CHAPTER 8

CONCLUSION & RECOMENDATION

The Aromatics (Thailand) Public Company Ltd (ATC) is developing a project ("Thai PTA plant") to construct and operate a facility to produce purified terephthalic acid (PTA) primarily to supply local markets in Thailand. The project is being developed as a joint venture with a number of key local polyester producers in Thailand which will offtake PTA product. The facility will be located at Map Ta Phut with estimated startup in 2001. Therefore, this is a main reason to do this research such PTA project appraisal from selected technology to review and evaluate the marketing, technical, commercial, and management aspects of the project.

Commercial discussions among the potential partners were still underway at the time of this writing. The most likely capacity for the facility is 350 thousand metric tons per year. Raw material para-xylene is assumed to be supplied from ATC's nearby aromatics facility. The overall material balance for the PTA plant at capacity is summarized in Table 8.1.

TABLE 8.1
OVERALL PTA MATERIAL BALANCE
(thousand metric tons per year)

Raw Material	para-Xylene	232.8
Solvent	Acetic acid	21.0
Product	PTA	350.0

Source: INCA Process Technology

8.1 MARKET OUTLOOK SUMMARY

8.1.1 Polyester

Thailand's polyester industry is well established and growing while PET resin is expected to develop strongly in the future. Total polyester demand is expected to increase from 388 thousand metric tons in 1996 to 579 thousand metric tons in 2000, an average annual growth rate of 10.5 percent. Thailand's PET resin industry is at an early stage of development. In 1996, PET resin consumption accounted for only 10 percent of the total polyester demand and is expected to grow to 22 percent of the total share by 2000.

Polyester fiber and PET resin capacities within Thailand will expand sharply over the next several years. Chem Systems projects that polyester capacity for all applications will expand from 537 thousand metric tons per year in 1996 to approximately 1.5 million metric tons per year by 2000 including expansions by existing producers and new entries. As a result, Chem Systems expects strong competition for exports of fiber and resin, relatively low operating rates, and corresponding pressure on pricing.

Within the East Asian region, Chem Systems projects total polyester production in all applications to grow from 8.7 million metric tons in 1996 to 12.7 million metric tons in 2000, corresponding to an average annual growth of 10.0 percent. East Asian polyester production is projected to reach 22.0 million metric tons by 2010. Through 2000, Taiwan is expected to remain the largest East Asian polyester producing country followed closely by China and South Korea. These three countries together are expected to account for nearly two-thirds of East Asia's total production. As a result of East Asia's expected strong growth and substantial capacity expansion, operating rates are expected to remain in the low 80 percent range through 2000.

8.1.2 PTA

Chem Systems projects PTA demand within Thailand to grow from 323 thousand metric tons in 1996 to 1.0 million metric tons by 2000, corresponding to an average growth of nearly 33 percent annually. All of the polycondensation expansion projects under planning or construction in Thailand are PTA-based.

Until startup of Tuntex's PTA plant in the fourth quarter of 1995, Thailand's PTA requirements were supplied entirely by imports by Amoco, ICI, Mitsubishi, and Mitsui.

Tuntex produced approximately 100 thousand tons in 1995 and approximately 380 thousand metric tons in 1996. Tuntex is currently considering a 900 thousand ton per year PTA plant in Thailand for startup in 2000 or later. Chem Systems has assumed about half of this planned capacity will proceed by the end of the decade. The Siam Cement-Mitsui joint venture plant (Siam Mitsui PTA Company) will have a capacity of 350 thousand metric tons per year. They have awarded the engineering, procurement, and construction contract to Mitsui Shipbuilding and the unit has a planned startup by late 1998.

Including Tuntex's plant and the startup of Siam Mitsui PTA's plant, Chem Systems expects Thailand to continue to have a capacity shortfall versus demand until 2000 when Tuntex's planned expansion is expected to start up. Tuntex and Mitsui are expected to target PTA exports to their polyester affiliates within the region and a net trade surplus is expected after 2000.

Chem Systems projects total capacity for PTA equivalents within East Asia to expand by 6.9 million metric tons, to 15.7 million metric tons per year in 2000. A significant surplus is projected for East Asia. Malaysia and South Korea are expected to be the major contributors to East Asia's PTA surplus after 1999. Chem Systems expects Amoco's Malaysia plant to supply local Malaysian polyester producers, and serve as an export platform for the region. South Korean PTA expansion is beyond what is needed to supply its growth in demand for polyester and will peak at approximately 600 thousand metric tons in 1998. Based on what Chem Systems considers as firm projects and not including speculative additions, the operating rate in East Asia is expected to drop to approximately 67 percent by 1998 and recover to the low 80 percent range only beyond 2000. Although not included in the forecast, Chem Systems expects that some marginal PTA producers may be forced to shut down and/or restructure as a result of poor financial performance if industry operating rates drop into the 60 percent range. The PTA project will have offtake commitments for a significant portion of its production.

8.1.3 para-Xylene

Thailand's demand for para-xylene presently stands at 281 thousand metric tons per year which will increase to 516 with the startup of Siam Mitsui PTA's plant in 1999. ATC has started up its 322 thousand metric ton per year plant, the first domestic production, and is developing a 45 thousand metric ton per year debottlenecking project for 1999. Additional para-Xylene projects under development and capacities (thousand metric Ions per year) include Thai Oil (300), Chevron/PTT (675), and Exxon Sri Racha (300). Thai Oil has started its mixed xylenes production at its refinery, and para-xylene production is expected in 2000. Chem Systems has assumed that the Chevron and Exxon projects will be implemented after 2000, after which Thailand would become a major exporter of para-Xylene within the region. In addition, Tuntex has received BOI approval for an 800 thousand metric ton per year para-Xylene facility (not reflected in the forecast).

Capacity in East Asia totaled almost 4 million metric tons per year in 1996 and is expected to expand to nearly 10 million metric tons per year by 2000. East Asia will remain a major importer until 2000 and import requirements are expected to steadily decrease through 2005.

The trend toward back integration and self sufficiency among the East Asian countries is creating a structural shift for the global para-xylene industry. The East Asian para-xylene environment reflects ongoing strong growth in demand, a large expansion in local supplies, and increasing competition for a declining (but still large) volume of imports by a growing number of major competitors.

As a result of the buildup now underway in para-xylene capacity, Chem Systems expects global operating rates to drop from 86 percent in 1995 to the high 60 percent range between 1998 and 2000, and to recover to the high 70 percent range only by 2005. Chem Systems has not included all of the announced capacity additions in the outlook and has assumed some unspecified rationalization or shutdowns during periods of very low operating rates.

8.1.4 Acetic Acid

Thailand's demand for acetic acid is approximately 20 thousand metric tons per year. Consumption will be primarily driven by PTA production and is expected to more than double by 1999 with the start up of Siam Mitsui PTA's facility, and increase to about 80 thousand metric tons by 2005. All acetic acid supplies are currently imported and no local production is considered in the outlook.

East Asia's acetic acid capacity totaled about 1.3 million metric tons per year in 1996. Chem Systems expects at least one major expansion within the region by 2000. BP is currently considering a joint venture project with Petronas for a 500 thousand metric ton per year plant in Malaysia by 2000. The plan includes a VAM plant, the major use for acetic acid. Hoechst Celanese (HC) has also announced plans for a major expansion of 500 thousand metric tons per year in Southeast Asia, possibly Singapore, where a VAM plant is currently under construction.

The ASEAN region is expected to import approximately 150 to 200 thousand metric tons per year until 2000 when the BP/Petronas plant is expected to start up. East Asia's deficit is expected to peak at 450 thousand metric tons in 1998 and remain at about 300 thousand metric tons per year on average through 2005. The United States and Japan are expected to continue to supply East Asia's growing deficit.

Based on Chem Systems forecasting for price and supply/demand of PTA, para-Xylene and Acetic Acid, we found some error from the forecasting due to the economic crisis. So, some data which are price of PTA and supply/demand of PTA and para-Xylene are need to re-forecast. But, we respect the trend of Chem Systems, therefore, only quantity and volume are need to be adjusted. After analysis on the data from PTIT compare with Chem Systems, we can determine the percentage of change in price of PTA and supply/demand of PTA and para-Xylene. Afterwards, the new forecasting data of supply/demand of PTA are come out as shown in the table 8.2 below.

TABLE 8.2 PTA SUPPLY AND DEMAND BALANCE IN THAILAND
(metric ton per year)

	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2010**
Thailand	-18	20	124	126	128	128	133	185
Adjusting Value (%)	-2.25	-2.25	-2.25	-2.25	-2.25	-2.25	-2.25	-2.25
New Value	**22.5**	**25.0**	**154.8**	**157.3**	**159.8**	**159.8**	**166.0**	**230.9**

It is expected that in the year 2000 to 2010, such supply of PTA will over the demand of PTA. So, it need to export to another country that still have more demand of PTA such as China or Pakistan.

For price of PTA and para-Xylene are shown in the table 8.3 below, the new price of PTA and para-Xylene are slightly lower than Chem System expectation but it still use the same trend as Chem System forecasting – trend case.

TABLE 8.3 PRICE FORECASTING FOR PTA AND PARA-XYLENE
(US$ per metric ton)

Year	PTA	Adjusted Value	PTA New Price Value	para-Xylene	Adjusted Value	para-Xylene New Price Value
1999	700	-0.1533	**593**	609	-0.3499	**396**
2000	716	-0.1533	**606**	619	-0.3499	**402**
2001	732	-0.1533	**620**	630	-0.3499	**410**
2002	750	-0.1533	**635**	641	-0.3499	**417**
2003	770	-0.1533	**652**	657	-0.3499	**427**
2004	794	-0.1533	**672**	675	-0.3499	**439**
2005	817	-0.1533	**692**	695	-0.3499	**452**
2006	842	-0.1533	**713**	714	-0.3499	**464**
2007	867	-0.1533	**734**	735	-0.3499	**478**
2008	893	-0.1533	**756**	756	-0.3499	**491**
2009	920	-0.1533	**779**	777	-0.3499	**505**
2010	948	-0.1533	**803**	800	-0.3499	**520**
2011	987	-0.1533	**836**	825	-0.3499	**536**
2012	1,017	-0.1533	**861**	852	-0.3499	**554**
2013	1,048	-0.1533	**887**	879	-0.3499	**571**
2014	1,079	-0.1533	**914**	907	-0.3499	**590**
2015	1,112	-0.1533	**942**	936	-0.3499	**608**
2016	1,145	-0.1533	**969**	966	-0.3499	**628**
2017	1,193	-0.1533	**1010**	997	-0.3499	**648**
2018	1,229	-0.1533	**1041**	1,029	-0.3499	**669**
2019	1,266	-0.1533	**1072**	1,062	-0.3499	**690**
2020	1,304	-0.1533	**1104**	1,096	-0.3499	**713**

8.2 INCA PROCESS TECHNOLOGY / LICENSING ASSESSMENT

PTA technology for the PTA project facility will be selected from one of the available licensors in the industry. The options are limited. ATC has held discussions with INCA, a subsidiary of the Dow Chemical Company. In addition to basic process comparisons with other leading technologies, important considerations in the selection include critical design and operating know how features and the possibility for further improvements in the technology.

In general, the basic oxidation and purification technologies for PTA manufacture have been extensively developed. The "experience curve" for the basic process technology is now approaching diminishing returns, and further major breakthroughs (i.e., new catalyst systems, raw materials and basic unit operations) are not anticipated in the future. The leading producers are expected to have greater extent of optimization and energy integration across the entire CTA/PTA complex and more advanced control schemes. Nevertheless, for the same capacity and location, ATC expects that differences in variable costs for the PTA technologies are relatively small. However, obtaining demonstrated technology and operating know how from an established licensor or operator is absolutely critical for a successful PTA project. Possible licensing options are highlighted in Table 8.4

TABLE 8.4
PTA LICENSING OPTIONS

Amoco	**Not available except in equity JVs**
ICI	**Equity JVs and selective licensing**
Mitsui	**Equity JVs and selective licensing**
Mitsubishi	**Equity JVs and selective licensing**
INCA	**Licensing**
Others	**Interquisa, Lonza, Huls**

Given the current state of development of CTA/PTA technology, the major factors affecting competitive advantage relate to economy of scale, site-specific cost factors, logistics costs, regional and local market positions, and operating experience. Amoco, ICI, Mitsui, and Mitsubishi PTA processes are all considered technically equivalent. These major producers have licensed processes extensively through the 1960's to 1980's time frame and are credited with major improvements and optimization as well as unsurpassed operating experience. Today these producers' strategies limit licenses which are usually issued as part of joint venture developments. Other possible sources of PTA technology include INCA and Interquisa. These technologies (both derived originally from Amoco licenses) are considered to be technically equivalent to the Amoco, Mitsui, ICI, and Mitsubishi technologies. INCA's qualifications are reviewed in detail in Chapter 4 based on information provided to ATC. Interquisa has not licensed its process to date but has said that it would be interested in selected licensing opportunities. Lanza's technology is not proven commercially, and the Huls process is not considered to be economical.

In summary, ATC believes that the INCA technology is demonstrated and is a viable alternative for the PTA project provided that acceptable commercial terms are negotiated for the license.

8.3 MANAGEMENT SUMMARY

According to ATC experience, such manpower to operate PTA project is about 94 persons which separated to operation line 64 persons and management & administration 30 persons. For the total wages and salary per year is about 1,571,334 US $. And increase at the rate of 5 percent per annum.

8.4 FINANCIAL & PARAMETERS ANALYSIS SUMMARY

After studying on the associated parameters which have an impact on PTA project by using the same financial model and change in some parameters. So, such NPV value before less initial investment is going to be equal with its initial investment will be notified us that the PTA project is going to be failed.

The results of these analyses are shown in the table 8.5 below by commencing with the highest to the lowest sensitivity to the PTA project.

TABLE 8.5
ASSOCIATED PARAMETERS TO PTA PROJECT

Parameter	% Increase/ (Decrease)
PTA Price	**(16.6)**
Para-Xylene Price	**37.1**
Plant Utilization Rate	**(46.0)**
Capital Investment	**80.0**

For para-Xylene price and PTA price, based on our experience in the past history from year 1985 to 1996 as shown in the table 8.6 and figure 8.1 below.

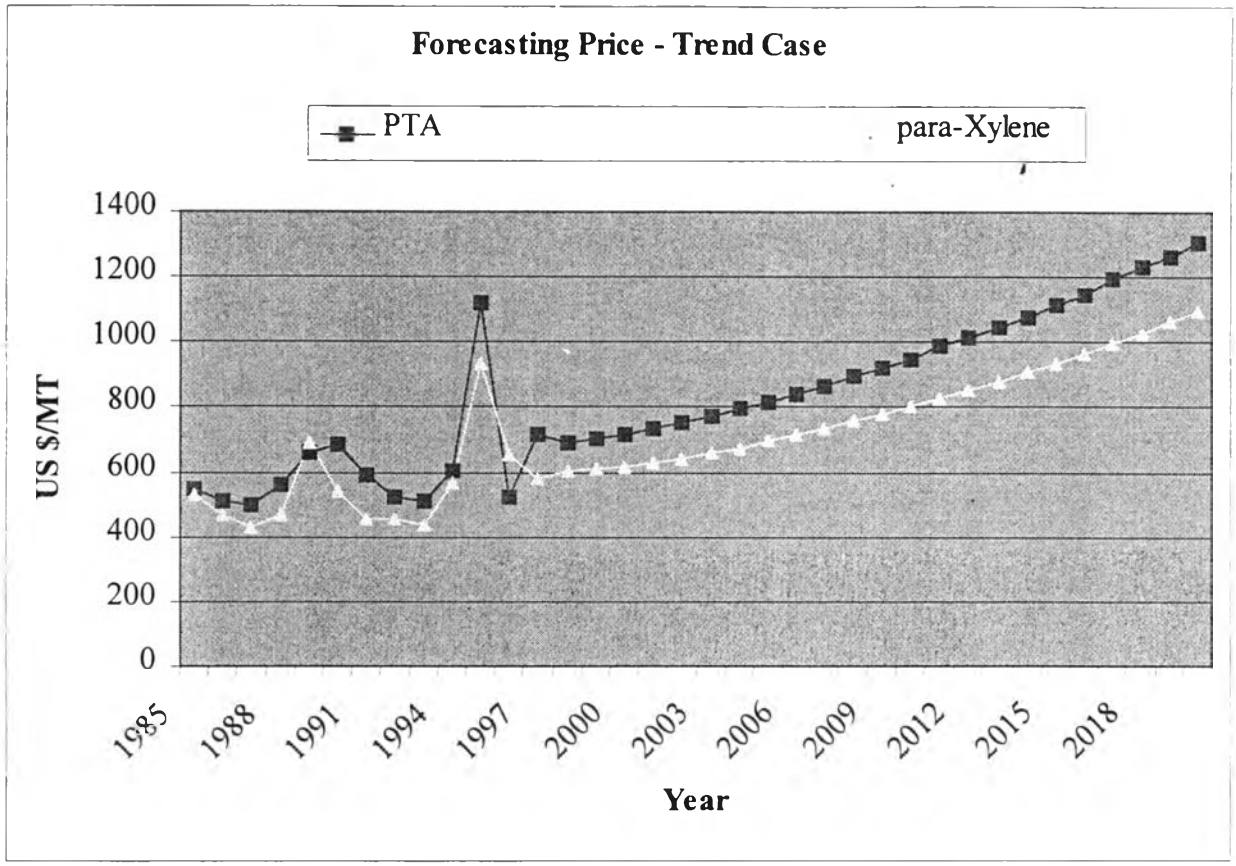
TABLE 8.6
SOUTHEAST ASIA CONTRACT PRICE FORECASTS - TREND CASE
(US Dollars Per Metric Ton)
Current dollars

	PTA	*para-Xylene*
	Historical	
1985	548	531
1986	511	465
1987	495	427
1988	558	464
1989	**658**	**688**
1990	686	541
1991	592	452
1992	523	452
1993	510	436
1994	602	564
1995	1,120	931
1996	**525**	**656**
	Forecast	
1997	714	581
1998	688	604
1999	700	609
2000	716	619
2001	732	630
2002	750	641
2003	770	657
2004	794	675
2005	817	695
2006	842	714
2007	867	735
2008	893	756
2009	920	777
2010	948	800
2011	987	825
2012	1,017	852
2013	1,048	879
2014	1,079	907
2015	1,112	936
2016	1,145	966
2017	1,193	997
2018	1,229	1,029
2019	1,266	1,062
2020	1,304	1,096

Source: Chem Systems Research for East Asia PTA and para-Xylene Price 1999

Such record had been shown that PTA price can be decreased over 10% in one year (1995-1996) and para-Xylene price can be increased over 20% in one year (1988-1989). It can be interpreted that this PTA project is very high sensitivity on these two parameters.

FIGURE 8.1
FORECASTING PRICE – TREND CASE



Nevertheless, from our record as mentioned above, the data have shown that there has a relation between these two parameters which is the trend of price. In generally, if para-Xylene price is increased or decreased, PTA price is increased or decreased accordingly. So, we can conclude that PTA project will not have too much effect from both PTA price and para-Xylene price. Except only one case that para-Xylene price is higher than PTA price which has only two times record in ten years period.

In order to analyze on the plant utilization rate, such data and record of demand and supply of PTA as shown in the table 8.7 below should be mentioned at first.

TABLE 8.7

ASEAN PTA EQUIVALENTS DEMAND

(thousand metric tons)

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2010
Indonesia	428	543	724	985	1,123	1,280	1,328	1,458	1,602	1,760	1,934	2,125	2,893
Malaysia	61	98	156	198	241	262	269	288	308	329	352	377	403
Philippines	35	36	41	48	56	64	73	76	80	84	88	93	110
Thailand	319	381	376	546	703	788	1,034	1,083	1,102	1,116	1,132	1,149	1,180
ASEAN Demand	**843**	**1,058**	**1,297**	**1,777**	**2,123**	**2,394**	**2,704**	**2,905**	**3,092**	**3,289**	**3,506**	**3,744**	**4,586**

ASEAN PTA EQUIVALENTS CAPACITY

(thousand metric tons)

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2010
Indonesia	475	525	825	1,865	1,865	1,865	1,865	1,865	1,865	1,865	2,200	2,300	3,000
Malaysia	0	0	500	500	600	600	600	600	600	600	600	600	600
Philippines	0	0	0	0	0	0	0	0	0	0	0	0	0
Thailand	0	400	400	420	420	770	1,220	1,570	1,570	1,570	1,570	1,570	1,570
ASEAN Capacity	**475**	**925**	**1,725**	**2,785**	**2,885**	**3,235**	**3,685**	**4,035**	**4,035**	**4,035**	**4,370**	**4,470**	**5,170**

ASEAN PTA EQUIVALENTS SUPPLY

(thousand metric tons)

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2010
Indonesia	304	350	560	1,000	1,250	1,400	1,400	1,458	1,602	1,760	1,934	2,125	2,893
Malaysia	0	0	225	450	500	550	550	550	550	550	550	550	550
Philippines	0	0	0	0	0	0	0	0	0	0	0	0	0
Thailand	0	100	370	420	420	770	1,054	1,207	1,228	1,244	1,260	1,282	1,365
ASEAN Supply	**304**	**450**	**1,155**	**1,870**	**2,170**	**2,720**	**3,004**	**3,215**	**3,380**	**3,554**	**3,744**	**3,957**	**4,808**

ASEAN PTA EQUIVALENTS SUPPLY/DEMAND BALANCE

(thousand metric tons)

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2010
Indonesia	(124)	(193)	(164)	15	127	120	72	0	0	0	0	0	0
Malaysia	(61)	(98)	69	252	259	288	281	262	242	221	198	173	147
Philippines	(35)	(36)	(41)	(48)	(56)	(64)	(73)	(76)	(80)	(84)	(88)	(93)	(110)
Thailand	(319)	(281)	(6)	(126)	(283)	(18)	20	124	126	128	128	133	185
ASEAN S/D Balance	**(539)**	**(608)**	**(142)**	**93**	**47**	**326**	**300**	**310**	**288**	**265**	**238**	**213**	**222**

Source: Chem Systems Research for East Asia PTA Supply and Demand 1996

Even though such supply of PTA in ASEAN region is over the demand especially Thailand and Malaysia. But, from Chem Systems, there has an evidence which show that in EAST ASIA still has more demand to absorb such excess supply as shown in the table 8.8 and figure 8.2 below.

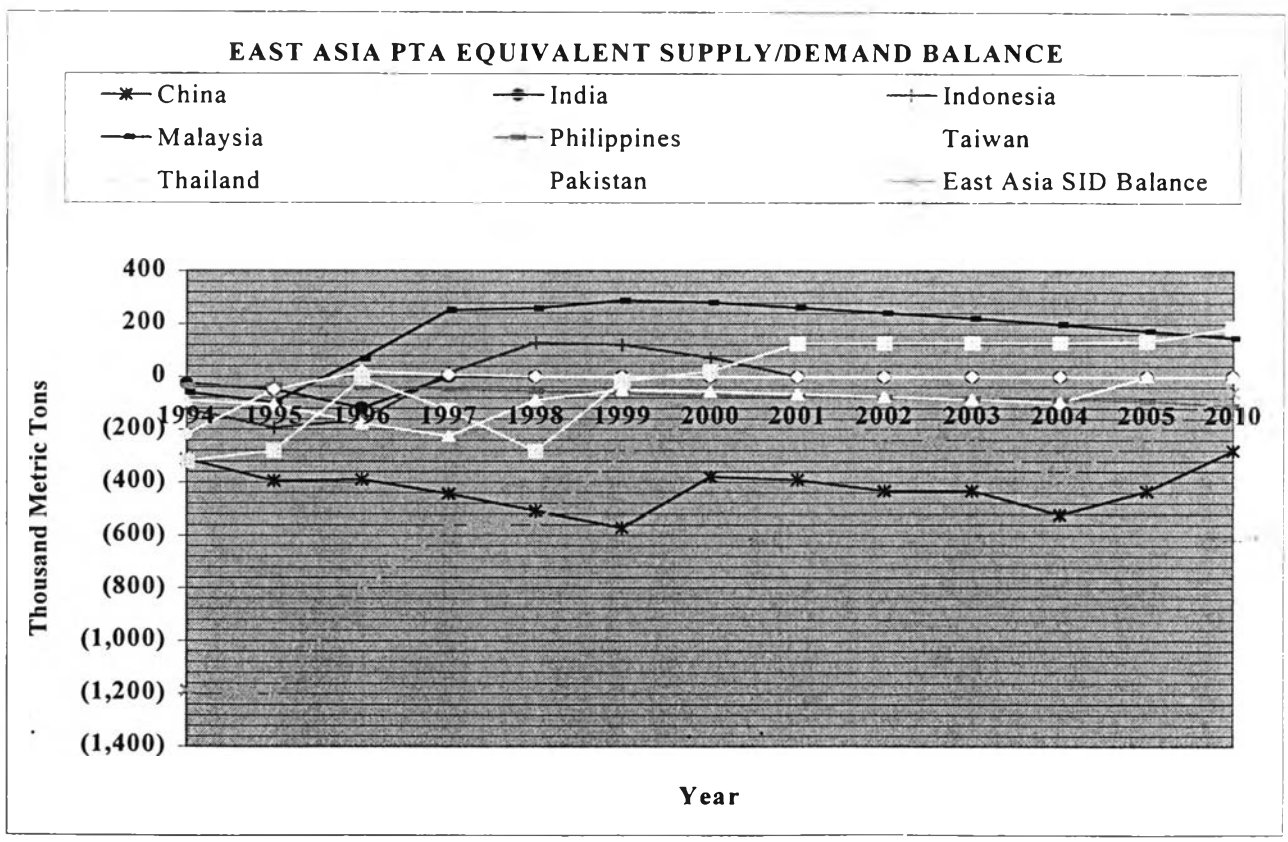
TABLE 8.8 EAST ASIA PTA EQUIVALENT SUPPLY/DEMAND BALANCE

EAST ASIA PTA EQUIVALENTS SUPPLY/DEMAND BALANCE
(thousand metric tons)

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2010
China	(313)	(395)	(390)	(444)	(509)	(572)	(380)	(391)	(433)	(433)	(523)	(435)	(281)
India	(26)	(49)	(118)	0	0	0	0	0	0	0	0	0	0
Indonesia	(124)	(193)	(164)	15	127	120	72	0	0	0	0	0	0
Malaysia	(61)	(98)	69	252	259	288	281	262	242	221	198	173	147
Philippines	(35)	(36)	(41)	(48)	(56)	(64)	(73)	(76)	(80)	(84)	(88)	(93)	(110)
Taiwan	(218)	(50)	19	7	0	0	0	0	0	0	0	0	0
Thailand	(319)	(281)	(6)	(126)	(283)	(18)	20	124	126	128	128	133	185
Pakistan	(91)	(106)	(178)	(225)	(89)	(51)	(57)	(67)	(77)	(87)	(98)	0	0
East Asia SID Balance	(1,187)	(1,208)	(809)	(569)	(551)	(297)	(137)	(148)	(222)	(255)	(383)	(222)	(59)

Source: Chem Systems East Asia PTA Equivalent, 1996

FIGURE 8.2
EAST ASIA PTA EQUIVALENT SUPPLY/DEMAND BALANCE



Therefore, such PTA supply in Thailand can be exported to China or Pakistan due to their still have more demand. From the evidence as mentioned above, we could conclude that there are only two reasons to reduce their plant utilization rate which are;

1. Unplanned shutdown (extraordinary case) which can be taken from the act of god such as flood, earthquake, or man made such as power supply is completely shut down. Even though, based on our experience in the past twenty years, there is no record which shown that Map Taphut (Rayong) has been faced with the act of god or power supply shortage. In some cases, such power supply is failed but it can be started again within two (2) days which will not has an effect to our PTA project.

2. Major maintenance (normally case which use only thirty (30) days in two (2) years period). This is an activity which normally do in every two (2) years period for ensure that the plant can be operated smoothly without the damage from all the equipment. In generally except extraordinary case, the plant utilization rate will be reduced from maintenance which is only five percent (5%) in one (1) year period.

So, for our base case, the PTA project will be failed when such plant utilization rate must be reduced over forty six percent (46%). Therefore, we can conclude that the plant utilization rate will not have an effect to the PTA project.

For the last parameter which is capital investment, such an impact to PTA project will be occurred when the capital investment is increase higher than fifty percent at initial stage of the project (year 2001). So, we would like to compare the capital investment increasing rate with United State (U.S.) increasing inflation rate in order to conclude about the increasing rate of capital investment that it can be increased in one year over than eighty percent or not. The table 8.9 and figure 8.3 as shown below is a year by year chart of the U.S. inflation rate based on the changes in the consumer price index and the gross domestic product implicit price deflator.

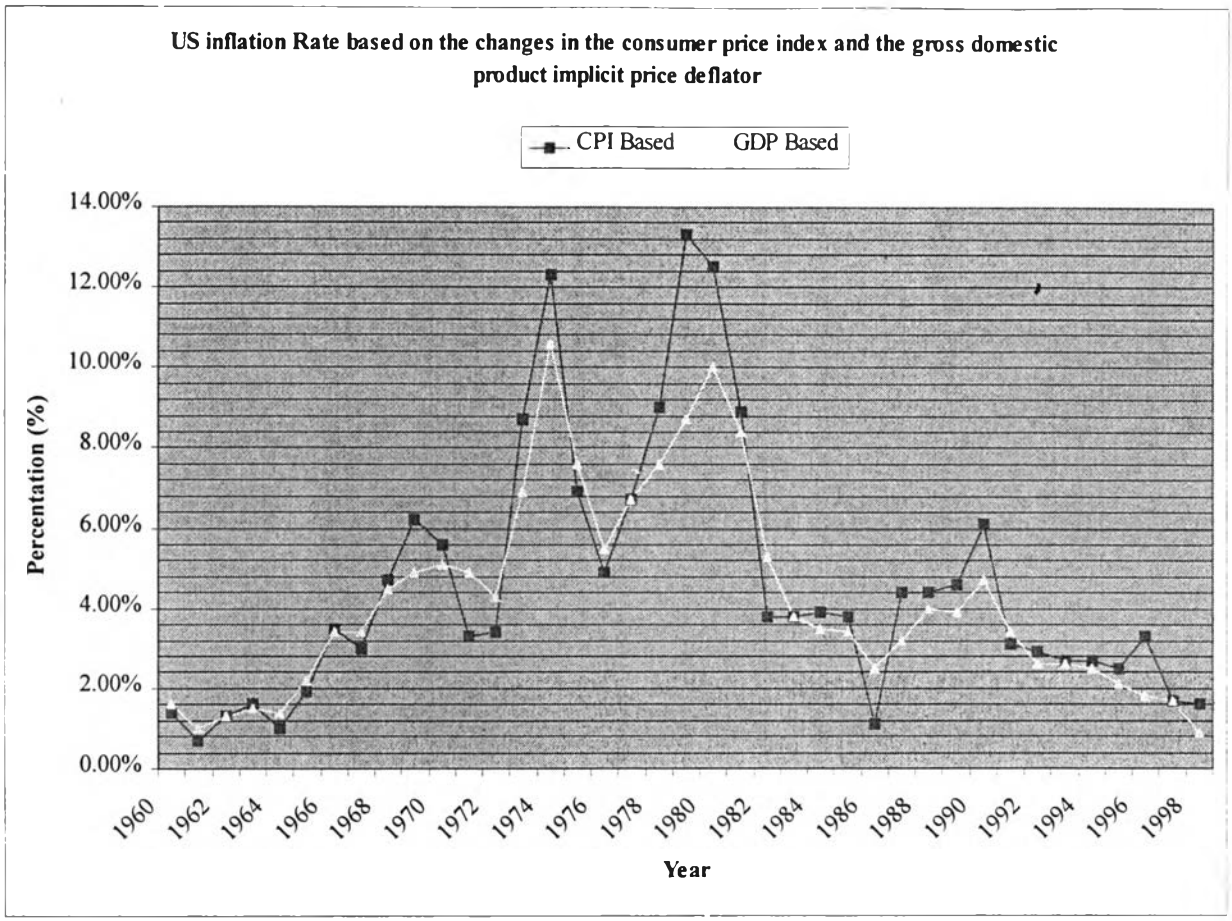
TABLE 8.9

U.S. Inflation Rate based on the changes in the consumer price index and the gross domestic product implicit price deflator

Year	CPI Based	GDP Based
1960	1.4%	1.6%
1961	0.7%	1.0%
1962	1.3%	1.3%
1963	1.6%	1.5%
1964	1.0%	1.4%
1965	1.9%	2.2%
1966	3.5%	3.4%
1967	3.0%	3.4%
1968	4.7%	4.5%
1969	6.2%	4.9%
1970	5.6%	5.1%
1971	3.3%	4.9%
1972	3.4%	4.3%
1973	8.7%	6.9%
1974	12.3%	10.6%
1975	6.9%	7.6%
1976	4.9%	5.5%
1977	6.7%	6.7%
1978	9.0%	7.6%
1979	13.3%	8.7%
1980	12.5%	10.0%
1981	8.9%	8.4%
1982	3.8%	5.3%
1983	3.8%	3.8%
1984	3.9%	3.5%
1985	3.8%	3.4%
1986	1.1%	2.5%
1987	4.4%	3.2%
1988	4.4%	4.0%
1989	4.6%	3.9%
1990	6.1%	4.7%
1991	3.1%	3.4%
1992	2.9%	2.6%
1993	2.7%	2.6%
1994	2.7%	2.5%
1995	2.5%	2.1%
1996	3.3%	1.8%
1997	1.7%	1.7%
1998	1.6%	0.9%

Source: U.S. Inflation Rate WWW.neatidea.com

FIGURE 8.3
US INFLATION RATE BASED ON THE CHANGES IN THE CONSUMERPRICE INDEX AND THE GROSS DOMESTIC PRODUCT IMPLICIT PRICE DEFLATOR



From the past history data from 1960 to 1998, there is no evidence which show that U.S. inflation rate can be dramatically increase about fifty percent within one year the capital investment can be increased higher than eighty percent (80%) in only one (1) year period. So, we can conclude that there is no effect from the capital investment to the PTA project.

8.5 THESIS RECOMMENDATION

According to result from NPV and IRR, such PTA project is still feasible to invest, even though, during ASEAN (include Thailand) economic crisis. However, such this thesis may act as a pre-feasibility study, some of data are incomplete. So, for further study on this project, such recommendations are mentioned below.

8.5.1 All data which used in this research is based on 1996 before ASEAN's economic crisis, some data may be out of dated. Therefore, ATC or other researchers who interesting in PTA feasibility study should contact to Chem Systems or other well known institution in petrochemical industry for seeking a new information about demand/supply and price forecasting of PTA, para-Xylene, and Acetic Acid.

8.5.2 Even though, this PTA project is very interesting to invest but the capital investment is essential to the project. So, ATC should consider on the source of this capital investment, where to get it.

8.5.3 In this research, the environment impact and social impact are out of scope. So, for further study, such these items must be concentrated due to PTA project is high sensitivity on these two items. Because, if this PTA project is cause of environment impact such as dust or fume spread into the air which directly impact to people around the plant area. Such PTA must be failed due to social impact (in this case is people around the plant area will force the Government to stop the project)

8.5.4 The organization structure to be provided in this research is only based on ATC experience in the past three years which is only illustrated in idea case may incomplete or not proper with this PTA project in the commercial run. So, ATC or other researchers should be further studied on this topic again for set up such details of job function and their experience in each position. Afterward, the wages and salary can be estimated for each position.

8.5.5 Details of equipment capacity must be furthered study, due to in this research is only provide a guideline of equipment by licensor's experience. So, ATC or other researchers should be concentrated on this topic in order to know that what type or capacity of equipment will be matched with this PTA project.