Chapter 11

Economic Evaluation of Pilot and Priority Projects

11.1 Introduction

This chapter discusses the procedure and results of economic, financial and environmental impact evaluations of the Pilot Project at Wat Chet Yod intersection as well as the proposed priority projects outlined in Chapter 9, namely the intersection improvements to five (5) other intersections in Chiang Mai in order to enhance the traffic safety level and improve traffic flow at these major intersections.

Economic evaluation is done using the cost benefit (B/C) ratio analysis of the proposed projects. The financial evaluation uses indicators such as the internal rate of return (IRR) and net present value (NPV) to assess the financial viability of the project. The environmental impact evaluation focuses on the impact on noise and vibration on the urban environment.

Economic evaluation is a measure of the level of economic viability of a project. The most basic indicator used is the B/C ratio. A ratio of more than 1.0 where the benefit exceeds that of cost will render the project economically viable. The higher the B/C ratio, the higher will be the economic viability.

Simple economic evaluation however does not take into account the discount rate of an investment. This means that it does not tell whether such a project is superior than other forms of investment, such as a comparable or competing project. To do that, a financial evaluation is necessary. IRR and NPV analyses take into account the discount rate, which is either taken to be the prevailing inflation rate of goods and services or the interest rate chargeable on commercial loans for investment.

11.2 Economic and Financial Evaluation for Pilot Project at WCY Intersection

(1) Expected Effects of Signal Installation and Intersection Improvement at WCY

For the pilot project at Wat Chet Yod intersection, the installation of signal facility is expected to produce significant direct and indirect benefits. Most importantly, the level of traffic safety will be increased. This will reduce the probability of traffic accidents. The signal equipment will systematically process the various conflicting traffic streams, so that the traffic flow is smoother. With this, overall delay time will reduce while average travel speed will increase. Decrease in delay time in turn will help save in fuel consumption and thus reduce the volumes of polluting gases emitted from vehicles.

Effects of the increase in travel speed can be easily measured by conducting a set of running speed survey by measuring the time taken for vehicle to travel through the intersection between two designated points before and after the signal installation.

Empirical data on the effects of signal installation at road intersections in the reduction of traffic accidents are hard to come-by as they require continuous measurement and monitoring over a long period of time. Moreover, many factors are involved in contributing to the overall betterment of traffic at road intersections so that it is difficult to ascertain the cause and effect relationship. Nevertheless, the table below shows the effects of signalization in the reduction of traffic accidents measured over a period of 6 months for 158 road intersections in three prefectures in Japan.

Table 11-1 Effects of Signal Installation in Accident Reduction at 158 Intersections in Japan

	Type of accident, Fatality, Casualty	Before signal installation	After signal installation	Decrease in Cases of Accidents
For 158 Intersections	Property	287	48	239 (83.3%)
	Person	222	50	172 (77.5%)
	Fatality	3	0	3 (100.0%)
	Injury	234	52	182 (77.8%)
Average for 1 intersection	Property	1.8	0.3	1.5
	Person	1.4	0.3	1.1
	Fatality	0	0	0.0
	Injury	1.5	0.3	1.2

Source: This study

In the above example in Japan, signalization effort at the 158 intersections has been able to reduce the number of traffic accidents, resulting in a 83.3% reduction in damages to property, 77.5% reduction in persons involved in accidents, 100% reduction on fatality and 77.8% reduction on injury.

Reduction in fuel consumption is again difficult to measure directly. Indirectly, the reduction in travel time (or delay time) can be translated into saving in travel time and fuel consumption costs. Travel cost comprises of several components, namely the vehicle operating cost (such as fuel cost, oil/lubricant cost, cost of wear and tear on the tires, insurance, taxes), persons cost (time cost of driver and passengers) as well as productivity of the vehicle.

Reduction in accidents can be expected by the signalization at Wat Chet Yod intersection. The effects of this can only be measured after the signal is operational and statistics on accidents at this intersection are compared with those before the signalization over a period of time such as six months or a year.

(2) Evaluation of the Pilot Project

The evaluation of the pilot project requires an estimation of benefits discussed above in monetary terms. These benefits are then compared with the actual project cost. The quantification of benefits mentioned above is not easy and thus not exact, which often subject to controversial arguments and disputes. This is not because of the lack of scientific methods of measurement but chiefly because many of the benefits are in fact subjective and difficult to quantify. For instance, the improved safety level of the intersection produces less anxieties and feeling of danger among drivers and pedestrians at this intersection. Such improved state of psychological well-being is almost impossible to measure in monetary terms.

Some of the benefits mentioned above however can be converted into more agreeable monetary terms. These include but are not limited to the following:

- Savings in delay time,
- Savings in fuel consumption, and
- Reduced accidents/incidents.

As explained earlier, savings in delay time can be translated into saving in vehicle travel time which in turn can be equate to saving in vehicle operating costs as well as person time costs.

Due to the saving in travel time through the intersection, fuel consumption is reduced and this is a direct saving in monetary terms in fuel cost.

The reduction in accident cannot be known until the signal is operational. The saving in accident cost as a benefit due to the pilot project therefore can only be calculated after data is gathered and compared with the before-installation situation. Although the number of reduced accidents may be known, the savings in costs due to this reduced accident rate is again a difficult task to accomplish. Data on accident cost in Chiang Mai is limited to only medical expenses of patients who sought treatment at the major hospitals. Data on cost of fatality is not available either.

For the purpose of this study, the savings in delay time is estimated and these are used to compute savings in vehicle operating cost and person costs. These benefits, although only a portion of the total benefits, will be used to evaluate the project for its economic and financial feasibility.

(3) Methodology for Estimating Benefits

A computer traffic simulation model is used in this Study to simulate the traffic flow through the intersection and to measure the average delay time of vehicle for getting through the intersection and the average travel speeds before and after the installation of signals. The Traffic Software Integrated System (TSIS) version 4.1 developed by Kaman Science Corporation under the direction of the Federal Highway Administration (FHWA) of the US is used. The system contains a microscopic street network simulation model called NETSIM which is suitable for simulating traffic flow at one or more street intersections.

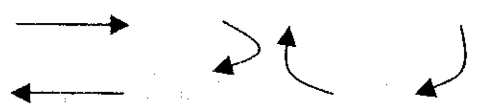
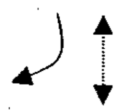
The model requires the input of basic data such as intersection geometries, lane numbers, turning movements, traffic volume by direction, signal phasing and timing plan. The model in turn generates various MOEs (measures of effectiveness), such as average delay time, stop time, total time, average travel speed, fuel consumption and volume of emissions.

For simulating the traffic situations at Wat Chet Yod intersection, traffic turning movement data obtained from traffic survey conducted in August 2001 is used. The existing intersection geometry is obtained from actual site survey conducted during the same period.

For simulating the traffic situation after the proposed traffic facility improvements, signal system with the proposed signal phasing plan and its timing as well as the geometric improvements are inputs into the model.

The phasing and timing plan for the proposed WCY improvement plan is as follows:

Table 11-2 Phasing and Timing Plan for the Proposed WCY Improvement

		Proposed 3-Phase Signal Plan									
	Cycle (sec)	S-1 (actuated V)			S -2 (actuated V)			S -3 (actuated V)			Remarks
Phasing plan											Vehicles
(actuated pedestrian signal)											Pedestrian actuated
		G	A	R	G	A	R	G	A	R	Signal lights
Morning peak hrs	140	73	3	3	32	3	2	18	3	3	Vehicle
								24	3	3	P.S.actuated
Off peak hours	100	46	3	3	27	3	2	10	3	3	Vehicle
								24	3	3	P.S.actuated
Evening peak hrs	130	61	3	3	37	3	2	15	3	3	Vehicle
								24	3	3	P.S.actuated

Source: This study

Simulation is done for the morning peak hour of 7 – 8 am. Another simulation is done for the off-peak hour of 12-13 pm. These are all separately done for cases under the existing conditions (as a non-signalized intersection) and the proposed signalization plan. For each simulation case, the average delay time, total travel time, and average travel speeds are obtained. The weighted average per PCU (passenger car unit) delay time is then computed between the peak and off-peak simulation results using the ratio of traffic volumes for peak and off-peak hours as the weights. This is taken to represent the average for the whole day for each case scenario.

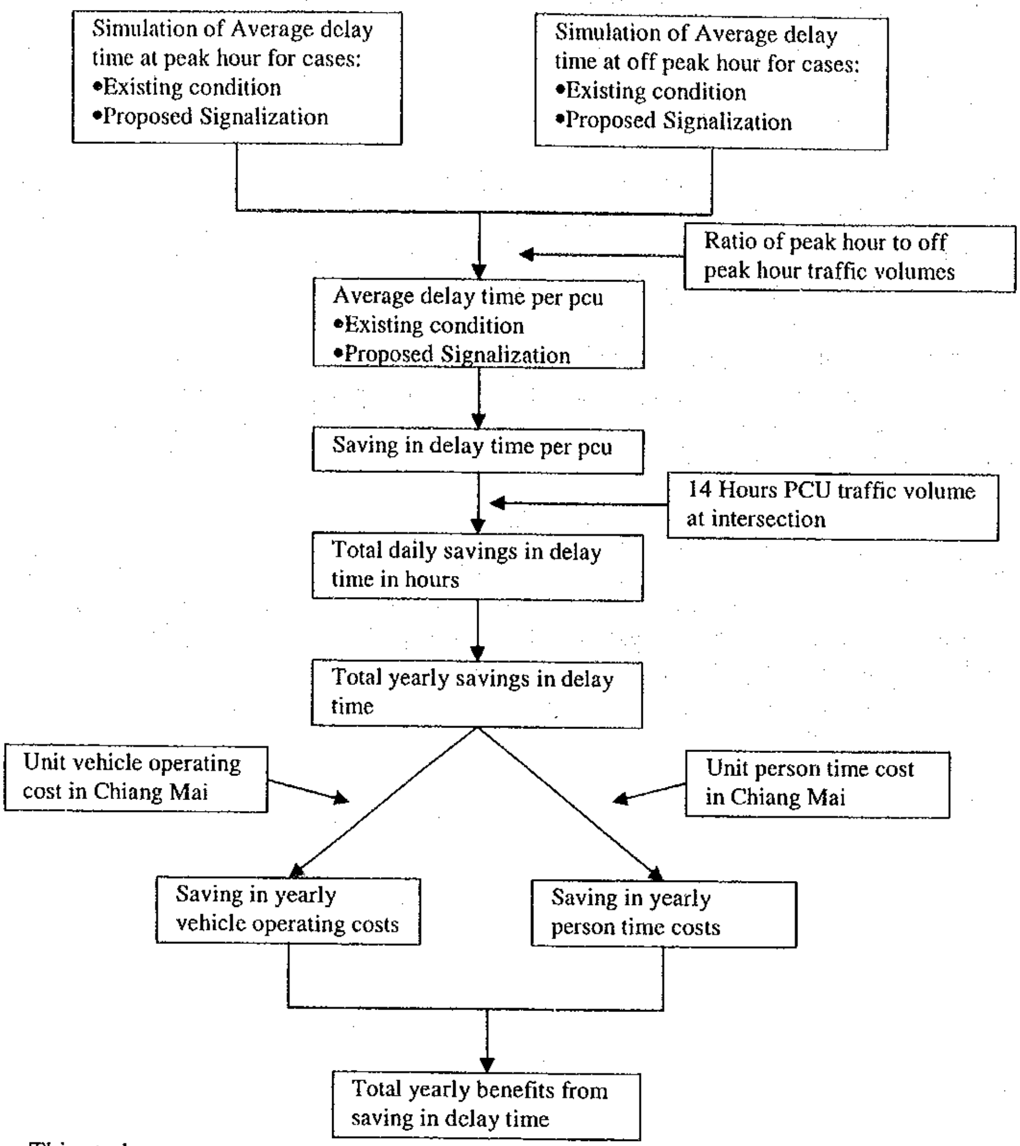
Next, the average per PCU delay times between the existing condition and the proposed signalization plan are then compared. The difference is the savings in per PCU delay time. This saving in delay time is thus taken as one of the direct impacts of signalization plan for the intersection and used as a key indicator to compute the benefits for the economic evaluation exercise.

The average delay time is first applied to the total traffic volume (14 hrs traffic volume in PCU) surveyed in August 2001 at the intersection to obtain the daily saving in delay time. Consequently, the annual saving in delay time is computed simply by multiplying the daily saving by 365 to obtain the annual savings assuming that the daily delay time is similar throughout the year.

The saving in total delay time is then converted into savings in vehicle operating cost and person time cost. Vehicle operating cost per hour is usually derived from analysis of vehicle maintenance cost, fuel and oil costs, vehicle depreciation and other costs. Person time cost is estimated from average hourly wage in Chiang Mai.

The saving of fuel consumption is a good indicator of the benefits but since this factor is already contained in the vehicle operating cost, it is not used in this evaluation so as to prevent double counting. The procedure in estimating the benefits from savings in travel delay time is given in the figure below.

The project life is assumed to be 10 years. To account for the growth in traffic over the next 10 years, an increase in the 14 hours daily PCU traffic volume is estimated from year 2007. The present traffic volume as enumerated in August 2001 is applied for up to 2006. From 2007, an increase of 10% to the 14 hours PCU volume is assumed and applied from 2007 to 2011 in the computation.



Source: This study

Figure 11-1 Procedure in Estimating Benefits from Saving in Travel Delay Time

(4) Results of Computer Simulations

Results of the simulations in terms of average total travel time, delay time, average speed and fuel consumption for the two scenarios at the Wat Chet Yod intersection for the peak hour and off peak hour are shown in Table 11-3 below. Using the ratios of peak hour and off-peak hour traffic volumes distribution, the weighted average delay time per PCU is computed and applied to the computation of total savings in delay time.

Table 11-3 Results of NETSIM for Pilot Project at Wat Chet Yod Intersection

	Per PCU (min/PCU)		Average Speed
	Total Time	Delay Time	(kph)
Peak Hours (7 to 8 am)			
Existing Situation (no signal)	1.58	0.98	17.3
Proposed Signalization Plan	1.08	0.61	25.0
Difference	**-0.50**	**-0.37**	**7.7**
Off Peak Hour (12 to 1 pm)			
Existing Situation (no signal)	0.99	0.41	26.9
Proposed Signalization Plan	0.79	0.33	33.5
Difference	**-0.20**	**-0.08**	**6.6**
Weighted* Average of peak and Off peak delay times			
Savings from Proposed Signalization Plan	**-0.35**	**-0.215**	**7.1**

Note: * weighted by peak and off peak hour traffic volume (0.467:0.533)
Proposed signalization plan = 3 phase signal plan
Source: This study

The above simulation results show that signalization of this intersection using the proposed 3-Phase Plan has reduced the delay time per PCU by 0.37 minutes or about 22 seconds during the peak hours and 0.08 minutes or about 5 seconds during the off peak hours. Overall, an average of 0.215 or about 13 seconds per PCU can be saved.

In terms of the average travel speed per PCU, the proposed plan is able to improve the speed by 7.7 kph during the peak hours and 6.6 kph during the off peak hours.

(5) Computation of Economic Benefits from Savings in Delay Time

The monetary benefits from savings in delay time at the intersection are estimated. First, the daily total saving in delay time is computed by multiplying the average saving in delay time per PCU (0.215 minute) for the proposed plan by the 14 hours PCU traffic volume. The 14 hours volume is representative of more than 85% of the total daily traffic.

The daily total saving in delay time by the proposed plan is computed to be 164 hours and the annual savings is estimated at 59,762 hours.

The unit cost of vehicle operating cost is adopted from data computed for Lamphun Province in 1998 at Baht 57/hour by the Northern Technical Center for Traffic Management System in Thailand. This unit cost is adjusted to 2001 for Chiang Mai at Baht 60/hour. Although this cost will slowly increase over the next 10 years due to inflation, for the computation here, however, the unit cost is assumed to stay the same.

The unit cost of person time cost is estimated based on the average wage earner salary and is computed to be Baht 33/hr. This unit person time cost will also increase in the future as wage level increases but for this computation, it is assumed to remain the same.

Related to the saving in person time cost is the vehicle occupancy rate. The average vehicle occupancy rate in the August survey is found to be 1.82 persons/vehicle. For this computation, however, one person per PCU is assumed.

The computation in estimating the total benefits accrued from saving in delay time for a 10 years period is shown in the table below.

For the proposed plan, a benefit of Baht 58.36 million for ten (10) years is estimated.

Table 11-4 Estimated Benefits from Saving in Delay Time

Items	Estimated Benefits
Computation for 2002-2006	
Average saving in delay time per PCU	0.215 minute
14 hours traffic volume in PCU	45,610 PCU
Total daily saving in delay time	164 hours
Total yearly saving in delay time	59,762 hours
Total yearly benefits from saving in travel time cost @ B60/hr	Baht 3.58 million
Total yearly benefit from saving in person time cost @B33/hr	Baht 1.97 million
Total yearly benefit	Baht 5.56 million
Estimated benefits for 5 years (2002-2006)	Baht 27.79 million
Computation for 2007-2011	
Est.14 hours traffic vol in PCU in 2007	50,171 PCU
Total daily saving in delay time	180 hours
Total yearly saving in delay time	65,739 hours
Estimated total benefits for 5 years (2007-2011)	Baht 30.57 million
Total Estimated benefit for 10 years	Baht 58.36 million

Source: This study

(6) Project Cost and Maintenance Cost

The signalization project at the Wat Chet Yod intersection is estimated at Baht 10.45 million. This include the equipment cost, geometric improvement cost and 20% as engineering cost.

Table 11-5 Project Costs by Items

Project Cost Items	Cost in Baht
1. Equipment	5.14 million
2. Geometric Improvement	1.42 million
3. Signal testing/others	2.15 million
4. Engineering cost at 20%	1.74 million
Total for Project	**10.45 million**
5. Maintenance cost at 5% of equipment a year	0.26 million
6.. Operation cost at 2% of equipment cost a year	0.102 million
Estimated maintenance and operation cost for 10 yrs incl. Inflation	**5.74 million**

Source: This study

Maintenance for the system is estimated at 5% of the equipment cost. This cost would include periodic inspection, repair of damage and malfunction, and costs of spare parts. Operation cost, which is cost of power and applicable utilities, is assumed to be 2% of the equipment cost. The 10 years maintenance and operation cost has factored in an inflation rate of 10% a year on spare parts and utilities and is estimated to be about Baht 5.74 million.

(7) Economic Evaluation

Assuming a project life for the signal equipment at 10 years, and a discount rate of 12%, the B/C ratios for the proposed signal plan is computed as:

B/C Ratio = [Total estimated benefits/total project cost] = [58.36 / 16.19] = 3.6

The Internal Rate of Returns (IRR) computed for the proposed plan is 49% while the project is found to have a Net Present Value (NPV) of Baht 17.1 million.

All these indicators show that the proposed signal installation is viable and great benefits can be expected from their implementation, even though only the savings in delay time is used to compute the monetary benefits. If savings in costs of accidents and others are taken into account, higher values can be expected for these indicators.

Table 11-6 Results of Economic and Financial Evaluation

Indicators	**Proposed signal plan**
B/C ratio	3.6
IRR	49%
NPV	Baht 17.1 million

Source: This study

(8) Sensitive Analysis

To test the viability of the project with fluctuating traffic volume and cost, a sensitivity analysis by increasing or decreasing the two factors by 15% is carried out. The results in the next table show that even with the worst scenario of increased cost by 15% and lower traffic by 15%, the project will still produce a B/C ratio of 2.3 and an IRR of 32%.

Table 11-7 Sensitivity Analysis for the Proposed Signal Plan

	Indicators	**Traffic at the Intersection**		
Project Cost		**+ 15%**	**Original**	**- 15%**
+ 15%	IRR (%)	47%	39%	32%
	B/C Ratio	3.1	2.7	2.3
Original	IRR (%)	57%	49%	40%
	B/C Ratio	4.1	3.6	3.1
- 15%	IRR (%)	66%	57%	47%
	B/C Ratio	4.2	3.7	3.1

Source: This study

(9) Conclusion

The above economic analysis show that the intersection improvement work at Wat Chet Yod intersection, which includes modification of intersection geometry and the installation of a signal system, is expected to produce large benefits to the road users.

By just estimating the monetary benefits that can be computed from the savings in delays by drivers, this benefit alone when compared to the cost of the project, is enough to produce favorable indicators such as B/C ratio, IRR and NPV; indicating that the project is highly economically viable.

The project is expected to produce a B/C ratio of 3.6 and an Internal Rate of Return of 49%. The project has a NPV of Baht 17.1 million.

If other benefits, as discussed in this section, such as savings in damages to properties and lives from reduced accidents, improved levels of air and noise pollutions; are taken into account, the amount of benefits will be even much higher as those computed above and will produce even higher evaluation results.

11.3 Evaluation of Other Five Intersection Improvements

(1) Proposed Improvements to Five Intersections

Among the 20 intersections studied and analyzed in this Study as reported in Appendix F of this report, improvements for six intersections (Nos. 1, 2, 5, 7, 13, and 18) were deemed urgent. The intersection at Wat Chet Yod was selected as the Pilot Project. Two of the other five intersections are high accident prone intersections (Intersection Nos.5 and 7) while the other three have high traffic demand and their efficiency can be improved by reviewing their signal timing plans or adoption of geometric improvement or traffic regulation measures.

Improvements to Intersections No.1, 5, 7 and 18.

Four of the five high priority intersections identified for priority improvements are under the DOH management as they are located along Super Highway. These are:

Table 11-8 Four Intersections for Improvement Under DOH Management

Intersection No	Name of Roads	Present Control	Major Problems	Proposed Improvements
1	Huay Kaew Road with Super Highway	Signal control under ATC	Incompatible number of exit and entry lanes.	Shifting of median to increase one right-turn lane on Super Highway, and adjust signal timing
5	Mahidol road with Haiya Road	No signal	High potential accident point, high speed on Mahidol	Signalization, and improvement of geometry on minor road
7	Chiang Mai Land road with Super Highway	No signal	High potential accident point with high speed traffic on Super Highway	Signalization, improvement with right-turn lane on Super Highway, removal of gate
18	Charoen Muang Rd with Super Highway	Signalized under ATC control	Very heavy traffic during peak hours	Widening of approach on Super Highway, and signal timing and phasing improvements

Notes:

1) The study team submitted the proposed improvement measures to the DOH of Chiang Mai District 2 and received the following comments.

- DOH is in agreement with the proposed improvement measures at the above four intersections.
- However, DOH wishes to amend the length of the right turn lane on Super Highway to Chiang Mai Land from the recommended 70m to at least 100 m, on account of the long queue on Super Highway during peak hours.

2) DOH placed median barrier and closed intersection No. 7 in May 2002.

Source: This study

Improvement Measures at Intersection No.13

Besides the above four intersections, the other intersection that warrants short term improvement is No.13, which is under the management of the Municipal Council of Chiang Mai.

Table 11-9 Intersection No.13 Improvement Under CMM Management

Intersection No	Name of Roads	Present Control	Major Problems	Proposed Improvements
13	Charoen Muang Road with Charoen Raj Road	Signal control under ATC	Space constraint but intersection and signal efficiency may be improved by removing minor movements.	Prohibit right turn traffic from east approach. Signal phasing and timing modification.

Source: This study

(2) Estimation of Project Cost

For the improvement and/or signalization of the proposed five intersections, the total project cost is estimated at Baht 25.4 million. This cost is comprised of intersection geometric improvement cost, signal equipment and installation cost or improvement cost; maintenance and operation costs for 10 years.

Maintenance cost for the proposed project is assumed to be 5% of the total equipment costs. This cost item is the cost of spare parts and repairs. Operation cost of the improved intersection is taken to be the cost of utilities and is assumed to be 2% of the equipment cost.

Table 11-10 Estimated Cost for Proposed Improvement at Five Intersections

	Item	Intersection				
		No.1	No.5	No.7	No.13	No.18
1	Geometric improvement cost	1,470	232	280	333	4,184
2	New signal installation		2,218	2,647		
3.	Improvement to existing signal	1,151			885	714
4.	Maintenance cost for 10 years (5% of equipment cost)	917	1,767	2,109	705	569
5.	Operation cost for 10 years (2% of equipment cost)	367	707	844	282	228
6.	Engineering services costs	524	490	585	244	980
	Total Cost for 10 years	4,429	5,414	6,465	2,449	6,674

Source: This study

(3) Estimation of Project Benefits

As discussed in the evaluation on the Pilot Project at Wat Chet Yod Intersection in section 11.2 above, benefits from the intersection improvement project include many categories, those that can be easily measured in monetary terms and those that are not.

Similar to the arguments presented in section 11.2, the savings in delay time of vehicles at the proposed project intersections is to be used for estimating the amount of benefits for the project for the purpose of this analysis. One must remember that there are many more benefits that can be expected, such as the reduction in traffic accidents, improvement of urban environment, and reduction in pollution.

The procedure for estimating the benefit for the proposed project is similar to the one used in the Pilot Project. Savings in delay time per PCU at peak hour and off peak hour are obtained from computer simulation of the five intersections. The average saving in delay time per PCU is then obtained. This is then used with the total daily or 14 hours PCU to estimate the total daily saving in delay time. Annual delay time is then obtained and this is converted to monetary values by multiplying the delay time saved with unit vehicle operating cost and person time cost. A project life of 10 years is assumed and the total benefit for the period is computed.

(4) Evaluation of the Improvement Measures at the Five Intersections.

Similar to the methodology used in evaluation for WCY intersection, NETSIM computer simulation model is used to simulate the effects of the proposed improvement measures at these five intersections.

Simulation of traffic flow under the existing conditions and again with the proposed improvements were carried out for the morning peak hours of 7 – 8 am for all the five intersections. Delay time per PCU is generated by the model for each run. Savings in delay time between the before and after improvement scenarios are computed.

Similarly, the simulation is again done for off peak hour, notably between 12-13 hours and the savings in delay times are again computed. Using the peak hours (6 hours of 6-9 and 16-19 hrs) traffic volume and the off peak traffic volumes as weights, the average savings in delay times are computed.

Results of Computer Simulation for Morning Peak Hour

Table below shows the results of NETSIM simulation results for the morning peak hour of 7-8 am at the five intersections.

Among the five intersections, the improvements to No.7 at Chiang Mai Land produced the highest saving in delay time per PCU during the 7-8 am peak hour at 1.90 minutes (114sec). This is followed by improvement measures at Intersection No.18 at 0.95 minutes (57sec) for alternative 1 improvement, Intersection No.1 at 0.47 minute (28 sec), Intersection No.13 at 0.42 minute (25 sec) and then Intersection No.5 at 0.22 minute (13 sec).

Table 11-11 Results of Savings in Delay Time per PCU during morning Peak Hour

Intersection No.	Condition	Total Travel Time/PCU (in min)	Delay Time/PCU (in min)	Average Travel speed (mph)
1: Huay Kaew Rd and Super Highway	Existing Condition	1.92	1.17	11.8
	Improved Condition	1.45	0.70	15.7
	Savings	**-0.47**	**-0.47**	**+3.9**
5 : Mahidol and Haiya Roads	Existing Condition	1.14	0.38	19.9
	Improved Condition	0.93	0.16	24.4
	Savings	**-0.11**	**-0.22**	**+4.5**
7 : Chiang Mai Land Rd and Super Highway	Existing Condition	3.38	2.65	6.7
	Improved Condition	1.47	0.75	15.5
	Savings	**-1.91**	**-1.90**	**+8.8**
13 : Charoen Muang and Charoen Raj Rd	Existing Condition	1.72	1.07	13.0
	Improved Condition	1.04	0.65	13.0
	Savings	**-0.68**	**-0.42**	**+0.0**
18 : Charoen Muang and Super Highway	Existing Condition	2.85	2.39	7.9
	Improved Condition Alt-1	1.91	1.44	11.8
	Savings	**-0.94**	**-0.95**	**+3.9**
	Improved Condition Alt-2	1.98	1.51	11.4
	Savings	**-0.87**	**-0.88**	**+3.5**

Source: This study

Results of Computer Simulation for Off Peak Hour

Similar computation is done for the intersection at off peak hour, taken as 12.00-13.00 hrs. Table below shows the results of NETSIM simulation results for the off peak hour at the five intersections.

Table 11-12 Results of Savings in Delay Time per PCU during Off Peak Hour

Intersection No.	Condition	Total Travel Time/PCU (in min)	Delay Time/PCU (in min)	Average Travel speed (mph)
1: Huay Kaew Rd and Super Highway	Existing Condition	1.36	0.62	16.6
	Improved Condition	1.29	0.54	17.5
	Savings	**-0.07**	**-0.08**	**+0.09**
5 : Mahidol and Haiya Roads	Existing Condition	0.87	0.08	26.1
	Improved Condition	0.90	0.13	24.6
	Savings	**+0.03**	**+0.06**	**-1.5**
7 : Chiang Mai Land Rd and Super Highway	Existing Condition	1.07	0.30	21.2
	Improved Condition	1.02	0.25	22.2
	Savings	**-0.05**	**-0.05**	**+1.0**
13 : Charoen Muang and Charoen Raj Rd	Existing Condition	1.69	1.04	13.4
	Improved Condition	1.36	0.98	9.7
	Savings	**-0.33**	**-0.06**	**-3.7**
18 : Charoen Muang and Super Highway	Existing Condition	2.64	2.17	8.6
	Improved Condition Alt-1	2.20	1.73	10.3
	Savings	**-0.44**	**-0.44**	**+1.7**
	Improved Condition Alt-2	2.05	1.58	11.0
	Savings	**-0.59**	**-0.59**	**+2.4**

Source: This study

Average Savings in Delay Time

Table below shows the computed average savings in delay time at the five intersections.

Among the five intersections, the improvements to No.7 at Chiang Mai Land produced the highest average saving in delay time per PCU at 0.96 minutes (58sec). This is followed by improvement measures at Intersection No.18 at 0.73 minutes (44 sec) for Alternative 2, Intersection No.1 at 0.25 minute (15 sec), Intersection No.13 at 0.22 minute (13 sec), and then Intersection No.5 at 0.07 minute (4 sec). Savings in delay time at Intersection No.5 is small, due to the small traffic volume at present.

Table 11-13 Average Savings in Delay Time per PCU

Intersection No.	Savings in Delay Time	Saving in Delay Time/PCU (in min)	Ratios of Traffic Volume	Weighted Average (in min)
1: Huay Kaew Rd and Super Highway	Peak Hour	0.47	0.45	0.21
	Off Peak Hour	0.08	0.55	0.04
	Weighted Average	-	-	**0.25**
5 : Mahidol and Haiya Roads	Peak Hour	0.22	0.45	0.10
	Off Peak Hour	-0.06	0.55	-0.03
	Weighted Average	-	-	**0.07**
7 : Chiang Mai Land Rd and Super Highway	Peak Hour	1.90	0.49	0.93
	Off Peak Hour	0.05	0.51	0.03
	Weighted Average	-	-	**0.96**
13 : Charoen Muang and Charoen Raj Rd	Peak Hour	0.42	0.45	0.19
	Off Peak Hour	0.06	0.55	0.03
	Weighted Average	-	-	**0.22**
18 : Charoen Muang and Super Highway	Peak Hour –Alt 1	0.95	0.46	0.44
	Off Peak Hour- Alt 1	0.44	0.54	0.24
	Weighted Average Alt 1	-	-	**0.68**
	Peak Hour –Alt 2	0.88	0.46	0.41
	Off Peak Hour- Alt 2	0.59	0.54	0.32
	Weighted Average Alt 2	-	-	**0.73**

Source: This study

Estimated Total Savings in Delay Time

The estimation of total savings in delay time by the improvements to the five intersections is given in the table below. The daily savings in delay time is used to estimate the annual savings. Traffic volume is assumed to remain about the same for the first five years and after which a 10% increase is assumed. As the table shows, large savings can be obtained from intersection with huge traffic demand, such as No.18. As a total, improvements to the five intersections can produced a saving in delay time up to 2,098 hours a day and 1.6 million hours for the 10 years.

Table 11-14 Estimated Annual Savings

		Estimated Annual Savings in Delay Time (hours)				
	Category of cost item	**No.1**	**No.5**	**No.7**	**No.13**	**No.18**
1	Daily saving in delay time 2001	228	42	688	148	992
2	Annual savings in delay times (2002-2006)	83,066	15,391	251,190	53,916	361,995
3	Annual savings in delay time (2007-2011)	91,373	16,930	276,309	59,308	398,194
4	Total Savings in delay time for 10 years	174,439	32,321	527,499	113,224	770,189

Source: This study

Estimated Total Benefits

Similar to the estimation of benefits for the pilot project, only the savings in travel time is used to estimate the savings in vehicle operation costs and person time costs for the economic evaluation of the five intersections.

Table 11-15 Estimated Benefits from Vehicle Operating Cost and Person Time

		Estimated Benefits (Million THB)				
	Category of cost item	**No.1**	**No.5**	**No.7**	**No.13**	**No.18**
1	Savings in VOC	52.3	9.7	158.3	34.0	228.1
2	Savings in Person Time Cost	28.8	5.3	87.1	18.7	125.4
	Total Savings	81.1	15.0	245.4	52.7	353.5

Source: This study

For the 10 year period, a total of savings in VOC for the improvement works at the five intersections is estimated to be about Baht 482.4 million while savings in person cost is estimated to be about Baht 265.3 million. In total, Baht 747.7 million can be saved from the improvement works.

Economic Evaluation

Comparing the estimated benefits from savings in VOC and person time cost above, with the estimated costs for improvements at each of the five intersections, the simple B/C ratios are computed as shown in the table below. Assuming a discount rate of 12 percent, the IRR and NPV are also computed.

Table 11-16 Economic Evaluation

	Economic evaluation				
Evaluation Indicator	**No.1**	**No.5**	**No.7**	**No.13**	**No.18**
B/C	18.3	2.8	37.9	21.5	53.0
EIRR (%)	243	41	660	339	572
NPV (mil. Baht)	36.98	3.71	117.62	24.45	170.37

Source: This study

11.4 Social and Environmental Impacts of Pilot Project

In accordance with Environmental Impact Assessment in Thailand, an EIA Report is not required for the pilot project. An informal assessment using the screening process adopted by Japan reveals little, but positive, impact on the environment

While optimized traffic flow at the intersection is beneficial, the impacts on local air quality and noise are likely to be marginal and within day-to-day fluctuation. The main benefits are associated with improved crossing of Super Highway and safety and therefore a reduction in the barrier effect of the road to outer neighborhoods. Signals will reduce driver stress and conflict.

Table 11-17 JICA Guidelines: Environmental Screening

Environmental Consideration			Screening	Evaluation	Remarks
Social Environment	1	Relocation of inhabitants	Relocation by demesne (conversion of right of occupancy, title of record to land	No	
	2	Economic activity	Loss of land production opportunity, change the structure of the economy	No	
	3	Transportation, life facilities	Effects on existing transportation, such as congestion and safety, including impact on schools and hospitals	No	Pilot project seeks to improve existing transportation
	4	Segmentation of regions	Segmentation of regional society by traffic inhibition	No	
	5	Excavation, cultural assets	Loss and decline of shrines and temples and buried cultural property	No	
	6	Irrigation rights, commonage	Inhibition of piscary, irrigation rights, and right of access to woodland	No	
	7	Health care and hygiene	Deterioration of hygienic environment due to waste and sanitation	No	
	8	Waste	Waste material and soil for construction and domestic waste	No	
	9	Hazard (risks)	Elevated risk of collapse, subsidence and other hazards	No	
Natural Environment	10	Landform, nature of the soil	Change of valiant landform and nature of the soil due to excavation and filling	No	
	11	Soil degradation	Topsoil erosion by rainwater arising from land formation and deforestation	No	
	12	Groundwater	Pollution by wastewater and leachate arising from excavation	No	
	13	Shallow water, lakes, river flow	Change of riverbed and river flow from landfill and wastewater	NA	
	14	Seashore, sea area	Coastal erosion and loss of vegetation caused by landfill and change in hydrographic conditions	NA	
	15	Plants and animals	Disturbance in lifecycle and extinction due to change in natural habitat	No	
	16	Meteorological phenomena	Change of temperature and wind condition due to large construction / improvement	No	
	17	landscape	Change of landform from improvement, inhibition of harmony by new structures	No	
Deterioration of Environment (DE)	18	Air pollution	Pollution by exhaust gas and dust due to vehicles	No	Minor impact on local air quality expect to improve existing situation
	19	Water pollution	Pollution by discharge of sediment and industrial waste	NA	
	20	Land pollution	Emulsion	No	
	21	Noise, vibration	Noise and vibration by vehicles	No	Minor impact on local vehicle movements without deterioration of existing situation
	22	Ground sinkage	Reduction of ground level caused by transformation of ground and decrease in level of groundwater	No	
	23	Effluvium	Emission of exhaust gas and odorous substances	No	
Overall judgment: Does this project require an IEE or IEA				No	

Source: This study

JICA