between Simulated and Actual Traffic Count along Bonifacio Drive and R-10 (Southbound)

4.3 Scenarios for Traffic Simulation

Five cases representing different scenarios will be evaluated through traffic simulation. These are summarized in **Table 4.**

Table 4. Scenarios for Traffic Simulation

Case	Year	Traffic Volume	Conditions
Case 0	1998	1998 Traffic Volume	**Base Data**
Case 1	2015	2015 Traffic Volume	"no port development in 2015" Forecasted Traffic Volume
Case 2	2015	2015 Traffic Volume + Additional Trucks due to Port Development	"do nothing case" Forecasted Traffic Volume + Add'l Trucks on Present Road Network
Case 3	2015	2015 Traffic Volume + Additional Trucks due to Port Development	Considered the proposed elevated expressway: 50/50, 40/60 and 30/70 split for traffic volume affected by the proposed elevated expressway
Case 4	2015	2015 Traffic Volume + Additional Trucks due to Port Development Considering the Effect of Rail	Considered the proposed elevated expressway and railway: average of Case 3; capacity of rail equal to capacity of 40 trucks/hr per direction (northbound and southbound)

4.3.1 Simulation of Base Case (Case 0)

Simulation of Base Case (Case 0) is the simulation of the present traffic situation at the study area. Data for traffic volume was gathered from the Traffic Engineering Center (TEC) while data for traffic signals and roadway geometrics were from actual surveys. **Figure 7** shows the simulated present average speed along the Study Area. The average network speed is 15.84 kph.

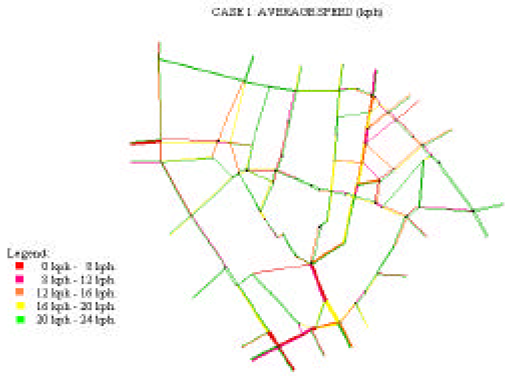


Figure 7. Results of Simulated Speed (kph) for Case 0

The simulation captures the actual trend of the average speed in the study area.

The simulation also captures the location of "hot spots" or congested intersections. To illustrate, **Figure 8** shows the traffic behavior at the intersection of P. Burgos St. and Bonifacio Drive. The congestion in this intersection due to the presence of significant number of queuing trucks directly affects the accessibility of the Port Area since this links the Port Area to the airport via Roxas Bouvelard and to the Southbound truck route leading to South Superhighway.

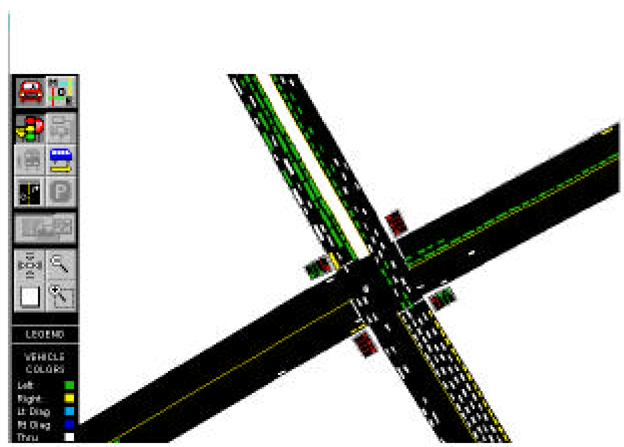


Figure 8. Simulation of P. Burgos and Bonifacio Drive Intersection

4.3.2 Simulation of CASE 1: " No Port Development Until 2015"

The 25-year port development plan was drafted in 1995 when the country was experiencing steady economic growth. The financial crisis that hit the Asian region in 1997 affected the timetable of the implementation of the proposed port development projects. It is within this scenario that CASE 1 is assumed, no port development projects until 2015. The traffic growth will be based on the forecasted traffic volume for the year 2015 of the MMUTIS Study. The present traffic volume was increased by almost times 3 as per the estimate of the MMUTIS

Study to represent the traffic volume by year 2015 assuming that there would be no additional traffic due to port development projects. This scenario yielded an average network speed of 10.72 kph. **Figure 9** shows the speeds at various links.

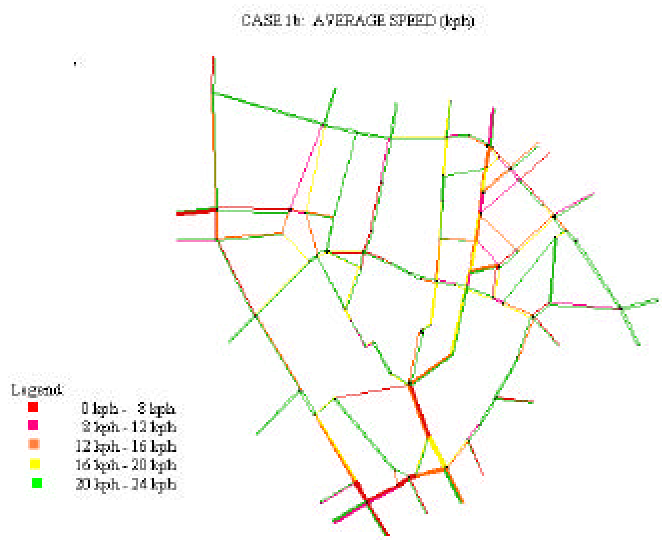


Figure 9. Results of Simulated Speed (kph) for Case 1

4.3.3 Simulation of CASE 2: "Do Nothing Scenario" - Forecasted Traffic Volume (2015) Plus Forecasted Trucks on Existing Road Network

The simulation of CASE 2 represents the "do nothing" scenario; forecasted traffic volume plus the additional trucks to be generated by the port development projects with no additional road infrastructure. The forecasted traffic volume is 3 times the present volume.

The average network speed considering the "do nothing" scenario is 10.56 kph. The effect of the additional trucks to be generated by the port development projects on the entire network is minimal, a decrease of 0.16 kph on the average network speed. However, on the designated truck routes, the effect is significant. A comparison of average speed and travel time between the results of Case 1b and Case 2 along Bonifacio Drive and R-10 are shown in **Table 5** and **Table 6** below.

Table 5. Comparison Between Case 1 and Case 2 (Bonifacio Drive)

	Average Speed (kph)			Travel Time (sec/veh-trip)	
	Case 1	Case 2	Diff.	Case1	Case 2
Bonifacio Drive (Northbound)	14.72	12.32	(-2.4)	134.1	160.7
Bonifacio Drive (Southbound)	16.32	15.84	(-0.48)	129.6	132.4

Table 6. Comparison Between Case 1 and Case 2 (R-10)

	Average Speed (kph)			Travel Time (sec/veh-trip)	
	Case 1	Case 2	Diff.	Case1	Case 2
R-10 (Northbound)	9.76	9.44	(-0.32)	256.2	274.2
R-10 (Southbound)	13.92	12.80	(-1.12)	169.8	186.5

4.3.4 Simulation of CASE 3: Forecasted Traffic Volume (2015) Plus Forecasted Trucks Considering the Proposed Elevated Expressway

The MMUTIS Study presented a proposal for a port access plan that would help link up the port area to its hinterland unhampered by the urban traffic congestion. The proposed R-10/C-3 elevated expressway should be connected to the Skyway Project to function effectively. Numerous road improvements are also being lined up as listed in the Medium Term Development Plan of the MMUTIS Study that would also help alleviate the traffic congestion.

For the simulation of CASE 3, the existing road network was used but the traffic volume was reduced assuming the effect of the proposed elevated expressway. Three cases are assumed wherein 30%, 40% and 50% of the traffic volume including the forecasted trucks to be generated by the proposed port development projects would use the proposed elevated expressway and the complimentary 70%, 60% and 50% will use the existing road network.

The result of the sensitivity analysis considering the average speed along Bonifacio Drive and R-10 are tabulated below in **Table 7**. In addition, a graphical representation (**Figure 10**) of the analysis shows that the effect of the variation of modal split is not significant.

Table 7. Sensitivity Analysis

	Bonifacio Drive Northbound (kph)	Bonifacio Drive Southbound (kph)	R-10 Northbound (kph)	R-10 Southbound (kph)
50/50	14.56	16.64	10.40	15.52
40/60	12.48	17.28	10.40	14.88
30/70	13.44	16.69	10.08	14.88

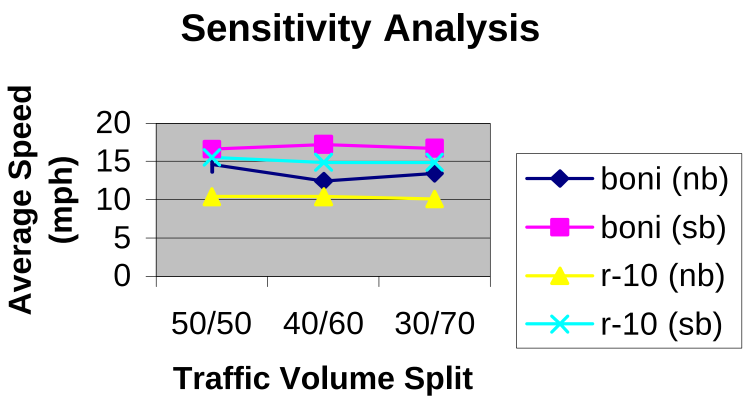


Figure 10. Sensitivity Analysis Graph

The average network speed considering the 3 modal splits is 11.36 kph. This improves the average speed of the "do nothing" case by almost 8%.

4.3.5 Simulation of CASE 4: Forecasted Traffic Volume (2015) with Forecasted Trucks Considering the Proposed Elevated Expressway and the Effect of Rail

The increasing freight traffic at the Port of Manila is having a significant impact on urban road system. In order to alleviate urban road congestion, railway rebirth and inland depot development are necessary. Outside of Manila, much of the growths are within the underlying provinces with fast developing industrial areas.

At present, there are two inland container depots (ICD) at the CALABARZON area. The Asian Terminals Inc. (ATI), which manages the South Harbor, established an inland container depot at Calamba, Laguna. The ICD is not yet connected with the existing Philippine National Railways (PNR) so the transport of containers from the Port Area is by trucks. There are plans, however, for spurlines that would connect the ICD to the existing PNR lines.

Located also in Calamba, Laguna is the first inland container depot (ICD) of the International Container Terminal Services Inc. (ICTSI), which manages the Manila International Container Terminal (MICT). This is connected to the Philippine National Railway (PNR) system through a set of spur lines and is the Philippines' first rail serviced ICD. The operation of the spur lines started last August 1997.

The JICA Study in 1994 proposed two ICD sites that will serve the northern provinces to be located at the Clark Air Base in San Fernando, Pampanga and POLO outside of Valenzuela. These ICDs will be connected to the existing PNR Lines via the North Rail Project.

Considering the same capacity for the northbound rail, 41 TEUs per trip (one-way), tabulated in **Table 8** are following assumptions for the optimum operations of rail in handling freight distribution to alleviate road traffic.

Table 8. Assumptions for Optimum Operations of Rail

length of train (21 15-meter long rail cars)	315 meters
speed of train	20 kph
time, in seconds, to cross road intersections	57 seconds (approximately 1 minute)
number of trips per hour	2 trips/hour

The presence of a revitalized railway system for freight handling slightly improved the average network speed to 12 kph. The effect of rail that would reduce 40 trucks/hr per direction (northbound and southbound) on the designated truck route in alleviating congestion is almost insignificant. However, the average speed of rail that is 20 kph is far better than even the present average speed in the road network, 15.84 kph. This in effect, will hasten the activity of container distribution to and from the Port Area to the ICD's outside of Manila. **Figure 11** shows the speeds of links in the network for Case 4.

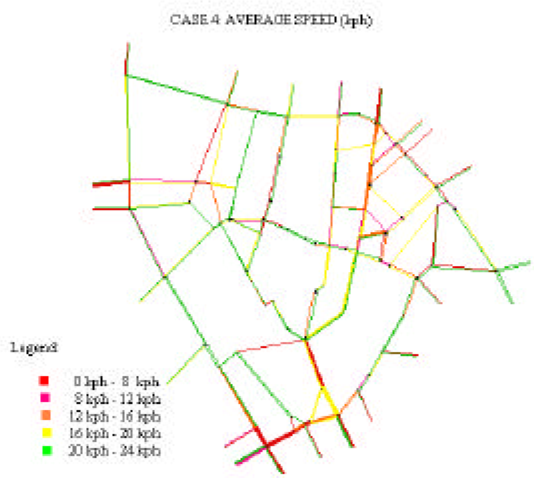


Figure 11. Results of Simulated Speed (kph) for Case 4

4.4 Comparison of Results and Analysis of Simulation

Table 9 shows the average network speed during the simulation of the five cases.

Table 9. Average Network Speed

Case	Average Speed (kph)
Case 0	15.84 kph
Case 1	10.72 kph
Case 2	10.56 kph
Case 3	11.36 kph
Case 4	12.00 kph

Assuming a "do nothing" scenario, 33% or 5.28 kph will be reduced from the present average network speed of 15.84 kph. The proposed elevated expressway considering the assumptions in the traffic distribution split would improve the average speed to 11.36 kph as compared to 10.56 kph of the "do nothing" scenario. The effect of rail that would reduce 40 trucks/hr per direction (northbound and southbound) on the road network in alleviating congestion is almost insignificant.

5. CONCLUSION AND RECOMMENDATIONS

Traffic simulation using TRAF-NETSIM can be used to assess and analyze traffic impact scenarios as in the case of the proposed port development projects. The software could be calibrated to adopt and reflect local settings.

From the results of the simulation, the effects of truck traffic to be generated by the proposed port development ports do not affect significantly the average network speed. However, it is a major factor in decreasing the average speed in the designated truck routes like Bonifacio Drive, R-10, P. Burgos, Ayala Blvd., Gov. Forbes St. and Tayuman St.. Additional roadway infrastructure and better access to the port is necessary for efficient traffic flow. The average speed of 10.56 kph for the “do nothing” scenario signifies a low level of service.

Based on the results of the study and outputs of the simulation, the following policies and countermeasures are recommended for the improvement of traffic flow and freight distribution.

1. Utilization of rail in freight distribution and inland container depot
   The utilization of rail in freight distribution has little effect to decongest the road traffic in Metro Manila based on the simulation of Case 4. However, a reliable railway system and inland container depots are vital in the industrialization of the country. These are necessary to support the “just-in-time” inventory control programs through fast cargo handling and delivery. The average speed of rail, which is 20 kph, is far higher than 15.84 kph, which is the present average speed. In addition, these will contribute to the efficiency of the port by quickly transporting inbound containers to the ICD, and by extending its yard capacity.
2. Optimization of signal timing and strict enforcement of traffic signals
   The simulation model considered “logical” behavior of drivers, i.e, to continue moving as allowed by the circumstances. This could be achieved in practice through optimal use of signal timing, strict enforcement of traffic signals and adequate traffic enforcement manning the intersections. In effect, drivers would strictly obey traffic signals and the green time is maximized. The Traffic Engineering Center, which controls the traffic signals, is now on the process of linking the traffic signals to the SCATS system. The system uses actuated signal systems and coordinated signal timings through area-wide traffic control system to minimize delays and increase capacity. Strict enforcement of the traffic signals could be achieved through coordination between the Traffic Engineering Center, which operates the traffic signals, and the Metropolitan Manila Development Authority, which handles traffic operations. However, at present, the traffic enforcers manning the intersections as well as the motorists are not yet fully aware of how the SCATS system operates. Traffic signals are sometimes turned off and the enforcers direct the traffic manually, which often lead to a more chaotic system.

REFERENCES

1. Athanailos, Ernest G. (1994) The integration of the highway capacity manual and the TRAF-NETSIM simulation model. **ITE Journal**.
2. Dey, Soumya S. and Jon D. Fricker (1994) Traffic impact analysis and impact fees in state departments of transportation. **ITE Journal**.
3. Asian Terminals, Inc. Website, http://www.asianterminals.com.ph.
4. Feasibility Study of Smokey Mountain Port Terminal, (1995) R-II Builders, Inc., Diliman, Quezon City.
5. Fujita Ikuo (1997) Lecture Ports and Harbors in Japan: Institutional Frame, Planning Process and Financing Scheme, University of the Philippines, Diliman, Quezon City.
6. Highway Capacity Manual (1985) Transportation Research Board.
7. Hoyle, B.S. and D. Hilling (1984) **Seaport Systems and Spatial Change**. John Wiley and Sons.
8. International Container Terminal Services, Inc. Website, http://www.ictsi.com.
9. JUMSUT: Metro Manila Transportation Planning Study (1983) Japan International Cooperation Agency.
10. Metro Manila Development Authority Website, http://www.mmda@evoserve.com.
11. Metro Manila Urban Road Transport Integration Project (1998), Halcrow Fox.
12. Philippine Ports Authority Website, http://www.ppa.gov.ph.
13. Philippine Transport Strategy Study, Final Report, Vol. 2: Main Text, Halcrow Fox.
14. Review of Master Plan and Feasibility Study for Rail Served Inland Container Depots (1986), Renardet S.A. Consulting Engineers.
15. South Harbor Expanded Port Zone (1999) Planning Resources and Operations Systems, San Juan, Metro Manila.
16. The Greater Capital Region Integrated Port Development Study in the Philippines (1994) Japan International Cooperation Agency.
17. The Port of Manila's 25-Year Development Plan, Philippine Ports Authority, Manila.
18. TRAF-NETSIM User's Guide Version 4.2 (1995) Office of Traffic Operations, Federal Highway Administration, Washington D.C.
19. Vergel, K. (1999) Analysis of Road Traffic Flow and Traffic Environment in Metro Manila, Tokyo Institute of Technology, Tokyo, Japan.
20. Wong, S.Y. (1990) TRAF-NETSIM: How it works, what it does. **ITE Journal**, April, 22-27.