Chapter 5.

Economic Analysis

This chapter will provide a detailed description of all assumptions used and a discussion of the economic results. In economic analysis of this project, the significant components consist of:

- The Initial cost
- Operation & Maintenance Cost (O&M cost)
- Tariff rate and Transportation Revenue, and
- Feasibility Assessment (or Decision-making for investment)

5.1 Principles of Economic Analysis

Economic analysis is a comparative study of investment and return under projects by taking monetary profits into consideration as an important factor. Such analysis is aimed only at benefits or return under economic projects and expenses or cost of projects. That is, the analysis will show a flow of monetary benefits or return arising from projects, and also a flow of expenses or cost to be incurred in the projects. With such benefits and expenses of the projects, it is possible to prepare a Cash flow. This cash flow is helpful as it informs the owner of the project when and how he will have to find money for expenses of the project, such as by obtaining a local or foreign loan. To obtain such loan from a source depends on the rate of interest and project officials ability for negotiation. Economic analysis, therefore, is made for the purposes of finding a conclusion as to what the financial position of the project under our consideration is and whether or not the project will survive.

In assessment of cash flow with respect to expenses and benefits, it is necessary to use actual buying prices and selling prices under the project or prices found in the market. This will reflect actual amounts of expenses and benefits under the project and will make it possible to learn from analysis as to whether or not the project will justify investment. In this case prices, which are used in assessment of amounts of expenses and of benefits, are very important. If a price, which is too low or too high, is chosen, the results of assessment will be very inaccurate. Therefore,

the price factor is capable of indicating the quality and efficiency of financial analysis of the project in respect of the extent of reliability.

5.2 Initial Cost

5.2.1 Initial Cost Estimation

The initial costs estimate is developed to evaluate the Preliminary-feasibility of the project, and summarises projected initial cost for the North pipeline.

Costs for major material items are from vendor quotes or current contract prices in Thailand. Quantities and materials are obtained from the preliminary engineering design configuration. Other cost parameters are provided by PTT. and Thappline information.

This section is the result of extensive analyses of the market, optimisation of various preliminary engineering design configurations to serve the forecast market demand, and safe operations of the pipeline system. Costs are categorised in the following manner:

Pipeline

Pipe is priced at US$ 700 per metric ton based on a current pipe purchase contract from another project in Thailand (source: PTT).

Construction

The construction cost or pipeline laying and installation cost of the North pipeline are based on the experiences of PTT and Thappline as following assumption in Pipeline Description, Clause 4.2.4.

Pump Stations and Valves

Pump stations and valves are to be constructed at terminal location along the pipeline routes that are at Saraburi, Nakhon Sawan, Pitsanulok and Lampang terminal oil depots. These costs include station piping, electrical, communication and control systems, buildings and structures, and security. Prices of pumps and valves are from local market price.

Meter Stations

Meter station will be installed at each depot and terminal custody transfer locations. Prices of meters are from local market price.

SCADA and Telecommunication Systems

SCADA is Supervisory Control and Data Acquisition. The pipeline will be equipped with a SCADA system, which will supply information to a central control facility from which the operation of the pipeline, pump stations and delivery control valves will be monitored, controlled and activated.

A communications system will connect the pump stations, terminals and mainline valves with the installed SCADA system, which is located in the central control facility. The backbone of the communications system will be the national grid (Fibre optics).

Cathodic Protection System

Cathodic protection is an effective and economical way of corrosion control in pipeline operation. The pipeline and its facilities will have its useful life extended many years by this method.

Land and Land Rights

The cost of obtaining easement for pipeline construction includes pre-acquisition, acquisition and compensation associated with Right-Of-Way (ROW) acquisition and restoration.

Tanks and Other Facilities

Tanks Cost is 15 Baht per litre of tank. The cost of terminal facilities (Depot) are not included.

Operations and Maintenance Facilities

This includes administration centre and maintenance facilities at strategic locations along the pipeline system.

Freight

Freight is the cost of transportation of offshore materials to port of entry on Thailand.

Insurance and Stamp Tax

This is the cost of Insurance and Stamp Tax, including all-risk insurance. Any Value Added Tax (VAT) is fully reimbursable. Under Clause 7.7, Section 3 of the Board of Investment (BOI) regulation this project is exempt from import duty.

EPCM and Corporate Overhead

EPCM (Engineering, Procurement & Construction Management) - Are cost associated with the engineering, design, procurement and construction management of the pipeline systems that is 12% of the construction cost.

Corporate Overhead - These are development costs associated with the project including consultants, and cost incurred during project execution.

Contingency

Allowance for Materials, Construction, and Engineering normal in the industry. Also includes Environmental Impact Assessment cost (EIA), Routing Survey cost, cost of Public hearing, and a project contingency over and above the physical contingency. This cost is equaled 20% of total cost.

5.2.2 The Initial Criteria for Initial Cost Estimation

1) Price of pipes 700 USD/tons.
2) Construction cost 40% of pipe cost[1].
3) Cathodic Protection 2,000 USD/km.
4) Prices of Pump & Meter depend on the local market price,
5) SCADA and Telecommunication cost using cost that actually designated by PTT and Thappline.
6) Land and ROW Compensation Cost 25,000 Baht per Rai (50% of market price).

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[1] Max S. Peters and Klaus D. Timmerhaus. Plant Design and Economics for Chemical Engineers. 2nd edition. Tokyo. McGraw-Hill, Inc., 1968. and

J. Frank Valle-Riestra. Project Evaluation in the Chemical Process Industries. United States of America. McGraw-Hill, Inc., 1983.

7) Damaged-assets (during construction) Compensation and Land restoration Costs 300 Baht per Metre.
8) Tank and Other Facilities 15 Baht per Litre of tank.
9) Insurance and Freight 1% of direct cost[1].
10) EPCM and Corporate Overhead 12% of the direct cost.
11) Contingency cost 20% of total cost[2].
12) The exchange rate of 38 Baht per 1 USD.

Source: PTT.

5.2.3 The Estimation of Initial Cost

The preliminary initial cost of the Northern refined petroleum products pipeline project is estimated as following (all details of the initial cost calculation are explained in Appendix H):

Items	*Million-Baht*
Direct Costs	
(1) Pipes costs	1,047
(2) Construction cost or Pipeline laying and installation costs	1,466
(3) Pumps costs	127
(4) Meters costs	24
(5) Cathodic Protection System cost	39
(6) SCADA and Telecommunication system costs	22
(7) Tank costs	810
(8) Land and Land Right-of-Way (R.O.W.) costs	199
(9) Damaged-assets compensation and Land restoration costs	153
(10) Equipment costs	117
Total Direct Costs	**4,004**

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[1] & [2] Max S. Peters and Klaus D. Timmerhaus. Plant Design and Economics for Chemical Engineers. 2nd edition. Tokyo. McGraw-Hill, Inc., 1968. and

J. Frank Valle-Riestra. Project Evaluation in the Chemical Process Industries. United States of America. McGraw-Hill, Inc., 1983.

Indirect Costs		
(11)	Freight and Insurance costs	40
(12)	EPCM 12%	480
(13)	Contingency 20%	905
	Total Indirect Costs	**1,425**
TOTAL CAPITAL EXPENDITURE		**5,429**

5.3 Operations and Maintenance Cost (O&M cost)

The O&M cost or called *Operations and Maintenance Expenditure (OPEX)* are based on PTT and Thappline's in-house data and estimated at five percent of total initial cost (please refer to Clause 5.2 and Clause 5.6.3 of this report for the complete base case estimate). Annual O&M costs will be escalated by the projected growth rate (as shown in Appendix D). These OPEX costs include:

1. Salaries
   - Corporate cost
     - Salaries, Allowance & Fees
   - Operations & Maintenance
     - Operations & Maintenance
     - Administration
   - Housing & other allowance
     - Housing, school & other allowance
     - Moving allowance – Personnal effects
2. Maintenance
   - Pump stations
   - Pipeline R.O.W.
   - Environmental
   - Community relations
   - Pipeline system
   - Vehicle O&M
   - Vehicle purchase @ 3 yr interval
   - SCADA & telecommunication
   - Building Maintenance
3. Office Exp. Furniture, hardware etc.
   - Corporate Office rental

- Furniture & Fixtures
- Computers & Hardwares
- Office Consumables
- Utilities Elec, Water etc.
- Travel & Accommodation
- Communications – Tel, Fax, Stamps

4. Energy cost
   - Energy cost
   - Pump electric consumption
5. Consultants
   - Engineering specialist
   - Environmental Consultants
6. Insurance (Safety)
7. Contingency (at 10% of 1 to 6)

Source : PTT and Thappline

5.4 Tariff Rate and Throughput Revenue

Before the analysis on the initial income will be launched to decide whether the project should be invested or not, the exact pipeline transportation cost has to be assessed. And then, the cost received will be compared with that for the transport by tanker trucks. To determine the internal rate of return of pipeline project compare to the effective existing mode that is tanker truck, the process starts with examining the pipeline transportation cost of products. Firstly, it should know about the actual transportation cost (Tariff rate) of pipeline before comparing to transportation cost by truck.

Tariff rate of pipeline is estimated to be 21.88 Satang/Litres[1] (or 0.043 St./Litres/Km). Schedule 5.1 in Appendix I show the computation of the unit costs of pipeline. In addition, tariff rates from Saraburi to Nakhon Sawan, Pitsanulok and Lampang oil depots are 7.31, 12.90, and 21.93 St/Litre, respectively, while transportation costs by truck are much higher, at 16.14, 23.91, and 34.91 St/Litre,

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[1] Note : This pipeline transportation cost (or tariff rate) is the actual cost (excluding the margin).

respectively[1]. Thus, it can conclude that the pipeline unit cost can be competitive with the unit cost of effective existing mode, tanker truck.

Transportation revenues are calculated by multiplying throughput volumes at each depot by the respective tariff.

5.5 Feasibility Assessment (or Decision-making for Investment)

5.5.1 Criteria on Feasibility Assessment

In making a decision for investment, it is imperative to depend on appropriate criteria or tools in decision-making. Tools for use in analysis of projects are of four kinds as under:

1) Payback Period

Payback period is the period in which net return or cash flow from the operation of a project is of the same value as an investment in the project. This method considers the number of years in which return will be even with investment funds. This method is a tool suitable for making a decision on a project with high risks or in a situation in which political fluctuation is prevalent. Thus, investors may have to consider making investment in a project, which yields return in a short time.

In determining the payback period, it is possible to calculate from the number of years in which the accumulated total of cash flow of benefits (cash inflow) of the project is equal to the cash flow of expenses (cash outflow) or the number of years in which the total of net cash flow of the project is equal to zero. The formula for calculation can be shown as follows:

$$\sum_{t=0}^{n} \text{Cash Inflow} = \sum_{t=0}^{n} \text{Cash Outflow}$$

Or $$\sum_{t=0}^{n} (\text{Cash Inflow} - \text{Cash Outflow}) = 0$$

Or $$\sum_{t=0}^{n} (\text{Net Cash Flow}) = 0$$

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[1] Note : Transportation Costs of truck refer to Clause 5.3.1 No.3 (Appendix B). Source : PTT.

where n = Payback Period

If a project has a very short payback period or if this value is the lowest, we may place the project in the top rank. If any project has a slow payback or this value is high, the project is placed in the next lower rank and so on. In the case of PTT, payback period of not more than 10 years is used for a project of infrastructure type, such as the oil pipeline, depot and quay projects.

However, this method has weak point. That is, expenses for investment in calculation are for disbursement in the present year, while profits or benefits to receive in return are of future years. The value of money in each year may not be constant and it is not advisable to make any comparison. Moreover, this method does not take into account return after the payback period or return to be derived throughout the life of the projects. Under this criterion, attention will be given to the selection of any project of which payback period is the shortest without regardless of future return after the payback period.

2) Net Present Value (NPV)

Net Present Value is the total of net return for which time value has been adjusted in each year (Accumulated Present Value of Cash Flow) with an aim to measure worthwhile return of a project. In general, a principle for making a decision to choose a project among several ones is that the best project should be one that yields highest NPV or to use the principle of selecting a project which provides highest profits in a short period. Any project with plus value is placed in a group for selection and any project with minus value is regarded as one not worth investing in. In the government sector, a decision for investment is not based always on the highest value of NPV as other factors also will have to be considered. Calculation to find Net Present Value (NPV) can be done as follows:

a) To make calculation to find present value of net return in each year (NPV of Cash Flow) and add up the said value of each year throughout the life of the project. Result is NPV of the project. Formula for calculation is as follow:

$$NPV = \sum_{t=0}^{n} \frac{B_t}{(1+i)^t} - \sum_{t=0}^{n} \frac{C_t}{(1+i)^t} \quad \text{or}$$

b) Calculate to determine total return in each year, deduct it with total expenditures in that year and the result is net return or net cash flow of each year. Then, use that value to adjust time value in each year throughout the life of the project. Next, the resultant values are added up to get NPV of the project.

$$NPV = \sum_{t=0}^{n} \frac{B_t - C_t}{(1+i)^t}$$

Where NPV = Net Present Value of the project

B_t = Benefits of the project in year "t"

C_t = Costs of the project in year "t"

i = Interest rate or Discount rate or Opportunity Cost of Capital

n = the Life of the project

1/(1+i) = Present Worth Factor (PWF)

When PWF or $1/(1+i)^t$ is multiplied by value of net monetary flow in the year "t", the result is present value of cash flow in that year. For PWF value, refer to the prepared table "Discount Factor Table". It is evident that calculation to determine NPV of the project be either a) or b) method will be produce the same result.

At present, owing to advanced technology in finding NPV, it is possible to get NPV from computer application program, such as Excel or Lotus.

3) Internal Rate of Return (IRR)

Internal Rate of Return of project is discount rate that will make benefits and expenses equal after calculation of discount into present value. This rate is that of ability of investment funds to create sufficient income to cover investment funds. In other words, which discount rate that will make net value equal to zero. This criterion is similar to the determination of NPV. The difference is the changes of the value of "i" value (Interest rate) in NPV to "r" value (Discount rate) in IRR.

In the calculation to determine IRR value, it begins with the reduction of benefits by expenses in each year throughout the project so as to get net

return or net cash flow in each year. Next, calculation is made to find a discount rate that will make the total of present value of net return give result in zero.

Calculation to find IRR value is similar to the formula on finding NPV. The difference is to change "i" value to "r" and this "r" value will turn NPV into zero value. Formula for calculation is as follows:

$$\sum_{t=0} \frac{B_t - C_t}{(1 + r)^t} = 0$$

where r = IRR value of the project

This calculation of IRR is done gradually (Trial and Error). That is experiment has to be made to find r value that will tum NPV into zero. One may have to waste time to make experiments of various values. In practice, interpolation method may be employed in determining IRR value that will turn NPV into zero.

$$IRR = DR_L + (DR_H - DR_L) \times \frac{(NPV_L)}{NPV_L - NPV_H}$$

Where
- DR_L = Lower bound discount rate
- DR_H = Higher bound discount rate
- NPV_L = Net present value of DR_L
- NPV_H = Net present value of DR_H
- IRR = Discount rate that will made NPV = 0

Thought it may take time to find this value in calculation, but it is a basic principle in making a decision to invest. At present, owing to advanced technology in finding IRR, it is possible to get IRR from computer application program, such as Excel or Lotus.

In analysis of a project, we have to find IRR value in order to compare it with the market rate of interest or with opportunity cost of capital. If the value of interest in the market in calculation is lower than rate of return from the project, it means that investment in that project will yield worthwhile return suitable for implementation. In case of PTT, its cost of loans (in normal condition) is 10% but a criterion is adopted for accepting a project at Financial Internal Rate of Return (FIRR) of 12%. On the other hand, the World Bank fixes Economic Internal Rate of Return

(EIRR) at 9-12% for developing countries. However, this study does not concern EIRR.

4) Benefits - Costs Ratio (B/C Ratio)

Benefits/Costs Ratio refers to the ratio of present value of benefits to present value of costs throughout the life of a project. Costs here include costs of Investment funds and expenses on Operation and Maintenance (O&M). Calculation to find B/C ratio can be done as follows:

$$B/C = \frac{\text{Present Value of Benefits (PVB)}}{\text{Present Value of Costs (PVC)}}$$

$$B/C = \frac{\sum_{t=0}^{n} \frac{B_t}{(1+i)^t}}{\sum_{t=0}^{n} \frac{C_t}{(1+i)^t}}$$

Where B_t = Benefits of the project in year "t"

C_t = Costs of the project in year "t"

i = Interest rate or Discount rate or Opportunity Cost of Capital

t = Year of the project (-3,-2,-1,0,1,2,...n)

Criteria for decision-making are as follows:

If B/C = 1 This means benefits and costs are of equal value. So, whether or not to choose the project depends on other supporting factors.

If B/C < 1 This means benefits are of lesser value than costs. It is not advisable to invest in that project.

If B/C > 1 This means benefits are of greater value than costs. Therefore, we will consider selecting such a project, which provides benefits to cover costs and placing it in a group of projects for selection.

In practice, the four methods under the above criteria will often be used jointly in decision-making. As for PTT, it will look first at IRR. If IRR exceeds the fixed criterion, i.e., 15%, PTT will then proceed to find NPV and Payback period.

5.6 Benefits and Costs of Project

5.6.1 Preliminary agreement and assumption on calculation to find benefits and costs of project

1. *Throughput* (or quantity of oil passing through pipeline) depends on demand and capture rate (from Table 4.5).

2. Supposes *Capture Rate* begins from 50% of demand in the 1st year of the project and increases by 5% a year to 75% in the 6th year. After that the quantity of oil passing through pipeline will be maintained at a rate equal to that in the 12th year until the end of the project in the 30th year. This will result in reducing capture rate to 27% in the 30th year of the project. The said capture rate is estimated on the basis of experience of PTT.

3. *Tariff Rate* (or Rates of service charges for capture). Using transportation costs by trucks that actually hired by PTT. for transporting from oil depot in Saraburi to Lampang, Nakhon Sawan and Pitsanulok will be sued by referring to the retail price of diesel oil of PTT. in Bangkok, which is in the range of 8.51-9.00 Baht/litre. Transportation costs in 1998 is used as the basis and this will be subject to escalation by 5% each year (the increase being adjusted to equal to Thappline).

4. *Throughput Revenue* (or Transportation Revenue) is calculated by multiplying throughput volumes at each depot by the respective tariff.

5. *Investment Funds*. Estimated investment funds in 1998 are used and readjustment is made in accordance with escalation factor up to the year of commencement of construction.

6. *Period of Construction* is 2 years. Funds will be used in the 1st year and 2nd year in the amounts of 40% and 60%, respectively.

7. *Escalation and Inflation*. Adjustment of inflation price of benefits and costs at 5% throughout the life of the project.

8. *Discount Rate* or Rate of Interest or Opportunity Cost is 10% for calculation of NPV and B/C Ratio.

9. *Operating and Maintenance Cost (O & M)* equal to 5% of initial cost (from experience of PTT). This cost includes operating, maintenance, staff training, power, corporate and general administrative charges. Annual O & M cost will be escalated by the escalation factor.

10. *Salvage Value* in the 30th year (end of the project life) is 20% of investment, using escalation factor as the multiplier so that the value will be closely similar to market value in the 30th year.

11. This is a project to be carried out by the government sector (PTT). So, no corporate income tax at 30% is paid.

12. For this project, *Equity* (or Investment funds) comes at the rate of 100% from PTT's equity[1]. No loan.

13. NPV, IRR and B/C Ratio belong 100% to investment or equity.

14. Rate of exchange at 38 baht/USD.

5.6.2 Economic Projections Period

The economic projections of the North pipeline cover the period from 2001 to 2032.

- The Construction Period

  The construction of the North pipeline will take approximately place over the period of two years to complete. Construction will commence in 2001, and the in-service date of this pipeline is expected to be in 2003.

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[1] Note : Moreover, in this project also includes the analyse of 2 rates of Equity that are 50% and 25% of PTT's equity in order to compare IRR and NPV with 100% PTT's equity as described in Appendix L.

- The Operating Period

  The economic projections assume the North pipeline will operate for at least 30 years upon completion. The operating period of this pipeline is 2003 to 2032.

5.6.3 Results of Economic Analysis

This is the economic result of the oil transportation by pipeline project compare to the oil transportation by truck based upon tariff rate. According to tanker truck is the most effective mode of oil transportation at present. Results of economic analysis that is calculated based upon the estimation and calculation of initial cost in chapter 4, can be summed up as follows (details in Table 5.1)

1)	Internal Rate of Return (IRR)	12.94%	
2)	Net Present Value (NPV @ i =10%)	2,088	million-baht
3)	Payback Period	9.83	years
4)	B/C Ratio	1.26	

Thus, It is obvious that this Northern region oil pipeline project can yield return to cover investment under every criterion and the rate is satisfactory. Moreover, it can be summarised that this pipeline can be efficiency competed with the existing main modes of transportation, which are tanker truck and rail.

5.6.4 Sensitivity Analysis of the project

To assess the impact of various variables on the economic viability of the project, sensitivity on the effect of these variables are performed. In analysis of sensitivity of project, important factors affecting the project are *Investment Cost, Tariff Rate, Throughput, and Operation and Maintenance (O & M) Cost*. So, the analyst has taken important factors affecting the project into analysis on sensitivity and results are shown in Table 5.2 (details in Appendix K).

Table 5.1 Cash Flow Statement, IRR, NPV, Payback Period and B/C Ratio

Case : Base

Project Life (Yr.)	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Items / Calendar year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Throughput (mml)	0	0	0	0	1,342	1,540	1,751	1,970	2,205	2,430	2,513	2,597	2,684	2,775	2,867	2,962	2,962
- Nakhon Sawan	0	0	0	0	427	490	557	627	701	761	787	813	840	869	897	926	926
- Pittsanulok	0	0	0	0	337	387	440	495	554	614	635	656	678	701	724	749	749
- Lampang	0	0	0	0	578	663	754	848	950	1,055	1,091	1,128	1,166	1,205	1,246	1,287	1,287
Escalation (%)		5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Escalation Factor		1.05	1.10	1.16	1.22	1.28	1.34	1.41	1.48	1.55	1.63	1.71	1.80	1.89	1.98	2.08	2.18
Tariff Rate (St / Lt)																	
- Nakhon Sawan	16.14	16.95	17.80	18.69	19.62	20.60	21.63	22.71	23.85	25.04	26.29	27.06	28.41	29.83	31.32	32.89	34.53
- Pittsanulok	23.91	25.11	26.37	27.69	29.07	30.52	32.05	33.65	35.33	37.10	38.96	40.91	42.96	45.11	47.37	49.74	52.23
- Lampang	34.91	36.66	38.49	40.41	42.43	44.55	46.78	49.12	51.58	54.16	56.87	59.71	62.70	65.84	69.13	72.59	76.22
Benefit (mmb)																	
- Throughput Revenue					427	515	614	725	853	990	1,075	1,166	1,266	1,374	1,491	1,617	1,698
- Salvage Value																	
Total Benefit					427	515	614	725	853	990	1,075	1,166	1,266	1,374	1,491	1,617	1,698
Cost (mmb)																	
- O & M					-271	-285	-299	-314	-330	-346	-364	-382	-401	-421	-442	-464	-487
- Investment			-2,172	-3,257													
Total Cost			-2,172	-3,257	-271	-285	-299	-314	-330	-346	-364	-382	-401	-421	-442	-464	-487
NET CASH FLOW			-2,172	-3,257	156	230	315	411	523	643	711	784	864	953	1,049	1,153	1,210

IRR = 12.94% **NPV** (i = 10%) 2,088 million-baht **Payback Period** 9.83 Years **B/C Ratio** 1.26

Table 5.1 Cash Flow Statement, IRR, NPV, Payback Period and B/C Ratio (continue)

Case : Base

Project Life (Yr.)	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Items / Calendar year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Throughput (mml)	2,962	2,962	2,962	2,962	2,962	2,962	2,962	2,962	2,962	2,962	2,962	2,962	2,962	2,962	2,962	2,962	2,962
- Nakhon Sawan	926	926	926	926	926	926	926	926	926	926	926	926	926	926	926	926	926
- Pittsanulok	749	749	749	749	749	749	749	749	749	749	749	749	749	749	749	749	749
- Lampang	1,287	1,287	1,287	1,287	1,287	1,287	1,287	1,287	1,287	1,287	1,287	1,287	1,287	1,287	1,287	1,287	1,287
Escalation (%)	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Escalation Factor	2.29	2.41	2.53	2.65	2.79	2.93	3.07	3.23	3.39	3.56	3.73	3.92	4.12	4.32	4.54	4.76	5.00
Tariff Rate (St / Lt)																	
- Nakhon Sawan	36.26	38.07	39.97	41.97	44.07	46.27	48.58	51.01	53.56	56.24	59.05	62.00	65.10	68.36	71.78	75.37	79.14
- Pittsanulok	54.84	57.58	60.46	63.48	66.65	69.98	73.48	77.15	81.01	85.06	89.31	93.78	98.47	103.39	108.56	113.99	119.69
- Lampang	80.03	84.03	88.23	92.64	97.27	101.88	106.97	112.32	117.94	123.84	130.03	136.53	143.36	150.53	158.06	165.96	174.26
Benefit (mmb)																	
- Throughput Revenue	1,783	1,872	1,966	2,064	2,167	2,275	2,389	2,509	2,634	2,766	2,904	3,049	3,202	3,362	3,530	3,706	3,892
- Salvage Value																	1,086
Total Benefit	1,783	1,872	1,966	2,064	2,167	2,275	2,389	2,509	2,634	2,766	2,904	3,049	3,202	3,362	3,530	3,706	4,978
Cost (mmb)																	
- O & M	-512	-537	-564	-593	-622	-653	-686	-720	-756	-794	-834	-875	-919	-965	-1,013	-1,064	-1,117
- Investment																	
Total Cost	-512	-537	-564	-593	-622	-653	-686	-720	-756	-794	-834	-875	-919	-965	-1,013	-1,064	-1,117
NET CASH FLOW	1,571	1,335	1,401	1,471	1,545	1,622	1,703	1,788	1,878	1,972	2,070	2,174	2,282	2,397	2,516	2,642	3,860

Table 5.2 Sensitivity Analysis Results

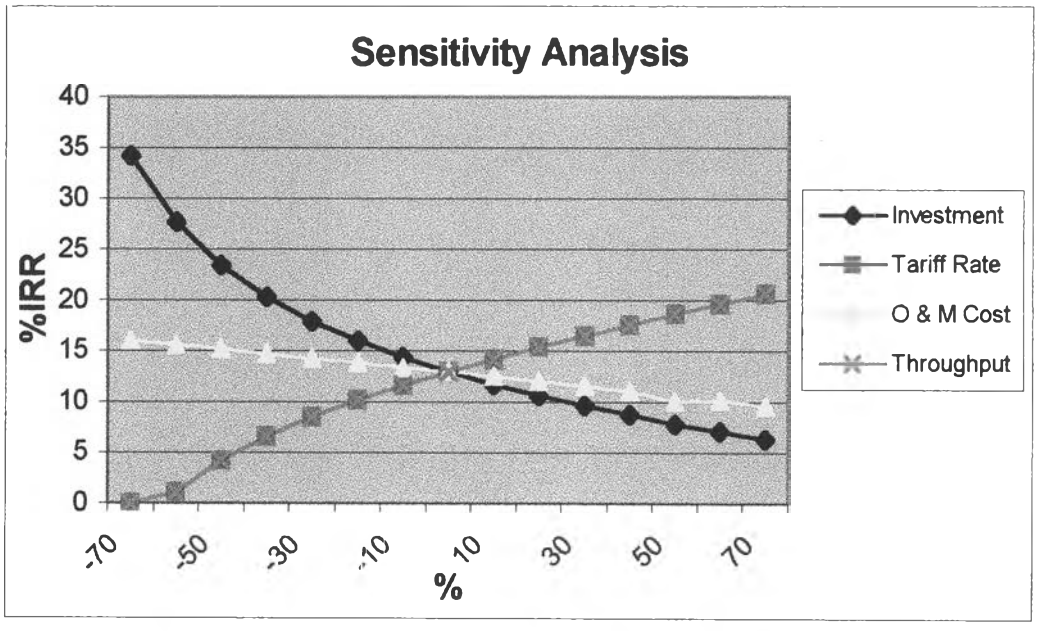
Case	(+)/(-) %	IRR %	NPV (i = 10%) (million-baht)	B/C Ratio (ratio)	Payback Period (Yr.)
(1) Base	-	***12.94***	***2,088***	***1.26***	***9.83***
(2) Investment	+10 / -10	11.72 / 14.34	1,289 / 2,887	1.15 / 1.40	10.72 / 8.94
	+20 / -20	10.62 / 15.96	490 / 3,686	1.05 / 1.57	11.06 / 8.06
	+30 / -30	9.63 / 17.70	-310 / 4,486	0.97 / 1.80	12.60 / 7.17
(3) Tariff Rate	+10 / -10	14.20 / 11.59	3,095 / 1,081	1.38 / 1.13	9.03 / 10.82
	+20 / -20	15.39 / 10.11	4,103 / 72.63	1.51 / 1.01	8.34 / 12.07
	+30 / -30	16.52 / 8.47	5,111 / -935	1.64 / 0.88	7.78 / 13.77
(4) O & M	+10 / -10	12.50 / 13.40	1,758 / 2,429	1.21 / 1.32	10.17 / 9.49
	+20 / -20	12.03 / 13.84	1,420 / 2,768	1.16 / 1.38	10.54 / 9.18
	+30 / -30	11.56 / 14.28	1,083 / 3,105	1.12 / 1.44	10.93 / 8.89
(5) Throughput	+10 / -10	14.20 / 11.59	3,096 / 1,080	1.38 / 1.13	9.03 / 10.82
	+20 / -20	15.39 / 10.11	4,104 / 72.63	1.51 / 1.01	8.34 / 12.07
	+30 / -30	16.52 / 8.46	5,111 / -935	1.64 / 0.88	7.78 / 13.77

As can be seen from the sensitivity analysis on Table 5.2 and Graph 5.1, it can be said that Tariff Rate and Throughput are the most sensitive in the range of $\pm$ 10 %. The steeper the line is the more sensitive it is, this means that a minor change in any of these two factors (Tariff Rate & Throughput) will have a big impact on the project. On the other hand if there is a bigger change for example, more than 10% (detailed in Appendix M), then the result would be different. As can be clearly seen from Graph 5.2, by looking at the slope of the line, it can be said that the Investment is the most sensitive then is Tariff Rate and Throughput. Operation and Maintenance cost does not have much effect to the project unlike the other three factors.

From Table 5.2, it can be seen that Investment funds is the most important negative factors for the project and next are Tariff rate and Throughput, which will have effects on the rate of return (IRR) of the project. On the other hand,

the most important positive factor for the project is also Investment cost. As for O&M, it has rather little negative and positive effects on the project.

A sensitivity analysis helps to identify variables that are most critical to the project viability. The variable that is most critical for this project is *Investment* as shown in Graph 5.1. In addition from Graph 5.1, it is found that when Investment cost increases to approximately 26.13%, IRR will be zero. It means that the project will not be viable for investment when Investment fund is pushed up by 26.13%. This situation might be possible if the economic regression is occurred that cause of the exchange rates fluctuation. Thus, Investment fund of the project must be control to ensure that they are within the estimate.



Graph 5.1 The Results of Sensitivity Analysis based on %IRR

In summary, It can conclude that the investment in this project is viable and the pipeline transportation project can efficiently compete with the existing oil transportation modes.