Alleviating Traffic Congestion in Manila, Appraisal of the Pasig Expressway

Baher El-Hifnawi
Cambridge Resources International Inc.

Glenn P. Jenkins
Queen's University, Kingston, Canada.
Eastern Mediterranean University, North Cyprus.

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Abstract

Travel in Metro Manila at present is characterized by high levels of congestion, slow travel speeds, long journey times and limited road capacity. The situation will be further exacerbated due to the expected growth in population and income and the subsequent increase in car ownership. Localized traffic management schemes are no longer sufficient to solve the problem. Solutions on the demand side curbing the demand for car ownership and use should be considered together with solutions on the supply side that involve the provision of new road space. This study completed an integrated financial, economic, stakeholder, sensitivity and risk analysis of the proposed modified version of the Pasig expressway.

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Alleviating Traffic Congestion in Manila

Appraisal of the Pasig Expressway

I) Introduction

Travel in Metro Manila at present is characterized by high levels of congestion, slow travel speeds, long journey times and limited road capacity. The situation will be further exacerbated due to the expected growth in population and income and the subsequent increase in car ownership. Localized traffic management schemes are no longer sufficient to solve the problem. Solutions on the demand side curbing the demand for car ownership and use should be considered together with solutions on the supply side that involve the provision of new road space.

Several tolled expressways are being considered to alleviate the worsening traffic conditions in the Metro Manila area. In 1994, the Strategic Alliance Development Corporation (STRADEC), in association with Marubeni and Kumagi Inc. submitted an unsolicited proposal to DPWH for the design, construction, funding and operation of three radial routes based on the alignment studies of the Metro Manila Urban Expressway System (MMUES).

Following preliminary studies, the proposal was modified in 1996. Two of the three proposed routes were dropped due to extensive right-of-way requirements. The project being considered now is a modified version of the third route (the Pasig expressway) whose alignment has been changed and has been extended.

II) **Project Description**

A) Project Objectives and Scope

The project's objective is to improve accessibility and reduce travel time between the eastern side of Metro Manila and the Makati area. The project will be undertaken by the private sector, hence engaging them in infrastructure development and relieving the DPWH of the financial and direct supervisory responsibilities over construction, operation and maintenance of the toll facilities for the duration of the 30-year concession period.

The project involves the construction, maintenance, and operation of 15.22 Kms of expressway from Edsa to Marcos Highway. The project consists of the following components:

1. Phase 1: Edsa to F. Bonifacio North gate 0.896 Km
2. Phase 2: F. Bonifacio North gate to Ortigas Ave. Ext. 11.574 Km
3. Phase 3: Ortigas Ave. Ext. to Marcos Highway 2.750 Km
4. Seven interchanges and/or entry/exit ramps
    - Edsa North on/off ramps (2 lanes each)
    - Rizal on/off ramps (2 lanes each)
    - F. Bonifacio North gate on/off ramps (2 lanes each)
    - C-5 on/off ramps (2 lanes each)
    - Imelda Ave. Interchange (2 lanes each)
    - Marcos Highway on/off ramps (2 lanes each)
    - C-6 connection ramps (2 lanes each)
5. Two toll plazas: one at Fort Bonifacio and one at Manggahan

The expressway will be mainly an elevated one with a small portion constructed at grade. Of the elevated section, 10.24 Km will be 6 lanes and 2.75 Km will be 4 lanes. The section of the expressway to be built at grade is 2.23 Km and will be 6 lanes wide. Table 1 shows the estimated distances of elevated and at-grade roadways by phases.

Table 1
Type and Distance of the Different Phases of the Expressway

Segment	Description	Span Length (m)	Span Width (m)	Segment length (km)
Phase 1: EDSA-FB Northgate	dual 3-lane viaduct, land construction	41.05	13.40	0.57
	dual 3-lane viaduct, river construction	41.05	13.40	0.33
	2-lane ramp-viaduct, land construction	41.05	8.90	2.19
	2-lane ramp-viaduct, river construction	41.05	8.90	0.21
	Sub-Total (excluding ramps)			**0.90**
Phase 2: FB Northgate-Ortigas Avenue	dual 3-lane viaduct, land construction	41.05	13.40	4.93
	dual 3-lane viaduct, river construction	41.05	13.40	0.26
	6-lane double deck viaduct, land construction	30.00	13.40	4.15
	6-lane at-grade		14.00	2.23
	2-lane ramp			2.24
	Sub-Total (excluding ramps)			**11.57**
Phase 3: Ortigas Avenue-Marcos Highway	4 lane viaduct	30.00	8.90	2.75
	Sub-Total			**2.75**
	Grand Total (excluding ramps)			**15.22**
	Grand Total (including ramps)			**19.86**

Source: Department of Public Works and Highways. Report on the Discussion between the Technical Evaluation Group and the Project Proponent, Pasig Expressway (undated)

B) Project Cost and Financing

Total project cost is estimated to be around 21 billion 1997 (year 0) Pesos. This includes all financial expenses and interest during construction (IDC).[1] Over 50% of the project cost accounts for the civil works. Financing costs and IDC represent about 25% of the total project cost, while land and right of way constitute around 15% of the total cost. Table 2 shows the breakdown of the project cost by year of expenditure.

Table 2
Project Cost (millions of Pesos)

	Year 0	Year 1	Year 2	Year 3	Total
Civil Works	1,777.97	4,039.76	4,632.26	542.52	10,992.52
Construction Supervision	76.17	179.57	211.30	16.28	483.32
Land/Right of Way	1209.75	2433.37			3643.13
Preoperative Expenses	82.39				82.39
Pre fabricated toll plaza		120.01	193.84		313.85
Detailed engineering	272.82				272.82
Mobilization	321.00				321.00
Traffic Management	74.41	187.50	243.00	49.99	554.90
Financing*	5,533.58				5,533.58
TOTAL COST (in year 0 Pesos)					**20,800**

* Financial Expenses are taken as a lumpsum in year zero due to lack of information. It is assumed that this value is a non-cash item and is, hence not included in the cashflows.

Source:

- Kumagai Co. Ltd., Marubeni Corporation, Strategic Alliance Development Corporation. Unsolicited Investment for the proposed Pasig Expressway, Addendum No. 2.
- Memo from the ICC Technical Board to the Chairman and Members, ICC regarding he Pasig Expressway Unsolicited BOT Proposal, 12 January 1998.
- Authors' modifications

[1] It should be noted that IDC while part of the project cost, will not be included in the cash flow statement as it was not actually paid.

The project will be financed through loans (50%), bonds (25%) and common equity (25%). The 50% loans are in turn divided into a 30% domestic loan and a 20% foreign loan.[2] The domestic loan carries a real interest rate of 3.75%, has a grace period of 3 years and is to be repaid in 6 equal installments. With an expected 8% rate of domestic inflation, the nominal rate of interest comes to 12.05%. The nominal rate of interest on the foreign loan is 7.12% based on a real rate of interest of 4% and an expected US dollar inflation of 3%. The grace period is 4 years and the principal plus interest is to be paid back in 8 equal installments. The convertible bonds have a real rate of interest of 2.4% and a maturity of 10 years.

III) Traffic Model and Forecasts[3]

The traffic and revenue forecasting studies were carried out by Halcrow Fox (HF) based on a SATURN traffic model. Such models typically have two main components: the description of the highway network and the matrices of traffic demands by vehicle category. Most models include a set of matrices corresponding to the weekday peak hour, another set of matrices for weekday non-peak hour and a third set for the weekend travel.

The highway network was updated from earlier work that HF had carried out in Metro Manila. The updates included the Skywalk, C5, and C6. The updated network included some necessary improvements to the road network such as grade separation at major interchanges. These improvements were not yet made but are expected to be

[2] The division of the loans into a foreign portion and a domestic portion was assumed to demonstrate the impact of a foreign loan.
[3] This section is based on: Halcrow Fox, Pasig Expressway, Traffic and Revenue Forecasts, Final Report, 12 November 1997.

undertaken due to their necessity. Only improvements that were considered to have a direct impact on the demand for the Pasig Highway were included in the model.

Origin destination trip matrices for each vehicle type were updated using the 1995 census data and other surveys to better replicate travel patterns and to serve as a sound base to derive forecast assumptions. The model was reasonably successful in replicating travel patterns in the base year (1997), as the difference between simulated results and actual counts was around 20%.

Future year models were developed for 2001, 2010, 2020 and 2030. These models were used to determine traffic forecasts for these years. Traffic forecasts for other years were extrapolated assuming constant growth rates between 2001 and 2010, between 2010 and 2020, and between 2020 and 2030.[4] A different growth rate was used for each of the three different classes of vehicles. Class 1 represented cares and jeepneys, Class 2 represented buses and light trucks, and Class 3 represented heavy trucks and trailers.

One of the key assumptions in building the model is that the *only change* in trip patterns will result from trip reassignment i.e. cars using different routes once the Pasig Expressway is built. One could also expect some changes resulting from road users switching from one mode to another, changing the time of the trip, and changing the origin or the destination of the trip (one could change place of residence, place of work, shopping, etc.) These latter effects were ignored in the model.

[4] This assumption was made by the authors.

IV) Financial Analysis

A. Assumptions

Most of the assumptions are based on the provided appraisal reports. Outlined below are the important assumptions and those that have been made or changed by the authors of this report.

1. Since almost all investment costs were given in Pesos, an arbitrary proportion of the investment cost and the debt were expressed in foreign currency.

2. The definition of mobilization used in the investment costs was expanded to include other items such as overhead and utility relocation.

3. Financial costs that include mostly interest during construction were not clearly spelled out in the project documents and were thus included as a lump sum in year 0 when estimating total project cost. To the extent that this item is IDC that is not paid during construction, it has no bearing on the cashflows and is not included.

4. The breakdown of civil works into its different components was based on tables in the Report on the Discussion between the Technical Valuation Group and the Project Proponents for the Pasig Expressway.

5. The physical contingency was added to the different components of the investment cost.

6. The project was assumed to have accounts payable in the order of 5% of its operation and maintenance expenditures.

7. The project was assumed to hold a cash balance in the order of 10% of its operation and maintenance expenditures.

8. It was assumed that all payments to the project would be in cash and so the project would not have any accounts receivable.

9. The rates of inflation for the Philippines Peso and for the US Dollar were taken as 8% and 3% respectively for the duration of the project.

10. The exchange rate in year 0 was taken as 39 Pesos per US Dollar. This rate depreciates by the difference in inflation rates every year according to the purchasing power parity model.

11. The project will pay VAT of 10% on its inputs and a corporate income tax of 35% on its profits.

12. The project life is 30 years after which the residual value of the civil works and the toll plaza are assumed to be zero. The lives of these assets for tax purposes were assumed to be 20 years only.

13. Administrative overhead is assumed to grow at a real rate of 1% per annum.

14. Annual maintenance is taken as 5% of gross revenues; and periodic maintenance is taken as 900 million year 4 Pesos every 5^{th} year.

15. Insurance cost is 2 million Year 4 US dollars per annum.

16. The annual average daily traffic (AADT) for the three classes of vehicles for the years 2001, 2010, 2020 and 2030 are estimates produced by Halcrow Fox using their traffic models. The AADT for the other years have been estimated on the basis of a constant annual growth rate of traffic. For example, the growth rate in Class 1 vehicles from 2001 to 2010 followed a constant annual growth rate. Another one was estimated for the years between 2010 and 2020 and a third one for the years between 2020 and 2030. This was carried out for each class of vehicle at each of the two tollgates.

17. Toll rates for the first year of operation were determined after negotiations between the project team and the DPWH. These rates are to be adjusted very two years according to the following automatic escalation formula:

- $TR^{Yr=t} = TR^{Yr=t-2} * [1 + \{F_w *((1 + D^{Yr=t-1})*(1+D^{Yr=t-2})-1)\} + \{P_w * ((1+I^{Yr=t-1}) * (1+I^{Yr=t-2})-1)\}]$

where:

$TR^{Yr=t}$ & $TR^{Yr=t-2}$ are the toll rates in year t and year t-2 respectively

F_w is the foreign exchange weight (the share of foreign exchange in total project cost)

P_w is the price weight (the share of domestic currency in total project cost)

$D^{Yr=t-1}$ & $D^{Yr=t-2}$ are rates of devaluation of the Peso against the dollar in year (t-1) and year (t-2) respectively

$I^{Yr=t-1}$ and $I^{Yr=t-2}$ are the domestic inflation rates in year (t-1) and year (t-2) respectively.

The above formula includes an adjustment element for the Peso inflation and for the devaluation in the Peso against the US dollar.[5] The lag in the adjustment would have the effect of lowering the effective toll rate throughout the life of the project.

18. The AADT and the toll rate are independent variables. In other words a decrease in the toll rate in this analysis will not result in an increase in the users of the expressway and vice versa.

B. Methodology

The analysis follows the Harberger/Jenkins methodology outlined in detail in the accompanying manual. Working tables are prepared in *nominal* terms to take into account the different impacts of inflation. Cashflows in nominal Pesos are first arrived at before being deflated to real cashflow statements.

The financial analysis has two main objectives in this particular instance. The first is to conduct an analysis from the point of view of the project sponsors (equity point of view) to determine their financial returns from the project. The second objective is to

[5] The automatic extension formula does not include an adjustment element for the US dollar inflation. It is also not entirely clear how the foreign exchange weight and domestic price weight will be estimated. It is also worth noting that there would have been no need to adjust for the foreign and domestic shares using the formulation the spreadsheet model undertaken in this study. The use of the purchasing power parity model to determine the nominal exchange rate each year makes it sufficient to

determine whether the tolls generated would sufficiently cover all operating and maintenance costs and debt servicing.

C. Results

Under the stated assumptions, the project is expected to generate a NPV of 4.3 billion Pesos for its sponsors and earn an internal rate of return of 21%. This implies that there could be some room for discussion regarding the set tariff rates.

Also, the positive net cashflows of the project indicate that it should have no difficulty in meeting its financial obligations and in covering the operating and maintenance costs.

D. Sensitivity Analysis on Financial Returns

The sensitivity of the financial results of the project to changes in a number of variables was tested. Specifically, the robustness of the Net Present Value from the owners' point of view and the net cash flow of the project were examined. A sensitivity analysis was carried out on the net cash flows from Years, 4, 9 and 14 to determine whether the project may face problems servicing its debt and financing its operating and maintenance expenditures if certain variables change.

Domestic Inflation Rate: The financial returns to the project are highly and adversely affected by the domestic rate of inflation. A 25% percent increase in the rate of inflation (from 8% to 10%) results in an almost equivalent decline in the NPV of the project from the owners' point of view. This is mainly due to the lag in the

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adjust for the domestic inflation rate only in the deterministic case. If the exchange rate does not adjust in this manner, then a separate adjustment for each of the two components will be necessary.

adjustment of the toll rate (every two years). The higher the rate of inflation, the larger the loss in toll revenues every second year (during which the toll rate does not get adjusted for inflation). An increase in the rate of inflation from the assumed level of 8% to around 17.5% would render the project unprofitable.

Annual Average Daily Traffic (AADT) & the Toll Rate: The NPV of the project and its NCF are sensitive to changes in either of these variables. A 5% decline in the AADT (or toll rate) would lead to a 15% decline in the NPV. A decrease of about 35% in the AADT (or toll rate) would result in a negative NPV for the project although it appears that the project would still be able to meet its operating obligations at that level. Both variables affect the financial returns in the exact same manner as they both work directly through toll revenues. There is a strong assumption involved however that the toll rate is independent of the AADT. In other words changes in AADT would not have an impact on the toll rate and vice versa. Ideally these should be linked in the spreadsheet model based on the demand elasticities.

Cost Overrun: A 5% cost overrun results in an 8% reduction in the project's NPV. While this implies that project returns are quite sensitive to changes in the capital cost, the project can overcome a 40% cost overrun and still yield positive financial returns. The impact of the increase in capital cost is mitigated by the increase in the depreciation allowances and interest expense, which lower the project's income tax liability.

Other Variables: The financial NPV of the project and the NCF are hardly affected by changes in the administrative overhead or annual maintenance because these variables constitute a small portion of the project's revenues.

E. Risk Analysis of Financial Returns

a) Assumptions:

Based on the sensitivity analysis conducted above, it was determined that the financial returns of the project are sensitive to the inflation rate, the investment cost, the levels of traffic and the toll rate. While there will always be a degree of uncertainty surrounding the first three variables, the toll rate will be set by the DPWH and hence should not be treated in the analysis as an uncertain variable.

Although traffic levels are likely to fluctuate from year to year, the main question with regard to the traffic level is whether the original estimates are reasonable or not. If they are, there will be the usual fluctuations around that estimate and its projected growth trajectory every year. The sensitivity indicates that the project will be able to withstand these fluctuations. If these estimates are not right, the project may start at a much lower or higher level. In other words, it is the starting level that is important in this case. Consequently, one risk variable is used to model the AADT. A normal distribution of ± 30% was used.

A cost overrun factor was modeled as a risk variable to determine the impact of an increase in the investment cost of the project's viability. A triangular distribution with a range of ± 30% was used. A different risk variable was used for inflation each year of the project as there is likely to be a different inflation rate each year. A step

distribution was used and the minimum inflation rate assumed was 5% and the highest was 13%. The distributions of the different risk variables and their ranges are given in Table 3: below:

Table 3
Risk Variables, Distributions and Ranges

1. Cost Overrun Factor	Normal distribution with parameters			
	Mean			0%
	Standard Dev.			10%
2. **Traffic Escalation Factor**	Triangular distribution with parameters:			
	Minimum			-30%
	Likeliest			0%
	Maximum			30%
3. **Inflation Rate**	Step Distribution			
(a risk variable for every project year)	Range			Prob.
	5%	to	7%	0.30
	7%	to	9%	0.50
	9%	to	13%	0.20

b) Results

The impact of changes in the risk variables outlined below was tested on the NPV of the project from the owners' point of view, the net cash flow (NCF) in year 4 and NCF Yr. 9. Five thousand simulations were run.[6] The risk analysis indicates that the project is financially very attractive and is far from risky as the probability of a negative return to the owners is almost negligible at less than 5%. It is also apparent from the simulations that the project will not have any problems servicing its debt under the present set of assumptions. The cumulative probability distribution for the NPV and some statistics are presented below in Figure 1 and Table 4 respectively. Needless to say, since the means of the risk variables used in conducting the risk

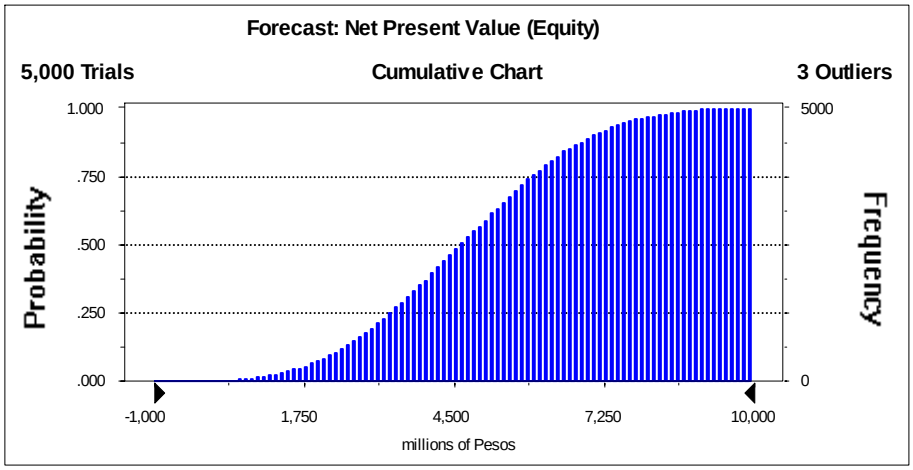
[6] Technical Note: One adjustment was made to the spreadsheet to be able to run the risk analysis. Spreadsheet variables selected as risk variables should have a "value" and not a "formula" in the spreadsheet cells. Since the rate of inflation was modeled as a different risk variable every year, it was

analysis were equal to the values of these in the deterministic analysis, the expected value of the NPV, and the two selected NCFs are close to those obtained in the deterministic case.

Table 4
Simulation Results for NPV (Equity)

Trials	5000
Mean	4,719
Median	4,688
Standard Deviation	1,845
Variance	3,404,055
Coeff. of Variability	0.39
Range Minimum	-888
Range Maximum	10,894
Mean Std. Error	26.09

Figure 1
Cumulative Probabilities for NPV



necessary to dueling these variables from the inflation rate in the table of parameters and plug in values for the inflation rate every year. The software Crystal Ball was used to conduct the risk analysis.

V. Economic Analysis

Economic values and conversion factors are estimated following the methodology outlined in the accompanying manual. The economic resource flow statement is then obtained by multiplying the line items in the total investment cashflow statement expressed in real terms by the conversion factors.

A. Economic Values and Conversion Factors

1. National Parameters

The economic discount rate for the Philippines has been estimated to be 10.30%, while the foreign exchange premium has been estimated to be 15.24%.

2. Economic Benefit of Output

The main economic benefits of this project are the time savings and the reduction in vehicle operating costs to road users. These benefits do not accrue only to the users of Pasig but also to the users of substitute routes who continue to use these routes after the construction of the expressway. As some of users of the substitute routes shift to the expressway, the remaining users will gain as well due to the reduced congestion.

An advantage of running transportation models is that one can run different scenarios. By running one scenario with the Pasig expressway and one without, it is possible to determine by examining average travel speeds and time in each scenario the time savings and the reduction in vehicle operating costs for all road users.

An important assumption made by Halcrow Fox in estimating these benefits is that the only source of trips on the Pasig Expressway is travelers changing their travel routes (route reassignment). In other words, there will be no trips resulting from the change in the modal choice of users (shifting from bus or jeepney to private car), no trips resulting from the change in the origin or destination of passengers and no trips resulting from the change in time of day used to travel. By ignoring these other sources of trips, it is conceptually clear that the traffic measured on the Pasig expressway will be an underestimate of the true level. Despite these assumptions, however, Halcrow Fox assumed that 20% of the trips made were *generated* trips i.e. trips that will not be made in the absence of the Pasig highway.

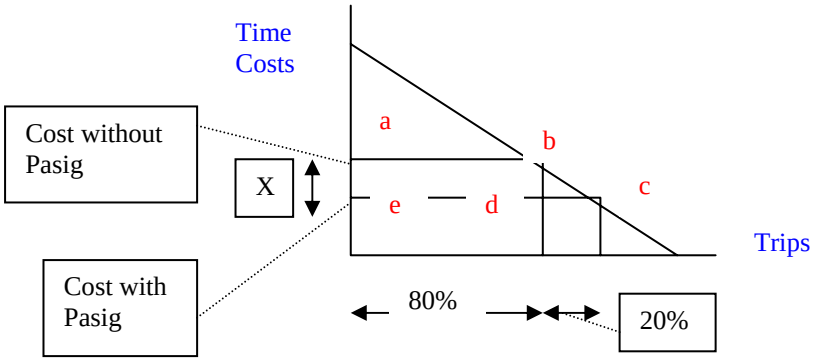
Ideally, one should divide road users into different categories by type of vehicle and by trip purpose. The main reason for such a categorization is that the value of time saved is likely to differ if the time saved is, for example, leisure time or work time. Both are a fraction of the wage rate, and the value of work time saved is typically higher than that of other purposes. Also the type of vehicle (whether car or jeepney for example) may give an indication of the income level of the passenger which in turn is helpful in determining the wage rate and the value of time. Savings in vehicle operating costs will depend on the type of vehicle.

Halcrow Fox used data provided by DPWH, stated preference surveys that they conducted and the results generated from their model to estimate the economic benefits of the project.[7] The necessary data breakdowns to include all beneficiaries in the economic resource flow statement were not available in the project documents.

Consequently, the total annual values of savings in time and vehicle operating resources provided in the documents were used.

Determining the different beneficiaries is not only interesting from a transportation perspective but also from an appraisal perspective as it provides one the opportunity to assess the gains and losses accruing to each group when conducting the distributional analysis. In this analysis, we divided the beneficiaries into existing users and generated users. Since 20% of the trips were assumed to be generated, 11.11% of the economic benefits accrue to generated users and the balance to existing users (see Figure 2 below). The same proportions were used to divide the savings in vehicle operating costs.

Figure 2
Benefits to Generated and Existing Users



Savings to generated trip users = bcd
Savings to generated trip users
as a % of total benefits = bcd/abcde
= (0.5*X*0.2) / [(0.8*X) + (0.5*X*0.2)]
= 0.1X / 0.9X
=11.11%

[7] For a detailed discussion of the methodology used by Halcrow Fox, see Halcrow Fox. Pasig Expressway, Economic Valuation, Final Report November 12, 1997 and Halcrow Fox. Pasig

3. Economic Cost and Conversion Factors for Inputs

The conversion factors for the inputs were estimated following the methodology outlined in the accompanying manual. Table 5 shows the conversion factors for all cost items. The conversion factor for freight (0.96) and the tradeable content (44%) have been estimated in the chapter on non-tradeables (Tables 11.3 and 11.4 respectively).

Table 5
Conversion Factors for Cost Items

Item	Conversion Factor
Civil Works	0.95
Skilled labor	0.96
..Unskilled labor	0.98
Equipment	0.93
Cement	0.89
Reinforcing Steel	0.97
Aggregate	0.95
Lumber	0.94
Fuel	1.00
Asphalt	1.09
PVC	1.00
Other material	0.96
Land/Right of way	0.92
Engineering studies	0.93
Construction supervision	0.92
Pre operative expenses	0.93
Pre fabricated Toll Plaza	0.93
Mobilization	0.96
Traffic Management	0.96
Administrative overhead	0.96
Annual Maintenance	1.01
Periodic maintenance	0.95
Insurance	1.15
Changes in Acc. Payable*	1.023/0.972
Changes in Cash bal.*	1.023/0.972

* First conversion factor is used in years in which there is no periodic maintenance and the second one is used in years in which the periodic maintenance is undertaken.

Expressway, Traffic Forecasts and Revenue Analysis, Final Report Addendum (undated).

I). Investment Cost Items

Investment cost items were broken down into civil works, construction supervision, land/right of way, preoperative expenses, prefabricated toll plazas, detailed engineering, mobilization and traffic management. The economic cost of each of these items was estimated and then a conversion factor was determined by dividing the economic cost by the financial cost. Each conversion factor was then applied to the financial price of its corresponding item for all years of the project.

The economic cost of civil works and its conversion factor were estimated as a weighted average of its various components. These components include skilled labor, unskilled labor, equipment, fuel, lumber, steel bars and railings, cement, aggregates, asphalt, PVC and other materials. The weighting of each item is based on its share in total cost of civil works. The CF for civil works was estimated to be 0.95.

Two broad types of *labor* are used in the civil works: skilled and unskilled. The economic cost for each type was estimated as the private supply price in the project area adjusted for the tax externality. Since unskilled workers typically do not pay taxes, it was assumed that only 30% of unskilled workers are drawn to the project from tax-paying activities. This is quite different from skilled labor where 85% of the workers are drawn from tax-paying activities. The balance of the project's demand for skilled labor (15%) is met from a new supply of labor hours. The conversion factors for skilled and unskilled labor are 0.96 and 0.98 respectively.

Equipment, fuel, cement, steel bars and railings, and PVC materials are importable items. Converting the financial prices of these items into their economic equivalents involved three steps. 1) Financial prices were reduced by the amount of custom duties and VAT. 2) The foreign exchange premium was applied to the CIF prices of these items. 3) An adjustment was made for the handling and freight components associated with moving these items from the port to the project site. This adjustment involved netting out direct distortions in the freight and handling markets and adding the foreign exchange premium to the tradeable proportion of these items.

Aggregates are a pure non-tradeable item and the only distortion affecting this market is the VAT. Consequently, the economic price was less than the financial (demand) price and the conversion factor was 0.95. The supply weight was assumed twice the demand weight to indicate that consumers of aggregates are less responsive to changes in prices than the suppliers as supply of aggregates is largely available and increases and the supply can be expanded to meet any surges in demand.

Lumber, an exportable item, was treated as a non-tradeable item due to a ban on exports. Similar to aggregates, the economic price was less than the financial demand price due to the VAT and the conversion factor was 0.94. The supply of lumber is tight, hence its supply weight was considered 0.5 compared to 0.9 for the demand weight.

Asphalt is poured on site and hence is a non-tradeable item. It also has a large tradeable content (90%). In this case, we first estimate the unadjusted conversion factor for the asphalt as a non-tradeable item adjusting for the VAT. The second

adjustment involves adding the foreign exchange premium to the tradeable component of asphalt. The conversion factor for asphalt is 1.09.

Detailed engineering design, construction supervision, preoperative expenses are carried out in part by locals and in part by foreigners. Consequently, the economic cost is estimated separately for the foreign part and for the local part. The local part in all these items is assumed to be carried out by skilled labor and hence will have the same conversion factor as that of skilled labor (0.96). The economic cost of the foreign component is obtained by subtracting the withholding tax from the financial price and then adding the foreign exchange premium to the proportion of foreign income that is repatriated. The conversion factor for the item is a weighted average of the conversion factors of the two components. The weights are the relative shares of the components in the total financial cost. The percentage repatriated in the case "construction supervision" (70%) was assumed to be less than that of the other two items (90%) because construction supervision involves more work in the Philippines and consequently involves less to repatriate.

Land/Right of way is a non-tradeable item and is adjusted for VAT. *Mobilization* and *traffic management* are treated as skilled labor and hence have the same conversion factor. The *prefabricated toll plazas* are tradeable and are adjusted accordingly as explained above.

II. Operating Costs

These costs include administrative overhead, maintenance, and insurance. Administrative overhead is skilled labor. Hence its conversion factor is the same as that of labor.

Maintenance is made up of annual maintenance and periodic maintenance. Annual maintenance was assumed to be made up of 10% skilled labor, 40% unskilled labor, 30% asphalt and 20% equipment. Its conversion factor was a weighted average of the conversion factors of these items using the weights above. Its conversion factor came to 1.0. It was assumed that the nature of the work in periodic maintenance is similar to that of civil works. Hence, the conversion factor of civil works (0.95) was used for periodic maintenance.

Insurance was treated as a tradeable and was increased by the foreign exchange premium. Its conversion factor was estimated to be 1.15.

Since *accounts payable and cash balance* are estimated as a fraction of total recurrent costs, their conversion factors are weighted averages of these costs. The conversion factor for these two items was 1.02 for a year with no periodic maintenance and 0.97 for a year where periodic maintenance is to be undertaken.

B. Results

The conversion factors discussed above are multiplied by the real financial cash flows in the total investment cash flow statement to obtain the economic resource flow statement. The Net Present Value of the project is 44.4 billion Pesos and has an IRR

of 23%. The large NPV can be attributed to the large time savings, and resources saved associated with the reduction in vehicle operating costs.

C. Sensitivity on Economic Results

The economic returns are most sensitive to levels of the AADT and to the values of time and vehicle operating resources saved. A 5% decrease in the AADT results in a 6.5% decrease in the economic NPV. Given the very high value of the NPV of the project, large drops in the AADT of over 50% would still not impair the viability of the project.

The sensitivity of the project to the level of savings in time and resources was tested by using a factor that changed the entire level of economic benefits of the project. Accordingly, a 5% drop in this factor would result in the lowering of the value of time savings and the value of resources saved by 5%. The 5% drop in the factor could be measuring a 5% decrease in time saved or a 5% decrease in the value of time saved per unit of time together with a 5% decrease in vehicle operating hours saved or a 5% decrease in the value of resources saved per operating hour.

A 10% reduction in the level of economic benefits results in a 14% decline in the economic NPV of the project. Nevertheless, the project can still withstand large decreases in the level of the economic benefits due to their high value.

The project is not sensitive to cost overruns due to the high level of economic benefits. A 10% cost overrun results in a 3% drop in the economic NPV. Changes in

the toll rate have a negligible impact on the economic NPV as toll rates are independent of AADT in the spreadsheet model.

D. Uncertainty of Economic Returns

The economic returns are sensitive to two variables: AADT and the level of benefits. These variables have to drop substantially however before the project returns turn negative. These two variables were modeled as risk variables. The traffic escalation factor used to model AADT was specified earlier when analyzing the financial risk. It was given a triangular distribution with a range of ± 30%. The benefits factor was specified as a normal distribution with a range of ± 40% (which translates into a standard deviation of 13.3%).

The economic returns of the project proved their robustness as the risk analysis indicated a zero probability of a negative return. The expected value of the NPV is close to the deterministic value as one would expect; and the coefficient of variation is low (0.24) also implying low variability in the returns.

VI. Distributional Analysis

A distributional analysis is conducted to determine the externalities generated by the project and to identify the major beneficiaries and losers. The externalities are measured as the differences between the economic and financial cashflows. Total externalities are estimated as follows:

$\sum$ PV(externalities) = NPV (economic) – NPV_{re} (financial)

Where:

$\sum$ PV(externalities) are the present value of the externalities discounted at the economic discount rate,

NPV (economic) is the net present value of the economic resource flows; &

NPV_{re} (financial) is the net present value of financial cash flows (total investment) at the economic discount rate.

Applying the above formula, the project generates 34.3 billion Pesos in externalities (44.3 – 10.0). This large value is distributed mainly among three stakeholders: the original road users , the generated road users and the government.

Original users, the largest beneficiaries of the project, are expected to gain 20.5 billion Pesos in present value terms over the life of the project. These are reflected in time and operating costs saved. The impact of changes in the AADT and benefits level analyzed on the gains to this group was also examined using risk analysis. The probability that this group will lose is less than 5%. At the same time there is a 20% probability that the gains of this group will exceed 26.5 billion Pesos.

The second largest gainer is the government which stands to net 11.3 billion pesos from the project in terms of taxes. The largest item is the corporate income tax revenue generated from the project. Its value is 10.1 billion Pesos. Other government externalities reflect the direct gains in import duties and taxes on labor, and the indirect losses in import duties associated with the foreign exchange premium. The risk analysis indicated that there is a zero probability of the government losing as a result of this project.

The third group of beneficiaries is the generated users. These are expected to gain 2.6 billion Pesos in time and operating costs savings. The risk analysis showed that there is less than a 5% chance that this group will lose as a result of the project.

VII. Conclusion

The project is economically viable, financially attractive and should have no problem servicing its debt and covering its operating and maintenance costs. It is likely that the tariff rate is set somewhat high and can be lowered without impairing the financial profitability of the project. It is also possible that DPWH can work out with the project proponents a tariff structure contingent on traffic levels and/or varying by time of day.