PETROCHEMICALS OUTLOOK OF SOUTH KOREA IN 2011 AND ITS IMPACT IN MALAYSIA FOR ITS FUTURE TRENDS

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PETROCHEMICALS OUTLOOK OF SOUTH KOREA IN 2011 AND ITS IMPACT IN MALAYSIA FOR ITS FUTURE TRENDS

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A project report submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering (Hons.) Chemical Engineering

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April 2012

DECLARATION

I hereby declare that this project report is based on my original work except for citations and quotations which have been duly acknowledged. I also declare that it has not been previously and concurrently submitted for any other degree or award at UTAR or other institutions.

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Specially dedicated to
my beloved family and friends

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ABSTRACT

This research was conducted to present an in-depth petrochemicals outlook of South Korea in 2011. In light of this, existing plant capacity and future capacity additions in South Korea's petrochemical industry were studied. Most of the data collected were confined to basic petrochemicals products such as olefins and polyolefin. The statistical data was compiled based on secondary resources, mainly extracted from country data, petrochemicals company's annual report and well-recognized market research. The olefin production capacity and olefins products supply and demand trend were captured from 2000 to 2015 and presented in charts. Overall, the olefins production capacity grew steadily in the past and the trend is forecasted to continue in a slower term from 2012 to 2015. Similarly, olefins supply and demand trend was increasing gradually from 2000 to 2011 and a tightening of supply and demand balance is expected from 2013 to 2015. In order to provide a clearer view, current capacity of olefin and polyolefin was summarized by location in the South Korea map. To date, no study has looked at the relationship between South Korea and Malaysia in petrochemicals sector. Hence, this research was carried out to fill in this gap and focus on the impacts in Malaysia as a result of South Korea's recent investments. SWOT analysis was employed to analyze the pros and cons for the business cooperation outcomes. Finally, complimentary business cooperation was proposed for South Korean based Titan Chemicals and Malaysia state-owned Petronas to mitigate the impacts in the near future. The proposed solution suggested Petronas to concentrates on the upstream refining sector while Titan Chemicals utilizes its expertise in downstream processing sector to consolidate each other.

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LIST OF SYMBOLS / ABBREVIATIONS

ABS	acrylonitrile butadiene styrene
ASEAN	Association of South East Asian Nations
BP	British Petroleum
btu	British thermal units
BTX	benzene, toluene and xylene
ECFA	Economic Cooperation Framework Agreement
EG	ethylene glycol
FTA	free trade agreement
GDP	Gross Domestic Product
HDPE	high density polyethylene
KTA	kilo tonnes per annum
LDPE	low density polyethylene
LLDPE	linear low density polyethylene
LNG	liquefied natural gas
LPG	liquefied petroleum gas
M&A	mergers and acquisitions
mt	metric tons
MTA	million metric tonnes per annum
PE	polyethylene
PET	polyethylene terephthalate
Petronas	Petroliam National Berhad
PP	polypropylene
PS	polystyrene
PTA	pure terephthalic acid
PVC	polyvinyl chloride
RAPID	Refinery and Petrochemical Integrated Development
RM	Ringgit Malaysia

SARS	Severe acute respiratory syndrome
tpa	tonnes per annum
UK	United Kingdom
US	United States

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CHAPTER 1

INTRODUCTION

1.1 Background

In many countries, petrochemical industry is the foundation to drive the overall economic performance. Petrochemical industry is one of the major chemical industries where the products are captured mainly from crude oil or natural gas. In essence, there are numerous routes to produce petrochemical products from hydrocarbon feedstock. From oil refinery, products such as naphtha, liquefied petroleum gas (LPG) or ethane is used in producing light olefins by steam cracking. This process makes use of steam to break down the hydrogen and carbon atoms into lighter and more valuable fractions. On the other hand, naphtha is also employed in catalytic reforming process to produce aromatics. In catalytic reforming, low octane ratings of naphtha is converted to high octane gasoline known as reformates which contains high concentrations of aromatics. Besides that, natural gas is an attractive feedstock used to produce synthesis gas by steam reforming of methane. This is achieved by catalytic reaction of steam at high temperature with methane to form synthesis gas.

A wide range of petrochemical products are classified into three classes of upstream petrochemicals. The first category is olefins which include ethylene, propylene and butadiene. Aromatic is the second category including benzene, toluene and xylene (BTX). Last category is synthesis gas that contains carbon monoxide and

hydrogen. Apparently, olefins markets gained popular interest as it represents the largest base chemical building blocks in petrochemical industry. The upstream petrochemicals are in turn classified as raw materials used in production of intermediate products such as polypropylene (PP), high density polyethylene (HDPE) and polystyrene (PS). Later, the intermediate products are further processed into downstream products like plastic bottles and plastic bags which are widely used in our daily life. Figure 1.1 illustrates an overview of petrochemical process from upstream of crude oil refining to downstream of end use products processing.

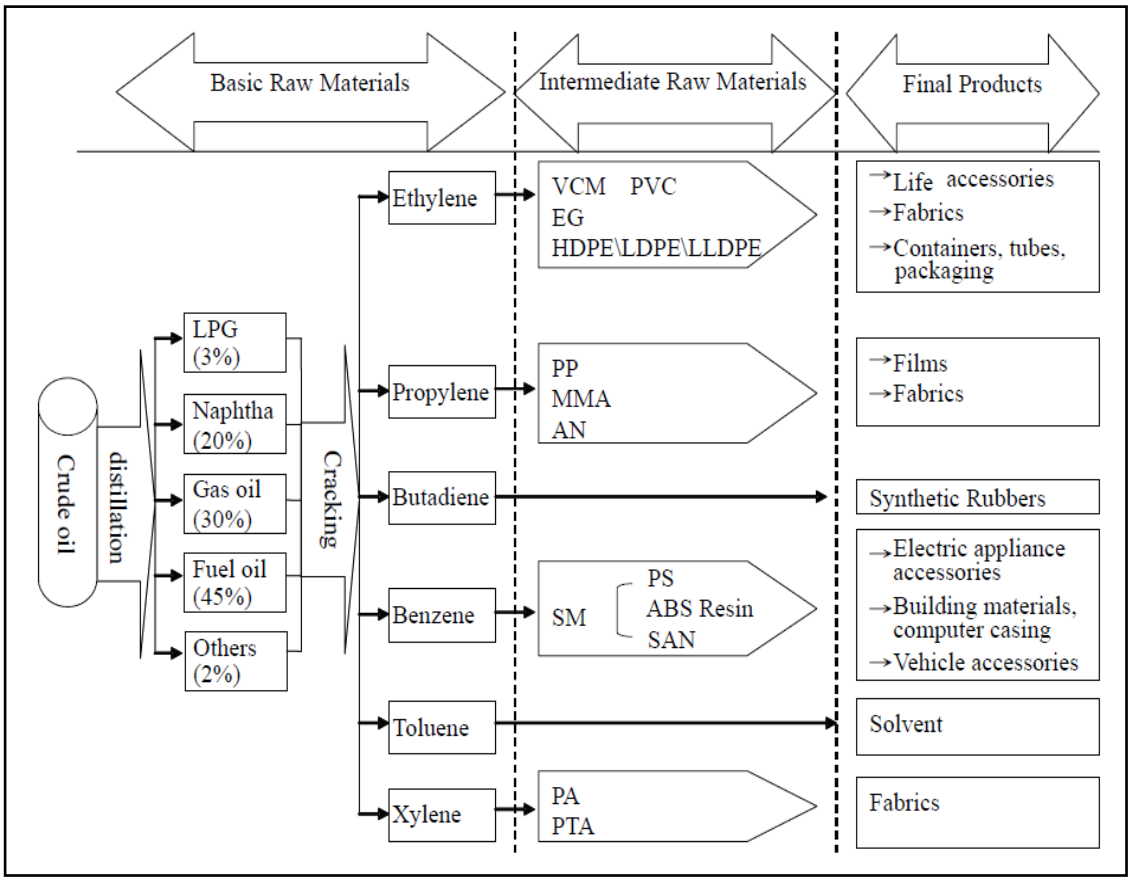


Figure 1.1: Petrochemical Process Flowchart (Source: Chen, 2010)

1.2 Petrochemical Industry in South Korea

South Korea is located in East Asia where it belongs to the southern portion of Korean Peninsula. South Korea is bordered by North Korea and the neighbouring

countries include China to the west, Japan to the east and Taiwan to the south. Hence, petrochemical industry in South Korea ideally benefit from the strategic location as a supply base for North East Asia. For instance, South Korea's petrochemical products are mainly export to China to sustain soaring demand within the country. In addition, a well-developed petrochemicals infrastructure together with support from the governmental policies is likely to promote the petrochemical industry. Over the past few decades, petrochemical industry has begun its full-fledged operation in South Korea. In spite of having a short history of 30 years, South Korea petrochemical industry has achieved a remarkably development in line with the high level of economic growth of the country. A summary of major milestone for South Korea petrochemical industry is presented in Figure 1.2. The large increase in production capacity along with rapid expansion in industry has gradually transformed South Korea to be one of the outstanding petrochemical producers.

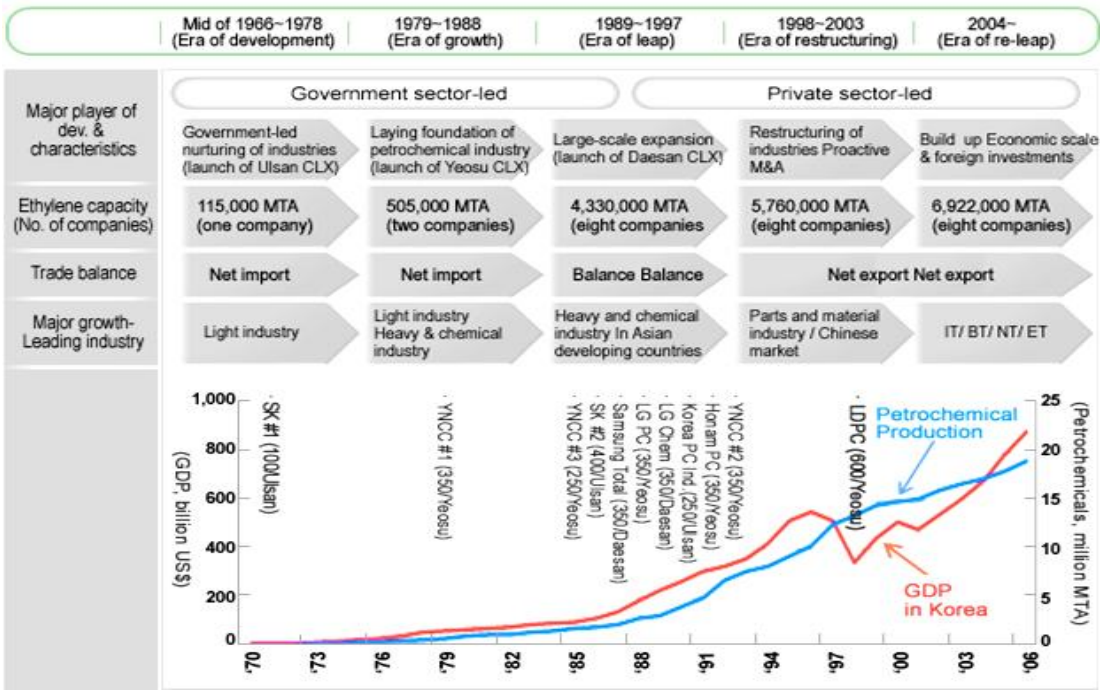


Figure 1.2: Development of South Korea Petrochemical Industry

(Source: Korea Petrochemical Industry Association [KPIA], 2008a)

Today, South Korea is host to the fifth-largest petrochemicals industry in the world according to Business Monitor International [BMI] (2010a). In 2007, Korea Petrochemical Industry Association [KPIA] (2008a) indicated that South Korea had

57.0 million tonnes per annum (tpa) of total capacity accounts for major petrochemicals. The petrochemical markets in South Korea are export oriented since domestic demand is less than 50 % of the production (Seddon, 2010). Some basic petrochemicals such as ethylene, propylene, butadiene, benzene and xylene have been identified as the prime constituent of the South Korea's export basket. As far as petrochemical industry is concerned, petrochemical plants in South Korea use naphtha as dominant feedstock and undergo cracking operations to produce a diverse range of petrochemical products. Over the years, the focus of the industry has so far been on downstream areas due to the fact that the country lacks indigenous oil and gas reserves. Hence, the country depends on imports of hydrocarbon feedstock which in turn results in feedstock cost disadvantage if compared with other countries. In an attempt to secure energy demands, South Korea trades its expertise in building infrastructure to exchange energy resources and petrochemicals (BMI, 2010d).

In South Korea, there are several major petrochemicals plants are established in Yeosu, Daesan and Ulsan, while a few small scale petrochemicals production facilities are located at Onsan (KPIA, 2008a) as shown in Figure 1.3. The major players in this field include South Korea-based Honam Petrochemical, LG Chem, SK Corporation, Samsung Total Petrochemicals, Korea Petrochemical Industry Company and Hanwha Chemical. On the other hand, foreign petrochemical producers consist of UK-based British Petroleum (BP) and Germany's BASF.

Figure 1.3: Location of Major Petrochemical Plants in South Korea
(Source: Moon & Cho, 2011)

1.3 Petrochemical Industry in Malaysia

Over the years, Malaysia is blessed with high abundant oil and gas reserves. This factor has drawn significant interest among the investors and the government in exploring petrochemical industry in Malaysia. In early 1990s, overall development of petrochemical industry was growing rapidly due to smart partnership of Malaysia with some of the world's leading petrochemical industries. Meanwhile, Malaysian Petrochemicals Association [MPA] (2006) has pointed out that the growth of the petrochemical industry is supported by the Malaysian Government and Petroliam Nasional Berhad (Petronas) which is also the national oil and gas company. On the other hand, the growth in Malaysian petrochemicals industry is also attributed to a well established infrastructure and integrated petrochemical complexes. For example, integrated petrochemical complexes help to reduce capital and operational costs by offering centralised utilities, well-organized storage services and a complete transportation network. As a result, petrochemical industry has become one of the major growth industries amongst other sectors in Malaysia.

At present, Malaysia has the world's 25th largest proven crude oil reserves of 4.5 billion barrels and the world's 12th largest natural gas reserves of 89 trillion cubic feet. Significantly, Malaysia is the world's third largest producer of liquefied natural gas (LNG) with a production capacity of 23 million tpa (BMI, 2010e). On top of that, Malaysia's strategic location in the heart of South East Asia and its close proximity to major markets in Far East have made the nation turn into an ideal springboard for petrochemical producers to launch into Association of South East Asian Nations (ASEAN) market. Today, Malaysia has become a major exporter of petrochemical products within ASEAN region as indicated in a study of Jabatan Pembangunan Kemahiran [JPK] (2010). Typically, commodity grade polymers and petrochemical derivatives are the two major exports of petrochemical products. Polymers are mainly exported to China, India and ASEAN countries. Currently, there are around 39 petrochemical companies are in operation in Malaysia and results in total investments of about RM 28 billion which is equivalent to US$ 7.36 billion (BMI, 2010e).

According to Malaysian Industrial Development Authority [MIDA] (2004), petrochemical industry in Malaysia is primarily concentrated in three world-class petrochemical zones including Gebeng in Pahang, Kerteh in Terengganu, Pasir Gudang and the adjacent Tanjung Langsat site in Johor is emerging to be the next developing zone as depicted in Figure 1.4. Basically, these areas are equipped with complete production facilities to ensure progressive development of downstream processing. According to the Third Industrial Master Plan by Ministry of International Trade and Industry [MITI] (2006), it covers a period from 2006 to 2020, Malaysian government is planning to develop Bintulu in Sarawak, Gurun in Kedah, Tanjung Pelepas in Johor and Labuan into new petrochemical zones.

Figure 1.4: World-Class Petrochemicals Zones in Malaysia (Source: Petronas, 2010)

In Malaysia, the key players include Petronas and Titan Chemicals. In fact, Petronas is the state-owned main domestic investor while Titan Chemicals is recently acquired by Honam Petrochemicals from South Korea. Foreign petrochemical investors include BASF, BP, Dow Chemical, Royal Dutch Shell, Exxon Mobil, Eastman Chemical, Idemitsu, Mitsui, Kaneka and Dairen Chemicals.

1.4 Problem Statements

In South Korea, petrochemicals market is primarily export oriented since the excess capacity overwhelm domestic demand growth. However, the dependence on Chinese exports market to soak up Korean production exposes the industry to significant risks because China is approaching self-sufficient level. If sustain, supply and demand trend in South Korea is likely to be spurred by Chinese market.

On the other hand, petrochemicals production capacity is under tremendous expansion in recent years as a result of strong competition from the Middle East and South Korea's neighbouring countries. As a result of the Japanese earthquake and tsunami in March 2011, the petrochemicals market is severely affected due to the immediate disruption of Japanese supply. In this case, the disasters will prompt restocking activity and a short-term tightening of the Asian market which poses various upward and downward risks to the petrochemicals producers in the region. Eventually, the petrochemicals market in this region is likely to be fluctuated over the medium-term.

Mergers and acquisitions activity has been driven in need of strengthening South Korea's petrochemicals market which has significant impacts on Malaysia. In 2010, Honam Petrochemical took over Malaysia's petrochemical producer Titan Chemicals to expand its petrochemical operations overseas. The acquisition has gained Honam Petrochemical a major manufacturing and marketing presence in South East Asia. Meanwhile, Malaysia's stated-owned company Petronas has announced to embark on a US $20 billion (RM 60 billion) Refinery and Petrochemical Integrated Development (RAPID) complex at Pengerang in the state of Johor, Malaysia. For this project, Petronas welcomes foreign parties to consider the partnership opportunity, particularly those renowned chemical companies who wish to expand overseas.

In consideration of the issues above, numerous potential risks and opportunities exist in the petrochemicals industry which opens up a new chapter for South Korea and Malaysia in terms of future decisions on business integration.

1.5 Aims and Objectives

The objectives of this research are:

i. To review recent petrochemicals outlook in South Korea based on petrochemicals production capacity and plant locations for various petrochemical products.
ii. To study the supply and demand of petrochemicals products trend in South Korea and make projections of the future market trends from 2000 to 2015.
iii. To analyze the impacts of South Korean's Titan Chemicals due to implementation of Malaysia's RAPID Project in Pengerang, Johor.
iv. To explore the possibility of business cooperation in petrochemicals industry between South Korea and Malaysia in future and analyze the underlying factors to discover unrealised potential in petrochemical industry.

1.6 Dissertation Structure

This research is organized as follows. In Chapter 1, a brief introduction of the background of petrochemical process and petrochemical industry are presented. The purpose of the first part is to guide the reader to a clearer and more precise idea of various petrochemicals process. In the second part, the research is more focused on the development of petrochemical industry in South Korea and Malaysia. In Chapter 2, literature review of the past research which is relevant to the study of petrochemicals outlook and markets trend are presented. Chapter 3 outlines the research methodology which is adopted in this research to collect data and perform data interpretation. Chapter 4 explores whether future cooperation between South Korea and Malaysia will be persisted and the market impacts on Malaysia are discovered in this chapter. A review of South Korea's petrochemical production capacity and forecast of supply and demand trend are presented in Chapter 4. Finally, Chapter 5 concludes the research and offers some recommendations to improve South Korea's competitiveness in petrochemicals industry. In brief, the thesis structure can be summarized as follows.

Chapter 1: General introduction to the research.

Chapter 2: Literature review on the past research related to the study.

Chapter 3: A summary of research methodology.

Chapter 4: Analysis of results and discussion of the study.

Chapter 5: Conclusion and recommendations.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview of Asian Petrochemical Industry

In order to study the petrochemical outlook of South Korea, a review of Asian petrochemical industry is part and parcel to understand the relationship between South Korea and Asian countries. The supply and demand of petrochemicals products trend in South Korea is closely tied to the competitions from neighbouring countries. Hence, a rough idea of the big picture is essential to provide further understanding on the research.

It is never a dull moment when speaking about the petrochemicals industry in Asia, especially when there are build-up of new capacity results from strategic alliances or mergers and acquisitions (M&A) activities. A recent research by Aruvian's R'search (2011) revealed that 21st century is seeing a paradigm shift from West to East, with Middle East emerging as global production hub for new capacity investment and Asia becoming a major consumption centers. In general, Asia is the world's largest and most populous continent which comprises of 46 different countries. However, most of the literatures only focus on a few significant markets such as China, India, Japan, Korea and Taiwan which will be further reviewed in the following subsection.

On top of that, many studies measure the size of a country's petrochemical industry based on the olefins capacity as it shows a direct relationship to economic growth, accounting for the largest segment in the petrochemical industry. In a recent study, Zinger (2008) found that the most significant issue now facing the Asian petrochemical industry is a surge in new ethylene capacity in Asia and Middle East over the next five years. Asia olefins capacity is growing at a healthy pace in last decades and the capacity is forecast to rise continuously in the next few years as depicted in Figure 2.1.

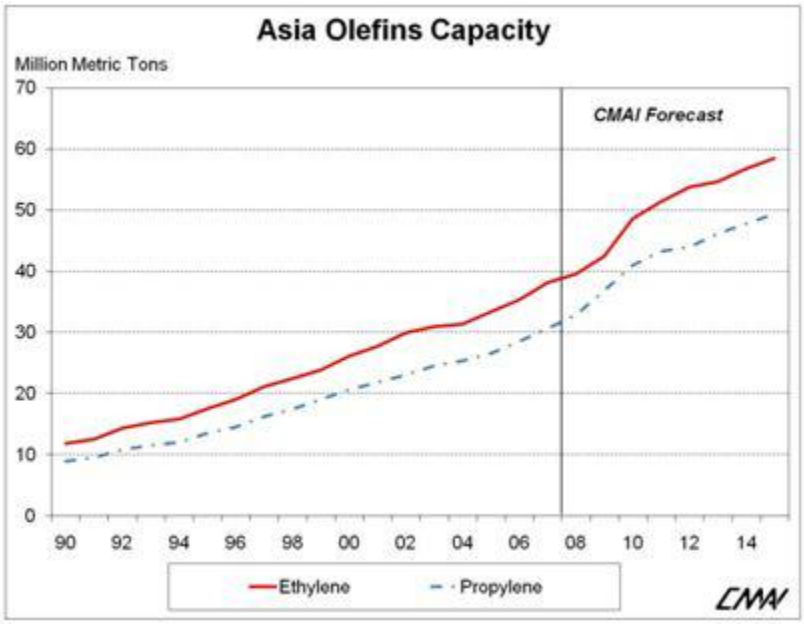


Figure 2.1: Asia Olefins Capacity (Source: Zinger, 2008)

Zinger (2008) realized that the large build-up of new ethylene plants are primarily attributed to the strong profit margins from 2004 to 2007 and rapid demand growth for ethylene and its derivatives in both China and Southeast Asia. However, these capacity additions are expected to result in a deep and extended profitability downturn for the ethylene industry during 2009 to 2012 (Zinger, 2008). Research by BMI (2010d) also confirmed that around 10 million tpa of ethylene capacity is due to come on stream in the Middle East and Asia in 2010 leading to a decline in capacity utilisation rates to around 82 %. Significantly, this trend could force some uneconomical capacity to close permanently in the coming years, particularly in North America and Europe. In addition, this would also bring fresh challenges to the

region in terms of the risk of global overcapacity in the near future. In sum, Asian petrochemical players are likely to be affected by a flood of Middle East supply and fierce competition among themselves in the coming years.

2.1.1 China

Over the past few years, China has become the most eye-catching petrochemical market leader in Asia due to the massive production capacity additions and rising consumption. In 2009, China accounted for 24 % of global petrochemical production capacity and 30 % of total global petrochemical consumption as indicated in Figure 2.2 and Figure 2.3 (Dunwoodie et al., 2010).

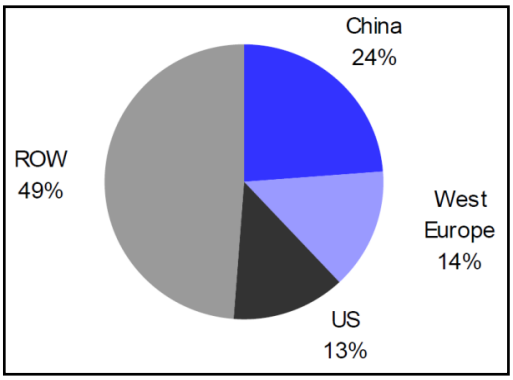


Figure 2.2: Global Petrochemical Production Capacity (mt) in 2009
(Source: Dunwoodie et al., 2010)

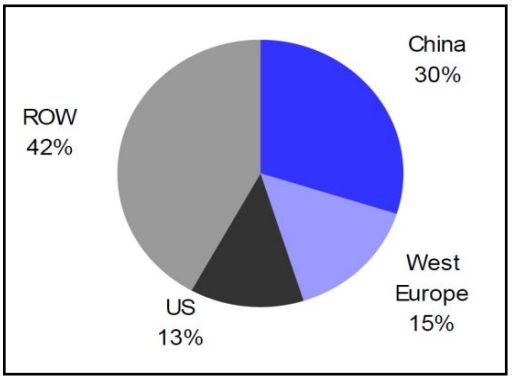


Figure 2.3: Global Petrochemical Consumption (mt) in 2009
(Source: Dunwoodie et al., 2010)

However, BMI (2010d) revealed that increase in size of the Chinese market along with growth in demand for petrochemicals are pushing up Asian ethylene feedstock prices and results in supply problems throughout Asia. To address the problem, Chinese ethylene production is scheduled to reach 21.38 million tpa by 2012 with seven major ethylene projects capable of producing 6.2 million tpa of ethylene, including an increase in the total production capacity of existing ethylene plants by 4.38 million tpa (BMI, 2010d). Likewise, Dunwoodie et al. (2010) estimates that China ethylene capacity will rise an estimated 74 % from 2010 to 2014 which in turn leading to an increase in global ethylene market share from 8 % in 2009 to 12 % in 2014. Figure 2.4 shows that China ethylene capacity is expanding rapidly in 2010.

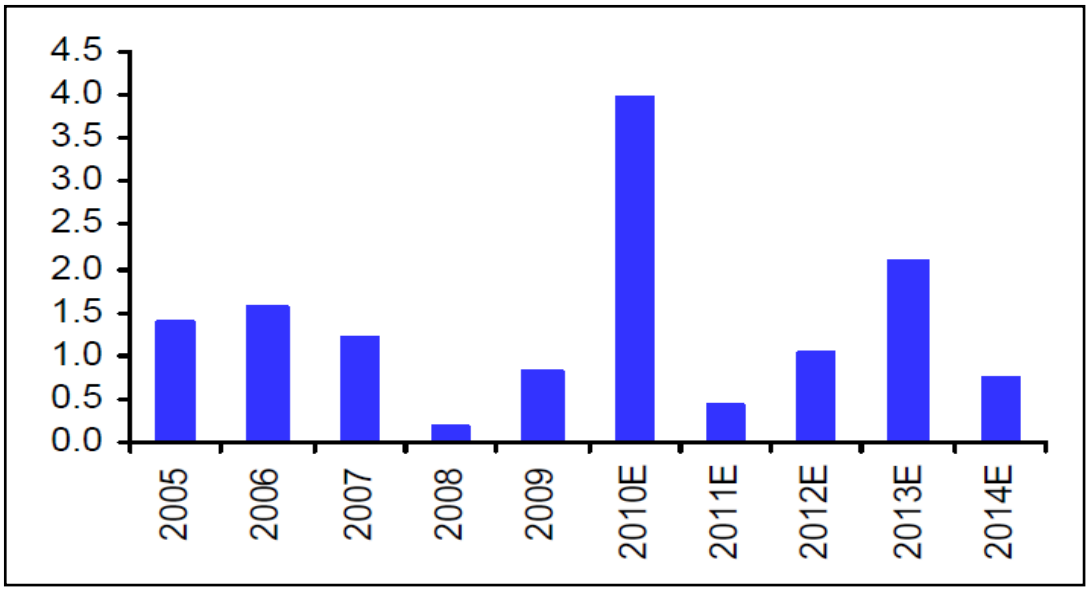


Figure 2.4: China Ethylene Capacity (mt) Additions from 2005 to 2014 (Source: Dunwoodie et al., 2010)

In terms of demand, Dunwoodie et al. (2010) analyze a robust ethylene demand is expected to continue as a result of China's continued rapid economic growth. On the other hand, a shift in investments from mainland to inland can be observed in China primarily due to the regions abundant coal reserves and the Chinese government's national agenda. In order to secure the nation's petrochemical industry, China make use of partnership strategy to establish joint ventures with Western companies whereas the majority of investments are done by wholly state-

owned Chinese companies to increase self-sufficiency. Despite heavy investment is observed in China, Dunwoodie et al. (2010) anticipated that the current level of 50 % self-sufficiency in petrochemicals is unlikely to increase beyond 55 to 60 % level in the foreseeable future. This implies imported petrochemicals products into the region should continue to rise and thus China will remain as a primary destination for ethylene exports from Middle East. On the contrary, research by BMI (2010d) pointed out that the massive capacity expansions from 2010 to 2012 will potentially leading to a decline in cracker operating rates to 80-85 %, which is widely regarded as the breakeven point for most petrochemicals producers.

Overall, China is expected to continue leading the Asia market in terms of propylene and propylene derivative demand growth (Zinger, 2008). The key to sustain China's rapid petrochemical demand growth will be based on success in managing its rapid economic growth. It is worth noting that the rate of petrochemical expansion in China is greater than that of Saudi Arabia. On the downside, China expansion could prolong profitability downturn especially for those countries which are heavily tied to imports into China. As shown in Figure 2.5, China's plastic imports are mostly come from neighbouring countries such as Taiwan, Korea, Japan and South East Asia countries.

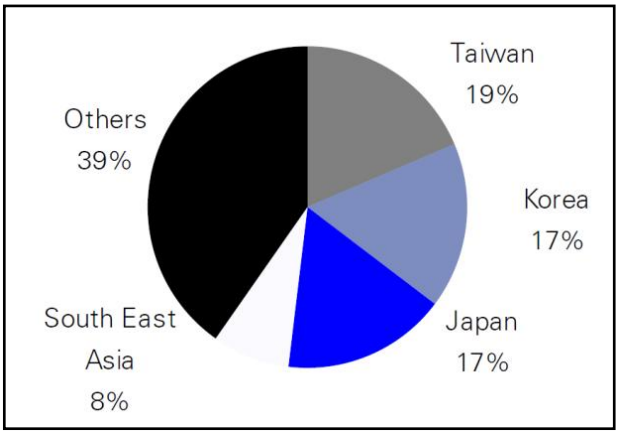


Figure 2.5: China Plastic Product Import by Origin (Source: Dunwoodie et al., 2010)

2.1.2 Taiwan

With today's growing concern about China petrochemicals market, Taiwan's petrochemicals industry faced a heavy global pressure to remain competitive and sustain in part of regional economic entities. In the past decade, Taiwan's petrochemicals market is highly dependent on export market to cope with limited demand growth in domestic markets. In this regard, China is the main target export market where most of the petrochemical products or plastic resins in Taiwan have been exported to China on average over 30 % of production as shown in Figure 2.6 (Dunwoodie et al., 2010).

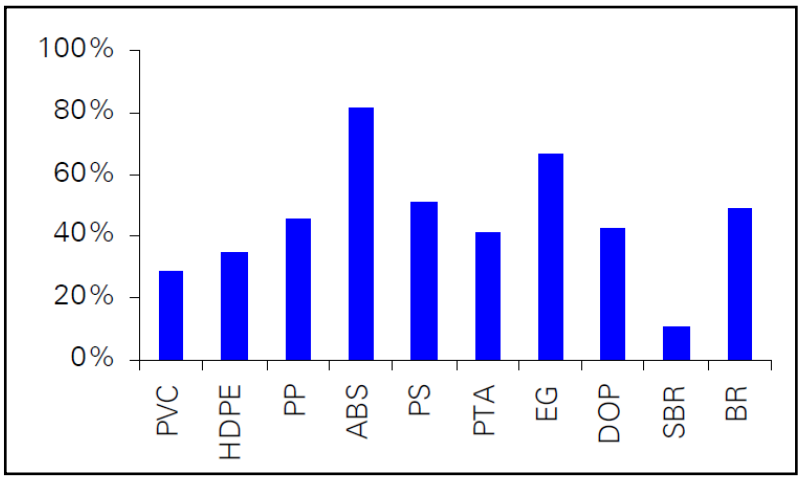


Figure 2.6: Percentage of Taiwan Petrochemical Products Export to China in 2008 (Source: Dunwoodie et al., 2010)

Facing the threat from Middle East players plus pressure of increasing self-sufficient rate in China, Taiwan's export markets to China is likely to stagnate or even shrink in the near future. In 2010, ASEAN has launched the free trade agreement (FTA) with China on most of the petrochemical products. In other words, the ASEAN will provide favoured or zero tariffs to China for imported goods. However, Chen (2010) has pointed out that the trading agreement create a severe disadvantage for Taiwan's petrochemical industry since Taiwan is not an ASEAN member and thus the nation have to bear the cost of a tariff averaging 6.5 %. The top three Taiwan's petrochemical products and their respective export values are summarized in Table 2.1. Here, a severe impact can be observed on the exportation

of Taiwan's major export item which is pure terephthalic acid (PTA) because ASEAN has the capability to export large quantity of PTA to China with the reduction from 6 % to zero tariffs.

Table 2.1: Overview of Competition between Taiwanese and ASEAN Petrochemicals in Mainland China (Source: Chen, 2010)

Unit: USD Million

HS	Product Name	Total Exportation of Taiwan	From Taiwan to Mainland China		From ASEAN to Mainland China	
			Amount	2010 Tariff %	Amount	2010 Tariff %
291736	PTA	1,796.3	1,573.8	6.5	1,315	6→0
290531	EG	1,133.9	1,035.6	5.5	214	5.5→5.5
390330	ABS	2,167.5	872.9	6.5	305	6.5→0

According to Dunwoodie et al. (2010), Taiwan's government is pushing aggressively for the cross-strait negotiation on Economic Cooperation Framework Agreement (ECFA) in order to defend the potential threat from FTA. In fact, ECFA works the same as a FTA but with a different name to prevent political sensitivity regarding cross-strait sovereignties. Meanwhile, Korea and Japan are also competing with Taiwan to sign FTA with China at the same time hoping an ASEAN+3 (ASEAN 10 members plus China, Korea, and Japan) multilateral FTA can be formed as soon as possible. Hence, if Taiwan can reach a zero tariff agreement with China earlier than Korea and Japan, Taiwan will be able to seize the competitive advantage in tapping into China's domestic market.

2.1.3 Japan

When talking about the petrochemical industry, Taiwan and Japan are in the same boat because Japanese petrochemical producers are also benefit from the large market in China. Similarly, massive expansion of large-scale facilities in Middle East and China also making the operating climate in Japan become intensively more difficult. Currently, Japan is suffered from the impact of natural disasters which

caused global supply chain interruptions. Meanwhile, Japan also faced the structural issues like decrease in domestic demand (Takahashi, 2011). In this regard, BMI (2010d) added that there have been no large M&A among the major companies while the markets remain smaller and much more diversified than Western peers. In addition, Japan's petrochemical industry is lacking of capacity expansion plans while restructuring plans are scheduled irregularly results in failure at the end. Most Japanese firms are observed to grow at slow pace in globalization and highly dependent on domestic market. Therefore, a shrink in Japan's petrochemicals products exports from 2004 to 2008 is shown in Table 2.2. In terms of benefiting from FTA with China, Dunwoodie et al. (2010) believed that Japanese petrochemical producers are likely to be lagging behind Korea under the above circumstances.

Table 2.2: Japan's Petrochemicals Products Exports from 2004 to 2008 (Source: BMI, 2010d)

	2004		2005		2006		2007		2008	
Olefins	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Ethylene	304,569	23,676	273,568	24,598	299,249	36,414	282,868	34,558	196,496	24,995
Propylene	356,978	27,123	388,633	37,512	507,987	58,306	492,904	58,453	510,126	63,153
Butadiene and isoprene	79,885	7,147	65,515	9,102	42,472	6,304	53,054	6,631	27,896	6,270

One major problem exist in Japan's petrochemical manufacturers is that they are heavily relies on naphtha, which is accounting for 94 % of the country's petrochemical feedstock compared to 60-70 % in Europe and 20-25 % in the United States (BMI, 2010d). Unfortunately, high crude oil prices have raised the price of naphtha and research by Dunwoodie et al. (2010) anticipated that price hikes for feedstock will continue in the next few years. According to BMI (2010d), Japanese petrochemicals producers also suffered from elevated logistics costs as their costs are highest in the world. Thus, Japanese petrochemical players are now opting for product-based alliances rather than mergers as a strategy to help restructure their petrochemical industry as well as to improve global competitiveness.

In a recent study, Takahashi (2011) suggested that the Japanese petrochemical industry needs to accomplish two objectives in order to achieve

sustainable growth. The first objective is to improve the quality of business and contribute to the sound growth of society through technology since Japan is the pioneer of technologies in terms of safety and environment. Secondly, the Japanese petrochemical industry needs to get a step ahead in the development of specialty, higher value-added products (Takahashi, 2011). In brief, it is important to implement structural reform in Japan including vertical and horizontal integration. Meanwhile, Japan should concentrate their resources on research, development and marketing of new technologies and products.

2.2 Overview of South Korea Petrochemical Industry

Petrochemicals industry is a large pillar of South Korea's trade which drive the overall economic growth of the country. At the moment, South Korea is the 5th largest petrochemicals player in the world where petrochemicals contribute 20-25 % of GDP (BMI, 2010d). The petrochemicals production facilities in South Korea are mainly concentrated in Ulsan, Yeosu and Daesan with a total of 11 naphtha cracking centres that are still being expanded to increase capacity (Neede, 2011). In 2010, both Yeosu and Daesan have 1.6 million tpa of ethylene capacity while Ulsan has just under 1 million tpa (BMI, 2010d). The major cracker operators are South Korea-based Hanwha Chemical, Honam Petrochemical, LG Chem, Samsung Total Petrochemicals, and SK Corporation. With over 30 years experience in the petrochemical industry, South Korea's petrochemical sector has become mature and highly integrated despite having limitation of oil and gas reserves.

For the standpoint of raw materials, naphtha is the prime feedstock used in South Korea's petrochemical industry. According to BMI (2011), the most urgent issue now is the rocketing oil prices have fuelled a surge in crude prices and raising price hike in naphtha feedstock. Figure 2.7 shows that the total naphtha consumption in South Korea is growing at fast pace in recent years and it is projected to grow at about 2.0 % per year, reaching about 1.02 million barrels per day (McConnachie, 2008). South Korea's petrochemical producers are likely to suffer with feedstock cost-disadvantage since they are heavily dependent on imported crude oil. In this

regard, several major players in the petrochemical industry have initiated mergers with larger multinational oil producers (Neede, 2011). For instance, Samsung General Chemicals started a joint venture with Total in 2003 to ensure a stable flow of feedstock (Neede, 2011).

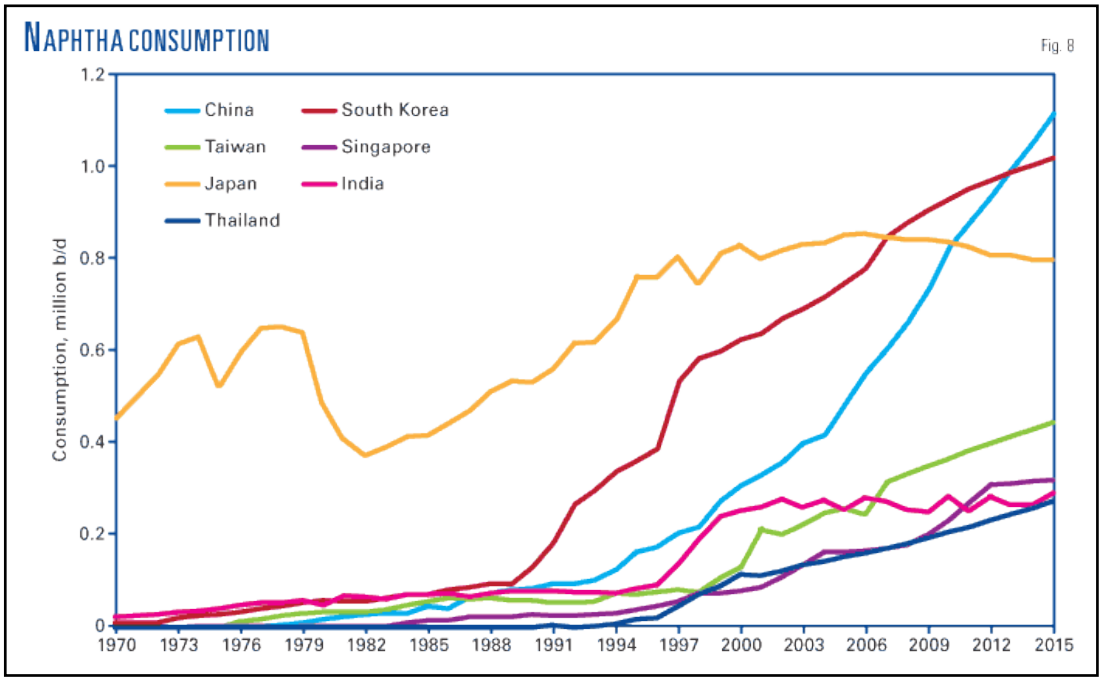


Figure 2.7: Asia Pacific Naphtha Consumption Trend (Source: McConnachie, 2008)

Petrochemicals market in South Korea is mainly export oriented since the nation witnessing surplus in domestic consumption. Taking year 2009 as an example, the production over domestic consumption ratio of some key petrochemical products in South Korea is on average above 100 % surplus of the domestic consumption as depicted in Figure 2.8 (Dunwoodie et al., 2010).

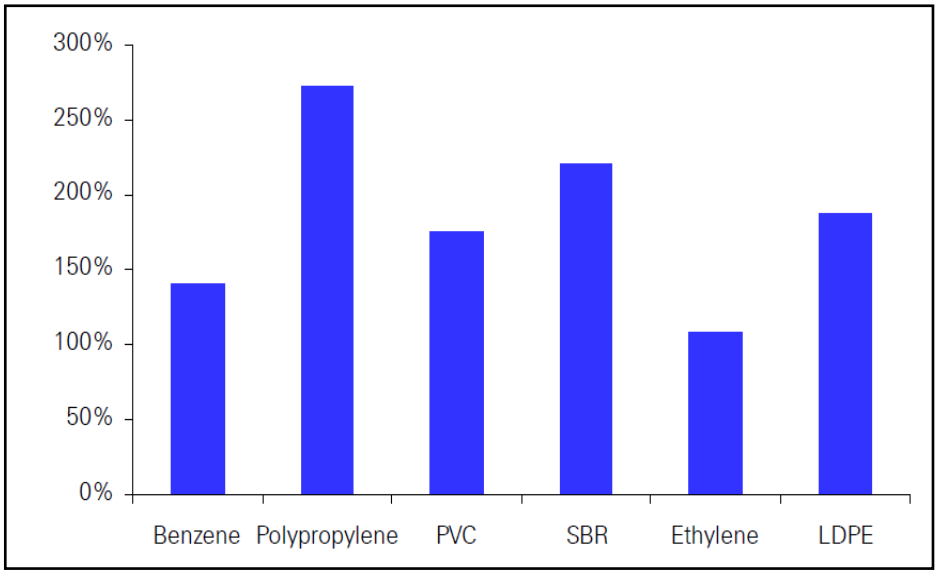


Figure 2.8: Korea's Production over Domestic Consumption in 2009 (Source: Dunwoodie et al., 2010)

Over the past decades, China, which shares its borders with South Korea, has become the top destination for South Korean petrochemical markets. Although the producers are likely to benefit from the current business cycle in the short-term, South Korea's petrochemicals producers might not be able to compete successfully against Middle East players in the long run (BMI, 2010d). To counter this, a recent study by Neede (2011) suggested that South Korea petrochemicals sector should diversify its export destinations to eliminate the downside risk. In response to the issues, research by BMI (2010d) also revealed that the companies have started to focus on increasing production of high-margin products. South Korea's petrochemicals companies are expected to expand production capacity by nearly a quarter in the near future to sustain the demand growth in China and counter increasing competition from the Middle East (BMI, 2010d).

A recent study announced that petrochemical manufacturers in the country would make a combined investment of about $12.8 billion on facilities through 2013 (Palma, 2010). The investment is expected to help domestic petrochemical manufacturers to improve the global competitiveness of their products at the same time reduce environmental impact. In line with Korean government policy, the country's petrochemical industry is now investing in clean energy (Kiyokawa, 2011).

As part of the plan, some of the new projects include an $883 million investment by LG Chem focus on lithium-ion battery manufacturing facility, a $2.38 billion ethylene production facility expansion by Yeosu NCC Company, and a $7.94 million solar cell module manufacturing unit to be developed by Hanwha Chemical (Palma, 2010). Recently, South Korea's petrochemical industry is planning for a massive expansion in xylenes capacity as the petrochemical players seek to take advantage of demand in China's polyethylene terephthalate (PET) industry (BMI, 2010d).

2.2.1 Production Capacity

According to KPIA (2008a), Korean petrochemical industry is the world's 5th biggest based on ethylene capacity and 4th largest in PE or PP capacity as illustrated in Figure 2.9.

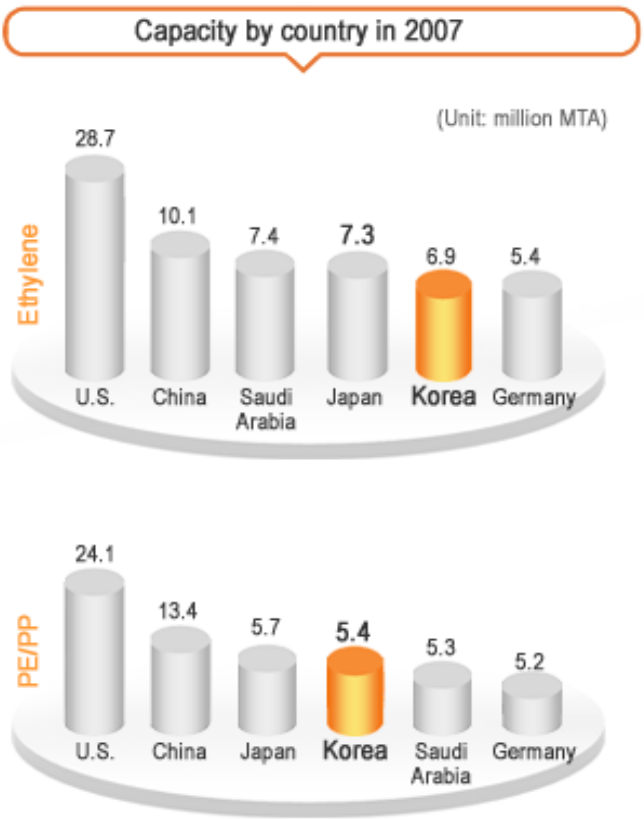


Figure 2.9: Position of Korea Petrochemicals Plant Capacity in 2007 (Source: KPIA, 2008a)

In 2007, the capacity of major petrochemicals in Korea is amounted to 57.0 million MTA which is comprised of a wide range of petrochemical products as shown in Figure 2.10. The key petrochemical products of South Korea are ethylene, propylene and BTX which accounted for 36 % of total petrochemicals production.

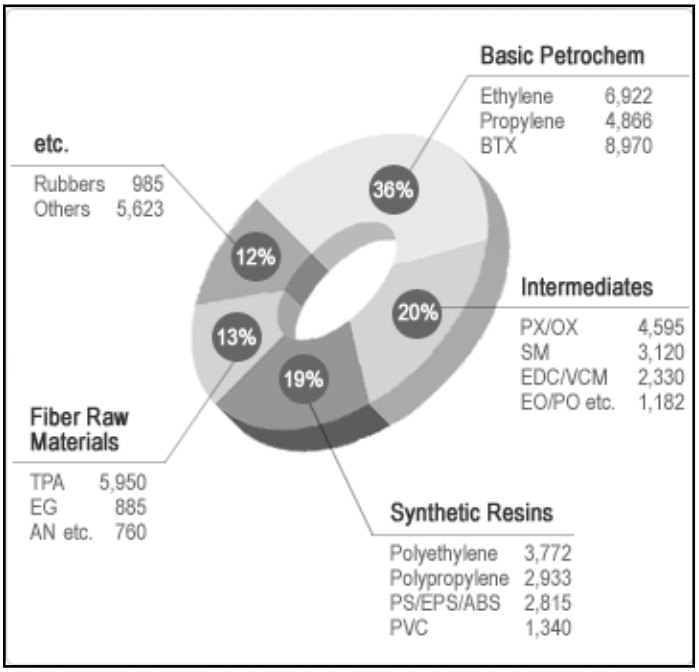


Figure 2.10: Pie Chart of Korea Petrochemicals Plant Capacity in 2007 (Source: KPIA, 2008a)

The capacities of basic petrochemical and synthetic resins are summarized in Table 2.3 and the trends are illustrated in Figure 2.11 and Figure 2.12 respectively. Over the years, the capacities of major petrochemical products are growing at healthy pace due to various M&A activities and domestic expansions. A sharp ramp up is observed on xylenes production capacity in 2010 because South Korea petrochemical producers seek to take advantage of demand from China's PET producers.

Table 2.3: Production Capacity of Major Petrochemicals from 2004 to 2010 (Source: Asia Petrochemical Industry Conference [APIC], 2010a)

Unit: MTA

Product	2004	2005	2006	2007	2008	2009	2010
Basic Petrochemical							
Ethylene	5,955	6,131	6,157	6,827	7,071	7,380	7,490
Propylene	4,016	4,103	4,345	4,847	5,064	5,642	5,480
Butadiene	940	905	881	990	1,087	869	1,077
Benzene	3,486	3,642	3,851	4,221	4,107	4,174	4,180
Toluene	1,834	1,792	1,545	1,748	1,534	1,818	1,950
Xylenes	2,107	2,269	2,450	2,673	2,206	2853	4830
Synthetic Resins							
LDPE (LLDPE,EVA)	1,660	1,713	1,729	1,823	1,773	2,087	2,141
HDPE	1,889	2,011	1,965	1,981	2,073	2,180	2,226
PP	2,859	2,893	2,942	3,084	3,333	3,710	3,869
PS (GP/HI)	791	770	655	681	638	611	621
EPS	365	373	407	395	354	330	335
ABS	1,198	1,188	1,282	1,364	1,240	1,404	1,457
PVC	1,231	1,339	1,373	1,377	1,365	1,476	1,530

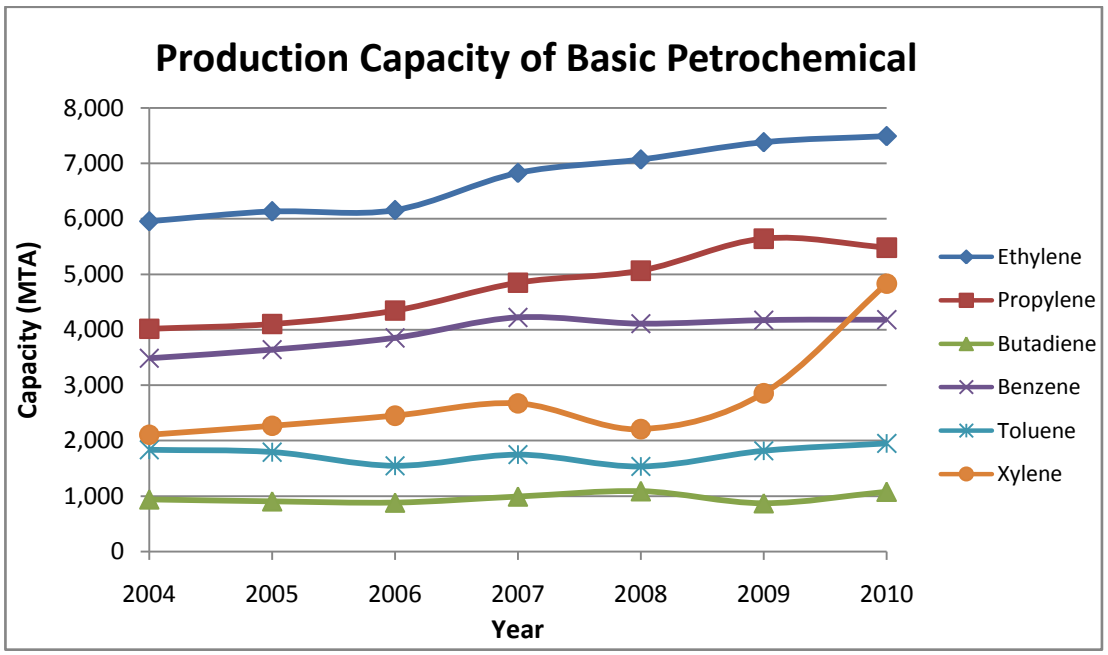


Figure 2.11: Production Capacity of Basic Petrochemical Products in South Korea from 2004 to 2010 (Source: APIC, 2010a)

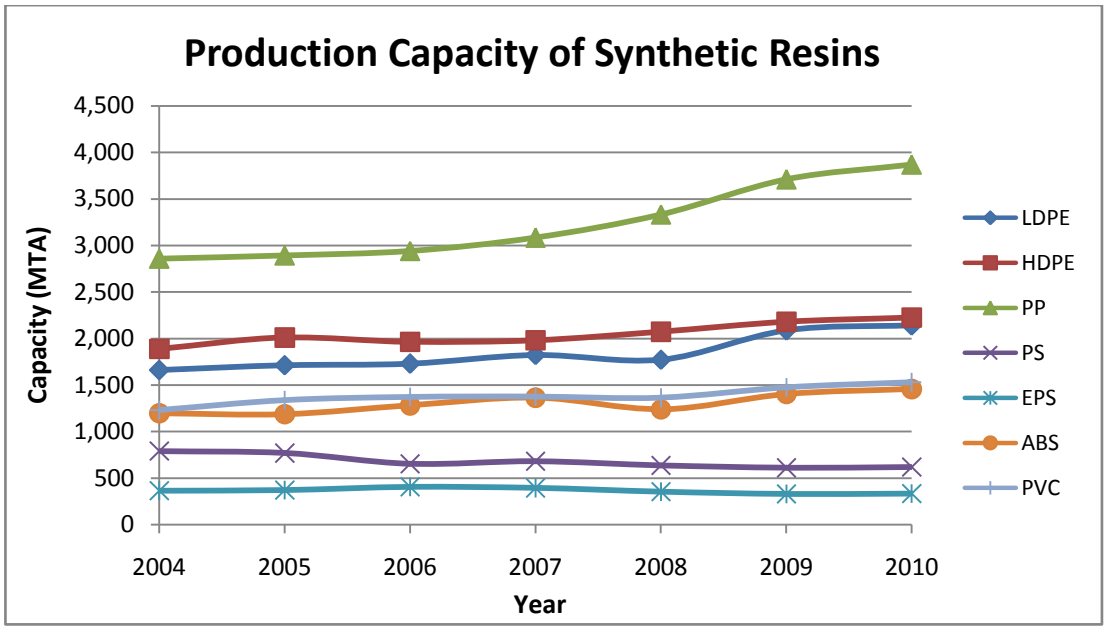


Figure 2.12: Production Capacity of Synthetic Resins Products in South Korea from 2004 to 2010 (Source: APIC, 2010a)

2.2.2 Supply and Demand

The pie chart in Figure 2.13 clearly indicates that in 2006, 77 % of the exports of the petrochemical industry in Korea headed to the Asian region, primarily accounting for 53 % of the export to China and Hong Kong and 24 % to other Asian countries. Korea was the biggest export country of petrochemicals in China (KPIA, 2008a).

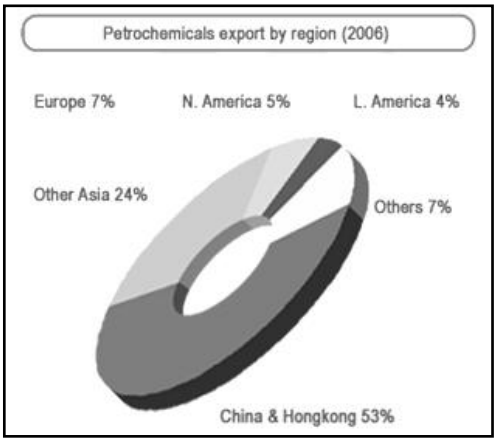


Figure 2.13: Petrochemicals Export By Region in 2006 (Source: KPIA, 2008a)

Petrochemical industry in Korea has developed from domestic demand-oriented industry to export-oriented industry since early 1990s. In 2006, exports consisted of 51 % of the production (KPIA, 2008a). From the left hand side of Figure 2.14, it is noticeable that the total production capacity overwhelms domestic demand in Korea after 1990s. The percentage of overcapacity is estimated at the right hand side of Figure 2.14. On average, the percentage of overcapacity for the major petrochemicals products is above 87 %.

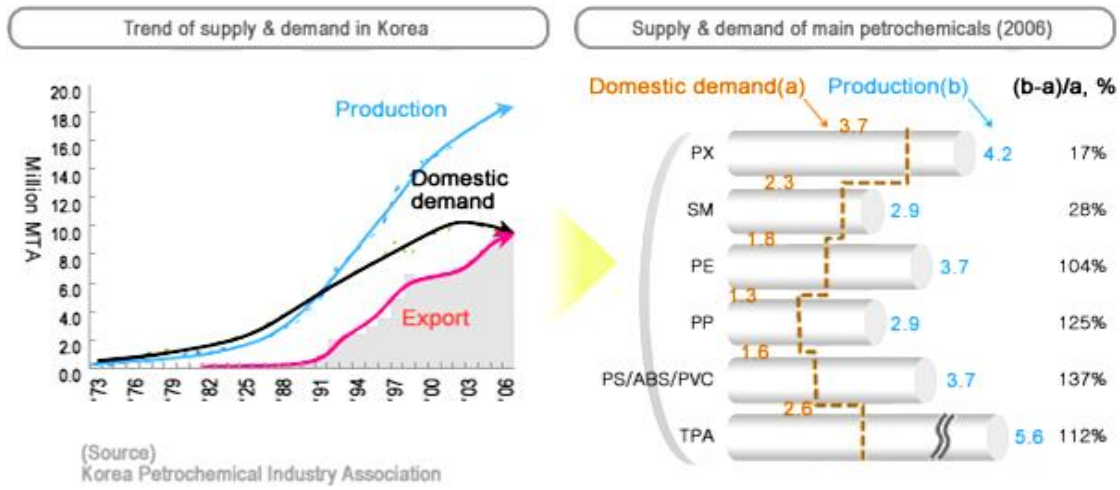


Figure 2.14: Supply & Demand Trend from 1973 to 2006 and Their Respective Percentage of Main Petrochemicals in Korea (Source: KPIA, 2008a)

As part of the research objective, the import and export capacity accounted for major petrochemicals products are listed in Table 2.4 below.

Table 2.4: Korea Petrochemical Supply and Demand from 2004 to 2010

(Source: APIC, 2010a)

UNIT: MTA

Product		2004	2005	2006	2007	2008	2009	2010
Basic Petrochemical								
Ethylene	Import	164	110	183	110	115	160	148
	Export	308	316	270	721	762	659	626
Propylene	Import	235	336	274	249	218	249	200
	Export	231	253	321	538	553	665	650
Butadiene	Import	78	68	116	139	213	291	300
	Export	146	126	121	161	191	228	200
Benzene	Import	249	350	443	317	260	227	140
	Export	1082	1209	1247	1194	1258	1270	1280
Toluene	Import	573	531	338	271	223	203	150
	Export	829	747	650	761	615	902	1000
Xylenes	Import	1208	949	1023	1544	1136	1072	1168
	Export	413	603	945	1403	1007	1385	1341
Synthetic Resins								
LDPE (LLDPE,EVA)	Import	36	41	42	41	39	35	36
	Export	755	822	803	771	790	1031	1063
HDPE	Import	10	12	12	7	9	8	9
	Export	1083	1204	1139	1127	1204	1345	1380
PP	Import	14	14	15	18	24	21	21
	Export	1579	1616	1653	1792	2026	2376	2490
PS (GP/HI)	Import	8	15	27	32	30	28	28
	Export	545	551	452	498	461	429	438
EPS	Import	1	4	7	3	3	5	5
	Export	138	161	184	174	135	112	115
ABS	Import	5	5	6	6	7	6	6
	Export	966	975	1082	1217	1240	1249	1299
PVC	Import	21	51	48	26	28	32	32
	Export	392	499	518	463	534	682	726

In order to illustrate the trend clearly, the data in Table 2.4 are converted into Figure 2.15 and Figure 2.16 with respect to the import and export capacity of olefins such as ethylene and propylene as it represents the major petrochemicals market. Here, it is obviously noticed that South Korea's petrochemicals market is export driven since the export capacity is outpaced import capacity in most of the years.

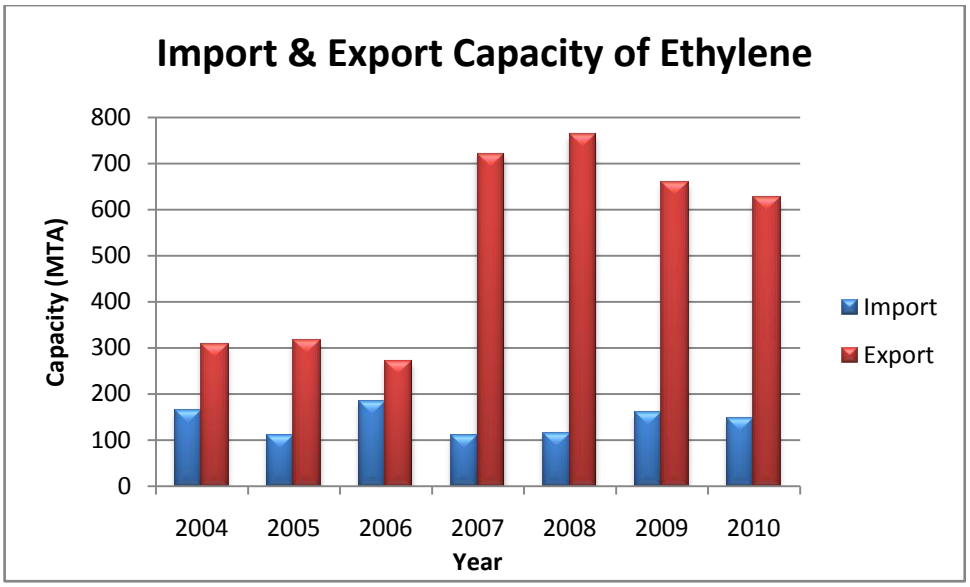


Figure 2.15: Import and Export Capacity of Ethylene in South Korea from 2004 to 2010 (Source: APIC, 2010a)

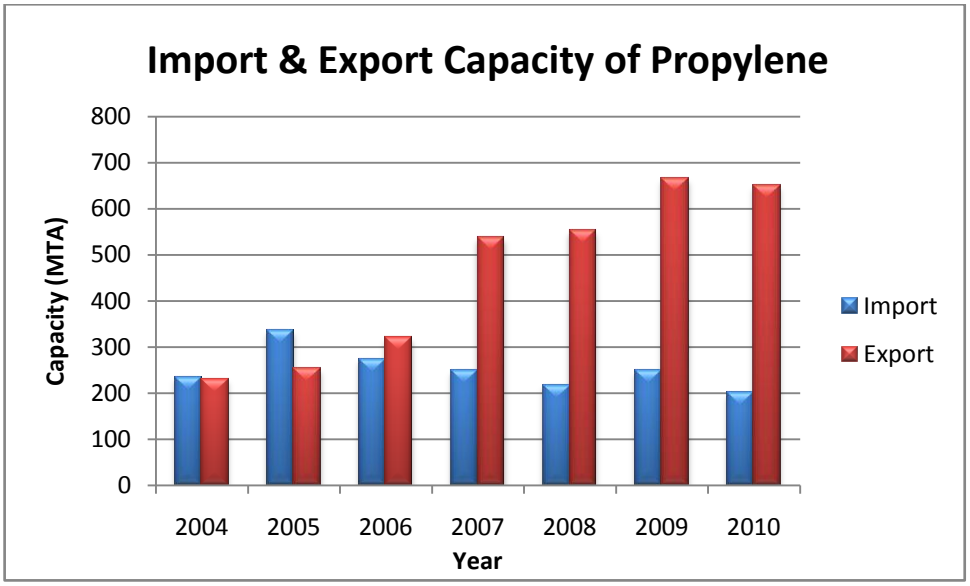


Figure 2.16: Import and Export Capacity of Propylene in South Korea from 2004 to 2010 (Source: APIC, 2010a)

2.2.3 Impact of China and Middle East

Earlier works have addressed some of the issues regarding a surge in new capacity from China and Middle East has implications on Korean petrochemical producers.

With growing concern on this matter, Dunwoodie et al. (2010) expected that the Middle East players are likely to penetrate through China import market and grab market share from South Korea. In other words, Middle East producers with cost advantages from lower cost of feedstock are expanding rapidly and targeting Korea's export markets. As shown in Figure 2.17, Korea's export market has a certain level of dependency on China, albeit the extent of dependency is not as high as Taiwan if considering the total production Dunwoodie et al. (2010).

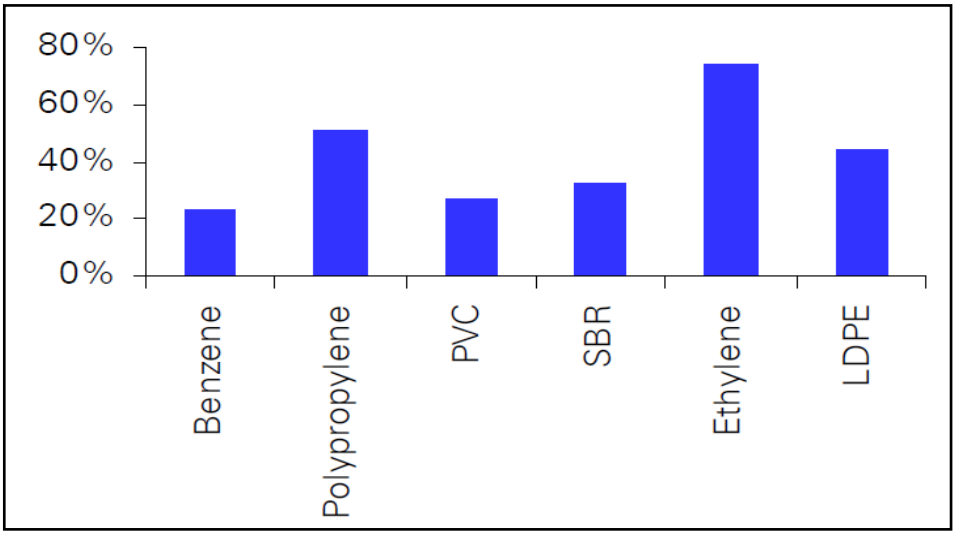


Figure 2.17: Percentage of Korean Petrochemical Products Export to China over Total Export in 2009 (Source: Dunwoodie et al., 2010)

In this case, a report by BMI (2010d) cautions that South Korea's reliance on China for petrochemical exports can put the nation at risk since China is now on the path of increasing self-sufficient rate and decreasing dependency on import. In addition, a tighter bank lending conditions and a more restrictive fiscal policy has been introduced to China in 2010 which caused a sharp decline in domestic demand (BMI, 2010d). This trend boosts up Chinese domestic production at the same time leading to a sharp slowdown in imports. In the long run, such trend will undermine Asian petrochemicals prices and severely squeeze South Korea's exports.

2.3 Overview of Malaysia Petrochemical Industry

Speaking about Malaysia, there is no doubt that the country is blessed with abundant indigenous oil and gas reserves. Malaysia has the world's 25th largest proven crude oil reserves, 12th largest proven natural gas reserves and world's third largest producer of LNG (BMI, 2010e). According to British Petroleum [BP] (2010), Malaysia has 5.52 billion of proven oil reserves up to 2010, with relatively stable production and limited exploration activity. Hence, BMI (2010e) forecast that the total can be expected to shrink gradually over the next five years and most probably dropping to an estimated 5.09 billion barrels by 2014.

In 2010, Malaysian petrochemicals industry has recovered from recession, with production surging due to export demand. With an annual average of 20 % export surplus, Malaysia is ranked 28th out of 121 countries becoming one of the 20 largest export nations worldwide (Lawrence, Hanouz, Doherty, and Moavenzadeh, 2010). Increased productivity and expansion in industry output over recent years have resulted in improved export performance. Facing the threat posed by China's rapid industrial expansion, Malaysia continues to attract foreign investment. For example, Titan Chemicals was acquired by South Korea's Honam Petrochemicals in 2010. After the acquisition, Honam Petrochemicals plans to invest US$200 million in an expansion of the Titan cracker in Pasir Gudang, Johor as part of the the company's vision to become one of Asia's top ten petrochemical producers by 2018 (Watanabe, 2011).

In 2010, Malaysian Petrochemicals had capacities of 1.74 million tpa ethylene, 1.13 million tpa propylene and 100,000 tpa butadiene. While intermediate petrochemicals production capacities include 240,000 tpa styrene, 44,000 tpa vinyl chloride monomer and 550,000 tpa xylenes. In the polymers segment, there was a combined capacity of 975,000 tpa PE and 560,000 tpa PP. On the other hand, it also hosts 1.77 million tpa of methanol capacity (BMI, 2010e).

As Malaysian petrochemicals industry continues to develop rapidly, there are growing concerns about the underlying factors which have contributed to the development of petrochemicals industry. Generally, many investors like to choose

Malaysia as their investment destination because of Malaysia's strategic location within ASEAN and close proximity to major Far East markets, economic stability, long-term reliability and security of gas supply, world-class facilities, competitive source of raw materials, and government's commitment towards development of petrochemicals industry. Until today, there are around 39 companies are in operation in Malaysia's petrochemical industry, with total investments of about RM 28 billion which is equivalent to US$7.36 billion (BMI, 2010e). Approximately 47 % of the investment is attributed to domestic sources and 53 % to foreign investment. The major leading investor in Malaysia's petrochemical industry is United States while other investors mainly came from Japan, United Kingdom, Germany and Taiwan.

Today, the petrochemical industry is developing rapidly in three main petrochemical zones which are Kertih in Terengganu, Gegeng in Pahang, and Pasir Gudang-Tanjung Langsat in Johor. Over the years, Malaysia's petrochemical sector has contributed significantly to the development of local downstream plastic processing activities. Table 2.5 shows the nameplate capacity for raw material in Malaysia in 2009.

Table 2.5: Nameplate Capacity for Raw Material in Malaysia in 2009 (Source: APIC, 2010b)

Product	Company	Capacity (kTA)
Ethylene	Ethylene Malaysia Sdn Bhd	400
	Optimal Olefins (M) Sdn Bhd	600
	Titan Chemicals Corp. Bhd	730
Total Ethylene		**1,730**
Propylene	Optimal Olefins (M) Sdn Bhd	95
	Titan Chemicals Corp. Bhd	520
	MTBE (M) Sdn Bhd	380
	Shell (FCC)	140
Total Propylene		**1,135**

In summary, the following set of data as listed in Table 2.6 shows an overview of Malaysia's petrochemical in terms of production, import, export and consumption. It is noticeable that most of the petrochemicals products experienced a downturn in 2010 as compared to 2009. It is most probably due to rising inflation

which resulted in higher crude oil prices that could pose a challenge to Malaysia's future petrochemicals industry. In response to this, Petronas is planning to start a feasibility study in Kertih, Terengganu to build a petrochemical complex consisting of 1 million tpa ethane cracker using natural gas feedstock to reduce its dependence on oil product imports. Petronas also plans to build an oil refinery and a naphtha cracker in southern Johor to further spur the growth of Malaysia's oil and gas downstream sector.

Table 2.6: Production, Import, Export and Consumption of Raw Material in Malaysia from 2007 to 2010 (Source: APIC, 2010b)

Product	Unit: KTPA	2007	2008	2009	2010	% Change +/- (2009 vs. 2010)
Ethylene	**Production**	1,581	1,686	1,617	1,505	-0.04 %
	Import	10	10	-	-	-100.00 %
	Export	101	136	140	90	-32.00 %
	Consumption	1,498	1,536	1,477	1,415	-3.00 %
Propylene	**Production**	839	870	867	808	0.30 %
	Import	33	40	25	8	0.00 %
	Export	78	97	95	50	-2.00 %
	Consumption	765	811	797	744	-5.00 %

CHAPTER 3

METHODOLOGY

3.1 Overview

As the petrochemical industry structure continues to change, a comprehensive understanding on the market fundamentals is a key step to forecast the market changes as well as industry trends enabling petrochemical players to develop sound business strategies and make informed decisions.

This research is conducted in order to present an in-depth petrochemicals outlook of South Korea in 2011. In light of this, plant capacity, supply and demand of products trend and future plans of South Korea's petrochemical industry are taken into account for analysis. In fact, there are numerous studies has looked at the petrochemical outlook of South Korea but until now no study has looked at the relationship between South Korea and Malaysia. Hence, this research is aimed to fill in this gap and focus on the impact in Malaysia as a result of South Korea's recent investments. As part of the objectives, the author intends to envisage the possibility of continuous business integration between South Korea and Malaysia in the near future.

3.2 Research Methods

3.2.1 Qualitative Approach

Qualitative research method is compatible to the study since the intention of this research is to draw out the petrochemicals products trend in South Korea through qualitative approach. In this case, the qualitative research method will make use of earlier studies and literatures review to reanalyse the supply and demand trends and make projections for future. For instance, studies about petrochemicals industry in South Korea and Malaysia enhanced the author's understanding about the production capacity as well as the imports and exports trend in the country. Literature review is commonly used to derive findings according to diversity of views exists among the articles which required further analysis to draw a conclusion for the research.

Instead of using statistical analysis, the qualitative approach utilizes content or holistic analysis to explain and comprehend the research findings in which primary inductive process is employed. For this method, only one subject or one case become the focus of investigation over an extended period of time. Qualitative research method can be very useful in the sense that it is more flexible to adjust and refine the research ideas as investigation proceeds. In most cases, qualitative approach includes reviews, interviews, observations, or published documents and literatures related to the research problem.

3.2.2 Quantitative Approach

On the contrary, quantitative methods emphasize on the quantification of relationships between independent and dependent variables. In other words, the key point of the approach is that the measurement is valid, reliable and can be generalized with a clear anticipation of cause and effect relationship. In most cases, measurements, numerical data and statistics are the major tools of quantitative approach.

In this study, quantitative method is suitable because it permits the research to be conducted in a very specific and set terms. In line with research objective, capacity, imports and exports data are normally collected from past researches which form a large quantity of materials. Without proper technique to organize the data, the materials are meaningless. In order to reanalyse the data, statistical method is employed to compile all of the data on yearly basis and convert the data into illustration of bar chart or graph. Here, a comparison of the trends can be easily recognized to investigate the relationship between each variable. Quantitative approach is primarily deductive reasoning in which a statement of statistical probability is expected with the least of complicated explanation.

3.3 Data Collection

Generally, there are various approaches to perform data collection in a research. For example, survey questionnaires, interviews, field observations, experiments, or even secondary data from works of other researchers. However, it is also worth keeping in mind that the choice of data collection method will affects the level of reliability, sustainability and adequacy of results.

3.3.1 Plant Capacity and Location

Data of domestic plant capacity is essential to the forecast the petrochemicals product trends in this study. By considering a comparison of total domestic plant capacity and total domestic demand, the percentage of surplus can be estimated. If high percentage is observed in most of the petrochemicals products, higher chances that the country will heading to an export oriented market trend. In most cases, the number and size of ethylene crackers indicates both a country’s likely output and also the relative efficiency as a producer.

In this study, most of the data obtained from secondary resources which means the author gather many different set of data from works of other researchers and then perform reanalyse on the data. Overall, the data used in the results mainly extract from government, petrochemical companies, market research specialists and third-party sources. Most of the data collected are confined to only a few major petrochemicals products such as olefins, aromatics, and synthetic resins.

In order to provide an overview of petrochemicals plants location, a map of South Korea is used to indicate various petrochemical products capacity located in different region of South Korea. Figure 3.1 shows a sample outcome of South Korea's map showing a few of the petrochemical plants location. The map is prepared by using AutoCAD software and the plant capacity data and location of the petrochemical plants are then added into the map.

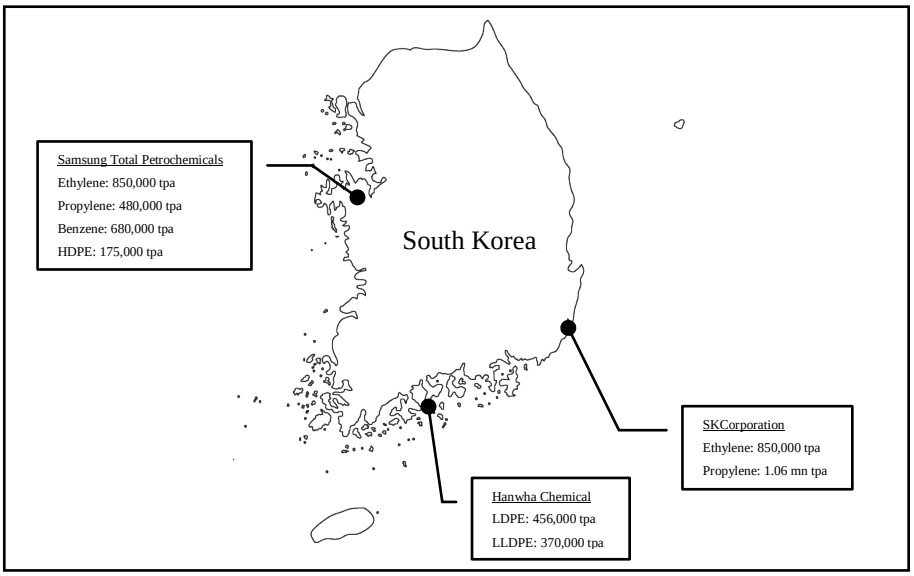


Figure 3.1: Sample Outcome of South Korea Map with Various Petrochemicals Products

3.3.2 Petrochemicals Supply and Demand

In order to forecast the petrochemical products trends for the next few years, data of previous supply and demand trends from 2000 to 2010 must be collected. Therefore, various methods are adopted to collect the data as outlined below.

1. Underlying economic growth trends.
2. Basic plant capacity and historic utilisation rates.
3. Government or industry projections.
4. Third-party projections from national and international industry trade associations.

Looking at the past petrochemicals products trend in each individual country, it is noticeable that the most of the supply and demand trends are significantly cyclical. If the trend sustain, an upturn in domestic demand is expected to increase the supply leading to a higher plant utilization rate.

3.4 Data Analysis

In principle, data analysis can be done in two ways, either qualitative or quantitative approach, or even combinations of two approaches are widely acceptable. Again, the choice of approach for data analysis depends on the expected result data typology. In most cases, textual data lends itself easily to qualitative analysis while interval data and ratio data normally work the best by using quantitative analysis approach.

3.4.1 Data Organization and Interpretation

During earlier phase of research, qualitative data are normally collected in large quantity which appears in various forms such as published journals, webpage, newspaper, magazine and book. After gathering all the data, process to organize the data is particularly crucial to ease the research during data interpretation phase. There

are a few methods where the data can be organized or tabulated in such a way that the results are presented concisely. In this case, the approaches employed in the study are outlined as below.

1. Comparison table (Plant capacity)
2. Graph, bar chat and pie chart (Supply and demand trends)
3. Map (Plant location and capacity)
4. Flow chart (Petrochemical process)

Overall, a general algorithm can be outlined where it utilizes the past research information incorporate with current data to carry out data interpretation. Basically, the interpretation of findings should include:

1. Review of major findings in the area of study.
2. Relate the findings to the problem statement.
3. Organize data in such a way that past and present data are tabulated accordingly.
4. Compare and analyze the underlying factors that affect the result.
5. Personal views and justification for the research findings.
6. Limitations of the study.
7. Recommendations for future research.

3.4.2 SWOT Analysis

While analyzing the possibility of continuous business integration between South Korea and Malaysia, the SWOT Analysis method has been employed to evaluate strength, weaknesses, opportunities and threats as illustrated in Figure 3.2. Typically, the SWOT analysis is served as a guideline to figure out the pros and cons of a market plan decision. In the SWOT analysis, several internal and external factors are taking into consideration and the key components are listed as below.

1. Strengths
    - The first quadrant should include the internal practice aspects that provide a competitive advantage to the decision.

2. Weaknesses
    - The second quadrant should mention the lack of strengths in certain areas which may be considered as internal weakness.
3. Opportunities
    - The third quadrant is comprise of the external factors which provide growth and differentiation possibilities.
4. Threats
    - This last quadrant should indicate the market and competitive activities which might negatively impact the practice.

Figure 3.2: Sample Outcome of SWOT Analysis

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Petrochemicals Outlook of South Korea in 2011

4.1.1 Petrochemicals Industry Issues in 2011

Speaking about the petrochemicals market, there is no doubt that 2011 was proving to be tough compared with previous years in the aftermath of several global crisis. In 2011, the petrochemicals market in South Korea is undergoing fundamental change due to three chief forces. The first is the slowdown in Chinese and US consumption growth (BMI, 2011f). The second is the soaring price of oil and naphtha feedstock costs. The third is the impact of the March 2011 Japanese earthquake that contributed to a shift in the petrochemicals market direction. Overall, South Korea's petrochemical industry continues to expand and diversify in 2011 while the demand has remained soft amid inflationary tightening measures in China, coupled with extremely uncertain European economic outlook.

Over the years, the massive capacity additions and success of the expansion of South Korea's downstream petrochemicals production are mostly attributed to the export markets, notably China and US. However, petrochemicals market profitability declined as 2011 progressed due to a declining of consumption growth is observed in China and US. Inflationary pressures are mounting in the Chinese economy and the situation is exacerbated by energy prices which inevitably hamper Chinese demand for South Korean petrochemicals products. On top of that, US economic growth slows down to 0.4 % from 1.9 % in the first quarter of 2011 which in turn upset

petrochemicals growth throughout the year (Kollewe, 2011). The slowdown trend has led many to cut expectations for oil consumption and significantly affect the demand of petrochemicals products from South Korea.

From the last quarter of 2010, the crude oil-to-natural gas ratio reached 20:1 with gas priced at US$ 4 per million British thermal units (btu) and oil at US$ 80 per barrel which is well above historical average of 8:1 as indicated in Figure 4.1 (BMI, 2011f). Going into 2011, the wave of surging crude oil prices are continually driven up and casting clouds over South Korean economy which placing the petrochemical industry on emergency footing. As a knock-on effect, the escalated oil prices have eventually raised the naphtha feedstock costs in the medium term. As a heavy naphtha-reliant petrochemicals producer, South Korea has felt a downturn pressure which slows down the overall petrochemicals growth. For instance, crackers and polymer output was at 80 % capacity in the fourth quarter of 2011. On the external front, a persistently high oil prices would likely trigger demand destruction and further damaging business and consumer sentiment. This situation is extremely unfavourable to South Korea's export-oriented economy in the long term.

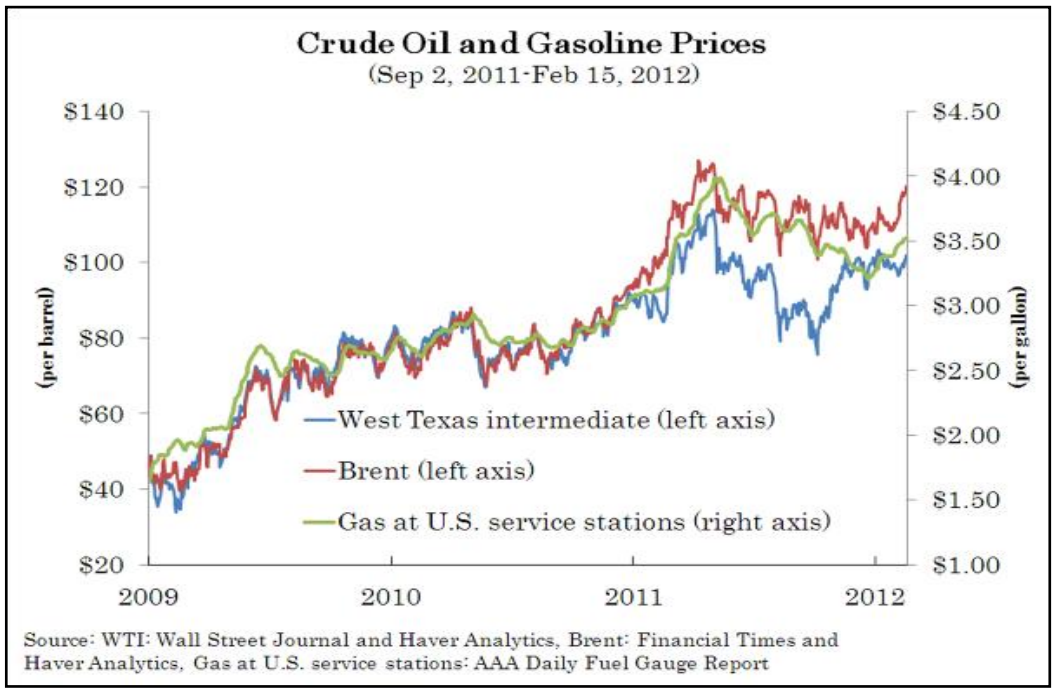


Figure 4.1: Global Crude Oil Prices (Source: United States Department of Commerce, 2012)

In the aftermath of Japanese earthquake disaster in March 2011, there is a large gap created in the petrochemicals market due to immediate disruption of Japanese supply. On the upside, South Korea is able to take advantage from Japan's misfortune. During the reconstruction period, petrochemicals are in demand while most of the petrochemicals products which previously supplied by Japanese are substituted by South Korea. In short term, this situation is largely benefited South Korea petrochemicals industry and the additional demands have spurred the export growth significantly. In 2011, South Korea's petrochemicals producers have successfully filled up the gaps left by Japan in the global market and boost their market shares. Meanwhile, Japanese also demand for South Korean exports that surge over the medium term on the back of Japan's massive reconstruction efforts.

Throughout 2011, petrochemical players in South Korea have realized a need to strengthen their core petrochemicals businesses as well as open new high-growth opportunities. In light of this, several petrochemical companies in South Korea have started to diversify their business to clean energy and advanced materials in addition to conventional petrochemicals. Facing a flood of lower-cost Middle East capacity, market analysts found that major South Korean companies slowly adopted investment strategy changes which focus in further consolidation rather than business expansion. Therefore, M&A activity has also been driven by the need to reinforce petrochemicals markets in South Korea.

4.1.2 Existing Plant Capacity

In many cases, the size of a country's petrochemical base is refers to the olefins capacity as it represents the indicator of the country's economy growth. Typically, the number and size of crackers determines both a country's likely output and its relative efficiency as a producer. In this study, the statistical data gathered are primarily focus on the olefins (ethylene, propylene and butadiene) and polyolefin (HDPE, LDPE, LLDPE, and PP) capacity.

According to BMI (2011f), in 2011, the combined olefins capacities included 7.83 million tpa ethylene, 5.87 million tpa propylene and 1.25 million tpa butadiene. Intermediate and aromatics capacities included 4.35 million tpa benzene, 330000 tpa ethylbenzene, 1.3 million tpa ethylene oxide or ethylene glycol, 6.63 million tpa terephthalic acid, 3.28 million tpa styrene monomer, 1.51 million tpa vinyl chloride monomer and 7.39 million tpa xylenes. In terms of petrochemicals products, polymer capacities include 1.92 million tpa HDPE, 1.03 million tpa LDPE, 1.22 million tpa LLDPE, 1.09 million tpa PET, 4.04 million tpa PP, 1.38 million tpa PVC and 975000 tpa PS. It also possesses capacities of 565000 tpa styrene-butadiene rubber and 1.48 million tpa acrylonitrile-butadiene-styrene.

Broadly speaking, South Korea petrochemicals plants are concentrated in four locations, namely Ulsan, Yeosu, Daesan and Onsan. Basically, there are a total of 11 naphtha cracking facilities that are still being expanded to increase capacity. Ulsan has two units of naphtha cracker operated by SK Group with the downstream facilities that are capable to produce 880 KTA of ethylene. In Yeosu, the country's biggest cracker player, Yeochun NCC runs three naphtha cracking units while Honam Petrochemical Corporation and LG Chem each operate one unit of cracker. In sum, there are total of five naphtha crackers with the downstream facilities to yield an annual 3460 KTA of ethylene capacity in Yeosu. Besides that, three naphtha cracking units and the downstream facilities of annual 2680 KTA ethylene are under operation in Daesan. Typically, the three cracker operators in Daesan are LG Chem, Lotte Daesan Petrochemical and Samsung Total Petrochemicals. On the other hand, one unit of naphtha cracker is operated by Korea Petrochemical Industry Company which contributes to an annual 470 KTA ethylene at the smaller complex in Onsan.

In order to provide a clearer view on the whole picture, a summary of the existing olefins plants capacity in South Korea is presented in Table 4.1. Here, the plant capacity is organized according to company and the ordering of the companies corresponds to the size of ethylene output, followed by propylene and butadiene capacity. In other words, company on top of the list possess highest yield of ethylene capacity which also considered as the largest olefins producer in South Korea.

Table 4.1: Existing Olefins Plant Capacity of South Korea in 2011

(Sources: BMI, 2010c, 2011f; Jagger, 2009; KPIA, 2008b)

EXISTING OLEFINS PLANTS					
No.	**Company**	**Capacity (KTA)**			**Location**
		Ethylene	**Propylene**	**Butadiene**	
1)	Yeochun NCC	1810	1100	-	Yeosu
2)	Lotte Daesan Petrochemical	1070	530	150	Daesan
3)	LG Chem	900	580	145	Yeosu
		760	380	140	Daesan
4)	SK Group	880	1055	130	Ulsan
5)	Samsung Total Petrochemicals	850	480	120	Daesan
6)	Honam Petrochemical Corporation	750	380	-	Yeosu
7)	Korea Petrochemical Industry Company	470	230	-	Onsan
		-	110	-	Ulsan
8)	Taekwang Industrial Company	-	250	-	Ulsan
9)	GS Caltex	-	200	-	Yeosu
10)	S-Oil Corporation	-	200	-	Onsan
11)	Hyosung Corporation	-	170	-	Ulsan
12)	Korea Kumho Petrochemical	-	-	235	Yeosu
		-	-	85	Ulsan

In terms of polyolefin, the plant capacity for polyethylene (PE) and polypropylene (PP) are summarized in Table 4.2 and Table 4.3 respectively. It is worth keeping in mind that most of the ethylene and propylene produced from cracking are further processed into valuable PE and PP. For the standpoint of profit, most of the petrochemicals producers are operating the naphtha crackers together with the downstream processing in a petrochemical plant. For instance, LG Chem is capable to produce olefins and polyolefin at the Daesan plant.

Collectively, the olefins and polyolefin capacity in 2011 is presented in the South Korea map attached in Appendix A. Basically, the map summarized all the capacities by company and the petrochemical plants location are pointed out in the map.

Table 4.2: Existing Polyethylene (PE) Plant Capacity of South Korea in 2011 (Sources: BMI, 2010c, 2011f; Jagger, 2009; KPIA, 2008b)

EXISTING POLYETHYLENE (PE) PLANTS					
No.	Company	Capacity (KTA)			Location
		HDPE	LDPE	LLDPE	
1)	Korea Petrochemical Industry Company	450	-	-	Ulsan
2)	Honam Petrochemical Corporation	370	-	-	Yeosu
3)	LG Chem	310	160	-	Yeosu
		160	120	80	Daesan
4)	Daelim Industrial	260	-	140	Yeosu
5)	SK Group	190	-	200	Ulsan
6)	Samsung Total Petrochemicals	175	100	125	Daesan
7)	Hanwha Chemical	-	380	370	Yeosu
		-	85	-	Ulsan
8)	Lotte Daesan Petrochemical	-	140	300	Daesan

Table 4.3: Existing Polypropylene (PP) Plant Capacity of South Korea in 2011 (Sources: BMI, 2010c, 2011f; Jagger, 2009; KPIA, 2008b)

EXISTING POLYPROPYLENE (PP) PLANTS				
No.	Company	Product	Location	Capacity (KTA)
1)	Lotte Daesan Petrochemical	PP	Daesan	800
2)	PolyMirae	PP	Yeosu	628
3)	Samsung Total Petrochemicals	PP	Daesan	570
4)	Honam Petrochemical Corporation	PP	Yeosu	380
5)	SK Group	PP	Ulsan	340
6)	Korea Petrochemical Industry Company	PP	Ulsan	330
7)	Hyosung Corporation	PP	Ulsan	280
8)	LG Chem	PP	Daesan	280
9)	GS Caltex	PP	Yeosu	180

In 2011, Yeochun NCC remained as the South Korea's leading cracker player with an annual 1810 KTA of ethylene and 1100 KTA of propylene output. On the other hand, LG Chem is recorded as the largest polyethylene producer with two plants operating in Yeosu and Daesan yield a total HDPE capacity of 470 KTA, 280 KTA of LDPE and 80 KTA of LLDPE. In the PP segment, Lotte Daesan Petrochemical with an annual 800 KTA of PP is leading the market.

4.1.3 New and Planning Capacity Additions

According to the Korea Petrochemical Industry Association (2008a), South Korea's petrochemical makers plan to invest Won 7.5 trillion (US$ 6.7 billion) in 2012 on upgrade and expansion of production facilities. The investment is targeted to help domestic petrochemical manufacturers to improve their global competitiveness at the same time reduce environmental impact. Richardson (2010) revealed that the country is set to raise the ethylene and propylene capacities by 700 KTA and 740 KTA respectively by 2013. On top of that, downstream expansions in PE and PP are also likely to take place.

In 2011, the petrochemicals industry continues to expand but only several small scales capacity are added as listed in Table 4.4. The reason behind the conservative capacity addition is mainly due to fears of second global economic slowdown, particularly amid in the euro zone crisis. Many uncertain risks and potential on-going effects such as demand destruction are anticipated as a result of the euro zone crisis.

In terms of olefins capacity, LG Chem has raised its ethylene capacity by 140 KTA to further strengthen its downstream system. This was accompanied by 70 KTA increase in propylene capacity and 23 KTA increase in butadiene capacity at the same site where the project was completed in April 2011. In May 2011, Samsung Total Petrochemicals has added 150 KTA of ethylene and 80 KTA of propylene capacity to its Daesan complex. At the same period, a new Fluid Catalytic Cracking (FCC) unit is installed to Hyundai Oil and thus 200 KTA of propylene was inserted to the market. In sum, a total combined 290 KTA of ethylene, 350 KTA of propylene and 23 KTA of butadiene capacity have been added to the South Korea’s petrochemical market in 2011.

Moving in to 2012, South Korea’s leading ethylene maker Yeochun NCC is mull augmenting capacity by 300 KTA at its No. 2 naphtha cracker. The project is expected to come on-stream by the first quarter of 2012 (Richardson, 2010). Similar to the expansion trend in 2011, LG Chem has planned to add a further 50 KTA of ethylene and 25 KTA of propylene to its Daesan Complex by July 2012.

While going into 2013, Honam Petrochemical Corporation will lead expansion over the medium term with growth at its Yeosu complex. The company is scheduled to raise its ethylene capacity by 250 KTA at the same time increasing propylene capacity by 120 KTA (BMI, 2011f). In terms of polyolefins, Honam Petrochemical Corporation also planned to build two new PE and PP plants which will produce 250 KTA of HDPE and 200 KTA of PP capacities. The project is anticipated to come on-stream by the first quarter of 2013. Upon completion of the project, the company will hike the capacity of its cracker from 750 KTA of ethylene to 1000 KTA and further raised the propylene capacity from 380 KTA to 500 KTA. Chemical Market Associates Inc. [CMAI] (2011) revealed that earlier in May 2011, GS Caltex has started with the construction of a new Vacuum Gas Oil (VGO) FCC unit and the project is to be completed by the first quarter of 2013. In this case, the new FCC unit is expected to add 250 KTA propylene capacities to GS Caltex.

Over the 2014 to 2015 period, the South Korea's petrochemicals industry is unlikely to see any new investment other than the amount earmarked for projects currently under way. Starting from 2014, market analyst predicted that the margins of most downstream petrochemicals are likely to weaken from new expansions as the industry is going into the typical petrochemical decelerate cycle. As a whole, a summary of the planning olefins capacity additions from 2012 to 2015 are recorded in Table 4.5. In short, the total combined planning capacity additions for ethylene is 600 KTA and 395 KTA for propylene.

Table 4.4: South Korea New Olefins Capacity Additions in 2011 (Sources: BMI, 2010c, 2011f; CMAI, 2011; Richardson, 2010)

NEW OLEFINS CAPACITY ADDITIONS IN 2011								
No.	Company	Capacity (KTA)			Location	Type	Start-up Date	Remarks
		Ethylene	Propylene	Butadiene				
1)	LG Chem	140	70	23	Daesan	Expansion	April 2011	Purpose to balance downstream system.
2)	Samsung Total Petrochemicals	150	80	-	Daesan	Expansion	May 2011	
3)	Hyundai Oil	-	200	-	Daesan	New FCC Unit	May 2011	Target for export market.
Total Capacity Addition in 2011		290	350	23				

Table 4.5: South Korea Planning Olefins Capacity Additions (Sources: BMI, 2010c, 2011f; CMAI, 2011; Richardson, 2010)

PLANNING OLEFINS CAPACITY ADDITIONS (2012 to 2015)								
No.	Company	Capacity (KTA)			Location	Type	Start-up Date	Remarks
		Ethylene	Propylene	Butadiene				
1)	Yeochun NCC	300	-	-	Yeosu	Expansion	1Q 2012	Target for export market.
2)	LG Chem	50	25	-	Daesan	Cracker Expansion	July 2012	
3)	Honam Petrochemical Corporation	250	120	-	Yeosu	Expansion	1Q 2013	Crude C4 from existing cracker will be diverted to butadiene production from 2010.
4)	GS Caltex	-	250	-	Yeosu	New FCC Unit	1Q 2013	Construction for 53 kbbl/day Vacuum Gas Oil (VGO) FCC unit started in May 2011.
Total Planning Capacity Addition		600	395	-				

4.2 Petrochemicals Future Trends of South Korea

4.2.1 Yearly Production Capacity Overview

After understanding the petrochemical outlook of South Korea in 2011, it is crucial to step back from the daily grind of business and look at the big picture of the petrochemicals market trend. Figure 4.2 depicts the total olefins production capacity from 2000 to 2015. Here, the actual yearly data are captured from 2000 to 2011 while the data from 2012 to 2015 are on forecast basis. The actual yearly data are mainly extracted from several well-recognized sources such as Korea Petrochemical Industry Association (KPIA), Business Monitor International (BMI), Asia Petrochemical Industry Conference (APIC), and Chemical Market Associates Inc. (CMAI).

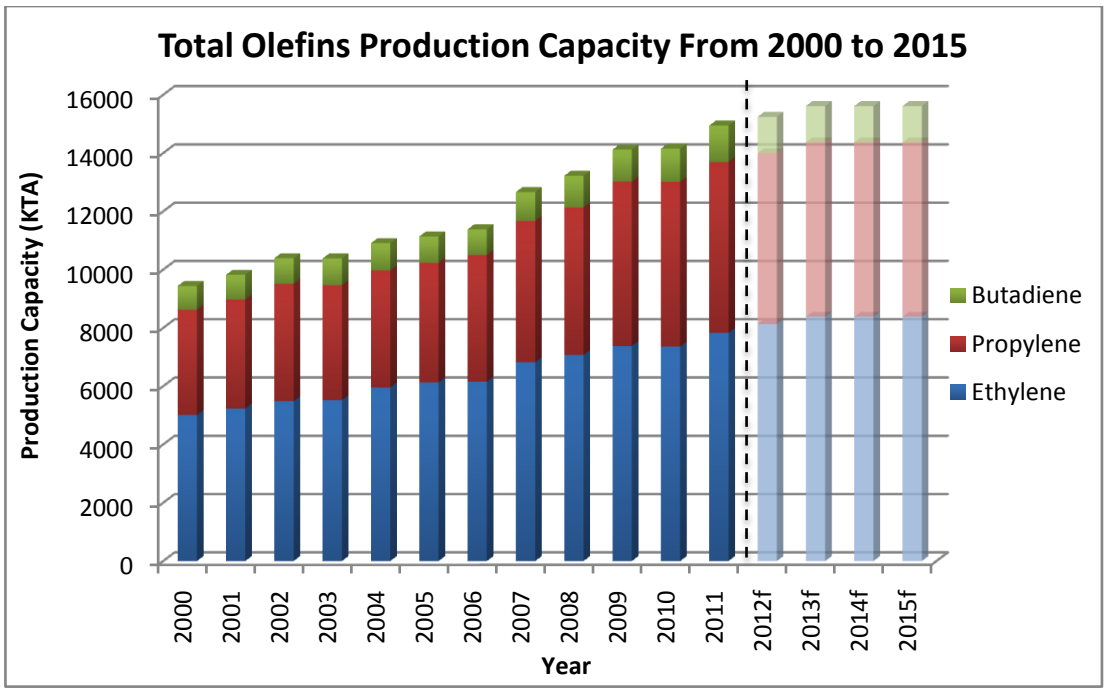


Figure 4.2: Total Olefins Production Capacity of South Korea from 2000 to 2015 (Sources: APIC, 2010a; BMI, 2009a, 2009b, 2010c, 2011f; Kiyokawa, 2011; KPIA, 2008b)

From Figure 4.2, it is worth noting that the olefins production capacity grew at a healthy pace over the year of 2000 to 2002. However, in 2003, the world

petrochemical industry has seen the production capacity show a slow increase. The dwindling productions in 2003 are mainly due to the outbreak of Severe Acute Respiratory Syndrome (SARS) in China, which is the major importer for South Korean petrochemical products (KPIA, 20008a). After recovered from the disease, in 2004, South Korea's production capacity had bounce back rapidly. Those projects that previously delayed were back on track following the years from 2004. However, the US Gulf Coast hurricane disruptions in 2005 have again slowdown the global market and the on-going effects are sustained until 2006. In 2007, the market has response to a strong production margin as a result of massive capacity additions.

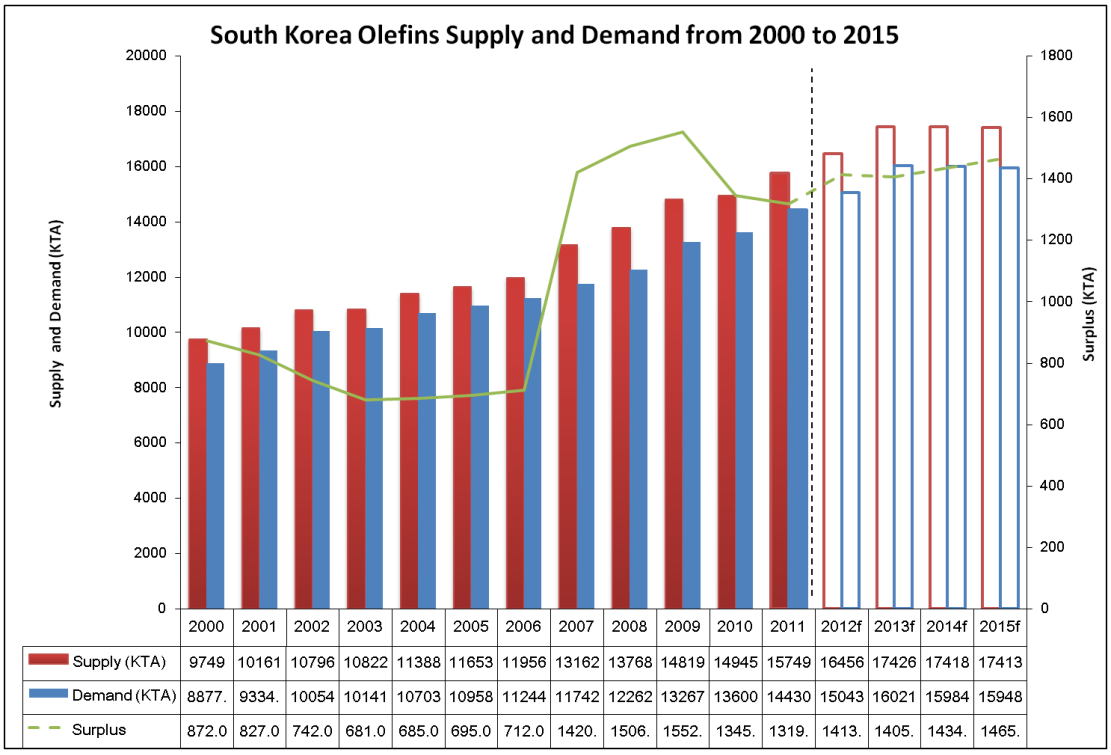
A weakening global economy in 2008 has contributed to a slower growth in production capacity. In 2008, the petrochemical players practiced cautious attitude toward investing in petrochemical projects to mitigate the downside risks. In 2009, growth in petrochemical demand contributes to positive export growth in South Korea. Starting from 2010, a fundamental change is taking place in South Korea's petrochemical industry. Facing a wave of new capacity additions in the Middle East, the petrochemical players are less reluctant to expand their capacity in the country. Instead, South Korea's petrochemical producers started to diversify their business by investing in clean energy and advanced materials.

In the previous section, an in-depth discussion on the current olefins capacity in 2011 and future capacity additions from 2012 to 2015 have been covered. The forecast trend of the total olefins capacity starting from 2011 to 2015 are clearly illustrated in Figure 4.2. In brief, the South Korea's petrochemicals production capacity is likely to stagnant over the next four years since only a few projects are announced to date.

4.2.2 Supply and Demand

When analyzing petrochemicals trend, it is essentially to understand the supply and demand trend for South Korea's petrochemical as it determines the degree of pricing power according to the producers of those petrochemicals products. Figure 4.3

depicts the supply and demand trend of the combined olefins products from 2000 to 2015.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012f	2013f	2014f	2015f
Supply (KTA)	9749	10161	10796	10822	11388	11653	11956	13162	13768	14819	14945	15749	16456	17426	17418	17413
Demand (KTA)	8877.	9334.	10054	10141	10703	10958	11244	11742	12262	13267	13600	14430	15043	16021	15984	15948
Surplus	872.0	827.0	742.0	681.0	685.0	695.0	712.0	1420.	1506.	1552.	1345.	1319.	1413.	1405.	1434.	1465.

Figure 4.3: Supply and Demand for Olefins Products in South Korea from 2000 to 2015 (Sources: APIC, 2010a; BMI, 2009a, 2009b, 2010a; Kiyokawa, 2011; KPIA, 2008b)

Basically, the supply and demand of the olefins product was increasing steadily from 2000 to 2011. For the next 4 years, a tightening of supply and demand balance is forecasted, particularly from 2013 to 2015. The study of Seddon (2010) revealed that the domestic demand for South Korea accounted for less than 50 % of the production, thus surplus of petrochemicals products can be observed throughout the 16 years period. Here, the surplus of olefins products refers to the excess of supply capacity after subtracting the demand. There is a sharp increased in surplus from 2006 to 2007 while the high surplus situation only sustain until 2009. Going into 2010, the surplus drop significantly and the future surplus trend is likely going upward but in lesser extent.

Typically, the production capacity in 2002 was better than 2001 and thus a high profitability in 2002 was observed. The upward trend is mainly attributed to a better supply and demand balance conditions. It is noticeable that the demand gradually improved from after the third quarter of 2001, primarily due to the World Cup and Asian Games held in Korea (KPIA, 20008a). Many visitors and investors were brought in to the country due to organization of international event.

On the other hand, exports during the second quarter of 2002 were slow as affected by the massive expansion petrochemicals plants in the Middle East and South East Asia aroused. However, the exports market trend was bounced back steadily from after the third quarter of 2002 mainly due to rising demand from China which is also the key importer of South Korean petrochemicals products.

In 2003, the world petrochemical industry has experienced a production capacity slowdown and the demands either sustain or surpass that of the last year. This situation generally contributed greatly to improve the supply and demand condition as well as improving the overall profitability. It is worth keeping in mind that during the first half of 2003, exports market was felled below those of the last year due to contracted productions in the related industries that are affected by the outbreak of SARS in China (KPIA, 20008a). Hence, the exports market in 2003 is severely squeezed in the aftermath of SARS crisis. From 2004 to 2007, a strong industry profit margins was observed taking advantage of entering the upturn of the typical petrochemical cycle.

In 2008, the revenue was decline radically as compared to 2007 due to the new petrochemicals capacity come on-stream in the Middle East and Asia. As a knock-on effect, unremitting rise in oil price was observed in addition to the slowdown of world economy initiated from US. At the same year, a soft landing economy situation was observed in China since Beijing Olympics took place in the country (KPIA, 20008a).

In 2009, a growth in petrochemicals demand has helped South Korean exports posting positive growth. South Korea’s trade surplus also grew slightly as compared to the last year. Imports were also boosted in the last quarter of 2009

which was attributed to an increase in demand for capital goods and consumer products (Yong, Park, & Cheng, 2010).

Going into 2010, olefin production almost levelled off and the exports of major petrochemicals was slowed slightly. The petrochemical industry in South Korea was experiencing a fundamental change in diverting their core petrochemicals business to clean energy and advanced materials in line with government policy (Kiyokawa, 2011). Hence, not much fluctuation was observed in the supply and demand side as compared to last year. However, many M&A and consolidation activities were carried out in 2010 in response to the high crude oil prices and realization of expansion need.

For 2011, the petrochemicals players in South Korea were focusing on increasing production of high-margin products. At the same time, domestic companies have put in efforts in monitoring strategic alliances among foreign rivals to prevent their market shares drop. Moreover, South Korean petrochemical firms are arranging to export US$ 47.5 billion worth of product in 2012 which an increase of 4.4 % from projected exports of US$ 45.5 billion in 2011. Meanwhile, South Korea is expected to import US$ 18.5 billion worth of petrochemical products this year, up 8.8 % from an estimated US$ 17 billion in 2011 (Yong, Park, & Cheng, 2010).

For the future year, the domestic production and demand is forecasted to grow no more than 3 to 4 % due to the slow growth in the overall production is expected. The situation is partially due to the slow recovery in the overall economy and the resulting slowdown in consumer sentiment. Therefore, the supply and demand trend for the next three years is showing a stagnant trend.

4.3 South Korea Recent Acquisition in Malaysia

Amid growing awareness of issues like massive rise in Middle East capacity, tougher business conditions is observed in South Korea. Mergers and acquisitions (M&A) activity has been driven by the need to strengthen petrochemical businesses and

markets. From 2004 to 2007, the South Korea M&A activities earnings have almost been doubled up compared to the trend in 1995 to 2000 as illustrated in Figure 4.4.

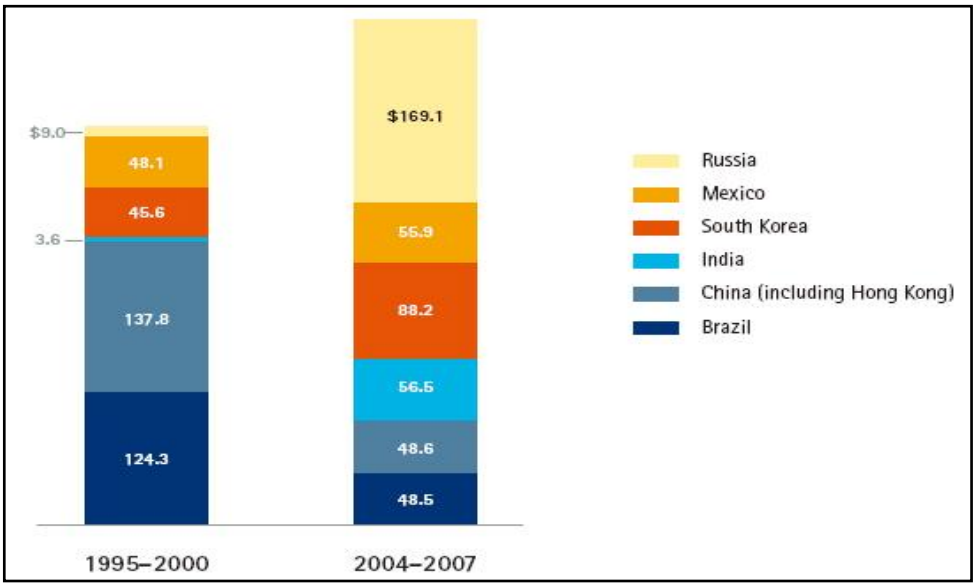


Figure 4.4: Countries Earnings (in US$ billions) from M&A Activities (Source: Bert, Ficery, & Sykes, 2009)

The most eye-catching M&A leader in South Korea is the Asia's seventh-largest chemical company which is also South Korea's second largest ethylene maker, namely Honam Petrochemical Corporation (Malini, 2010). Over the years, Honam Petrochemical has been actively investing and expanding overseas to boost the company's presence in the Southeast Asian market. In terms of consolidation, Honam Petrochemical also participated in the restructuring of the South Korean petrochemical industry by acquiring various domestic petrochemicals companies such as Hyundai Petrochemicals, KP Chemical and Lotte Daesan Petrochemical. According to Malini (2010), Honam Petrochemical has an ambition to become a "top-tier Asian chemicals company" with sales of Won 40 trillion (US$ 33.96 billion) by 2018.

Stepping out from the homeland, Honam Petrochemical is keeping its eyes open for more opportunities in Asia, particularly in basic chemicals, intermediates and specialty chemicals. In line with this, Honam Petrochemical has acquired Malaysia's Titan Chemicals from the Chao Group of Taiwan and investment group Permodalan Nasional Berhad (PNB) in November 2010. In essence, Titan is

Malaysia's biggest integrated producer of olefins and polyolefin which operating 10 integrated process facilities in Pasir Gudang and Tanjung Langsat in the state of Johor, Malaysia. However, it is worth keeping in mind that both Honam Petrochemical and Titan Chemicals share the similarity to buy naphtha feedstock from others for their operation.

After the acquisition, Honam Petrochemical has indicated that it might expand further overseas in attempts to take full advantage of this new-found confidence in petrochemicals. A series of Honam Petrochemical expansion records are shown in Table 4.6. In the long run, market analysts have predicted Honam Petrochemical will generate visible synergy from acquisitions of petrochemical companies in new growth markets.

Table 4.6: Summary of Honam Petrochemical Corporation Expansion Record (Source: Kim, Lee, & Choi, 2011)

Year	Activity
1992	Completes naphtha cracker
1992-2000	Downstream expansion (EG, HDPE, PP, PET, EOA, MMA)
2003	Acquires Hyundai Petrochemical
2004	Acquires KP Chemical
2006	Establishes Daesan MMA
2008	Revamps Daesan plant
2009-2010	Acquires Lotte Pakistan PTA and Lotte Chemical UK
2010	Acquires Titan Chemicals

4.3.1 Impacts in Malaysia

Many marketers believed that it was a strategic acquisition for Honam Petrochemical since Titan Chemicals would enable it to gain a strong foothold in the petrochemical industry. The acquisition also facilitates Honam Petrochemical become Asia's largest ethylene maker. Since the acquisition of Titan Chemicals, Honam Petrochemical Corporation has announced to increase capacity by revamping the plant. In addition,

downstream plants have also been expanded and new derivatives have been introduced at the site.

Typically, the acquisition is likely benefitted Malaysia's petrochemical industry since the country total olefins capacity will be raised. The increased olefins capacity will not only boost Honam Petrochemical's competitiveness but also consolidate Malaysia's petrochemical industry position at the global stage. In fact, the increased productivity and expansion in industry output will eventually improved Malaysia's export performance.

On the other hand, Honam Petrochemical has brought in their expertise and experience to Malaysia which significantly improved the petrochemicals sector. Apparently, the transfer of knowledge and technology of downstream processing are likely to take place through the acquisition. Over the years, South Korea petrochemical players are proved to possess highest level of facility management and operational knowledge in Asia, as evidenced by their ability to keep production up (Kim, Lee, & Choi, 2011). Hence, synergy is also possible in management of the petrochemical complex, marketing and sales.

On top of that, the entry of Honam Petrochemical into the Malaysian petrochemical industry symbolized the company's confidence in the prospects of the industry and the economy. In response, Titan Chemicals posted a net profit of RM 72.1 million on revenue of RM 1.69 billion (Leong, 2010). Hence, the market situation has proven confidence to the investors and this is likely to raise interest among the worldwide petrochemical players which in turn attracts foreign investment to Malaysia.

4.4 Malaysia Recent Petrochemical Industry Expansion

In May 2011, the state-owned energy giant Petronas announced to construct a US$ 20 billion (RM 60 billion) to build the Refinery and Petrochemicals Integrated Development (RAPID) project as reported by Suzuki (2011). The project will be

commissioned by the end of 2016 at Pengerang in Johor, Malaysia. The site in Pengerang was chosen because of its strategic location near international shipping lanes and deepwater port facilities. For this project, Malaysia aims to become a world class integrated oil, gas and petrochemical trading hub. In addition, the project is expected to broaden and diversify the country's industrial base as well as to strengthen the capacity to meet domestic fuel requirements and secure the energy supply in Malaysia.

In this case, the project will comprise a crude oil refinery, a naphtha cracker and a petrochemicals and polymer complex. According to Suzuki (2011), the crude oil refinery will be able to produce 300000 barrels per day of gasoline, jet fuel, diesel and fuel oil while the naphtha cracker is designed to produce a combined 3 million tpa of ethylene, propylene, C4 and C5 olefins per year. The polymer complex is expected to produce differentiated and highly-specialised chemicals. As a whole, RAPID is expected to attract significant investments from international companies within and further down the business value chain. In light of this, the project aims to partner with major international petrochemical players to form a long term mutually beneficial partnerships.

It is worth keeping in mind that the naphtha cracker would be Petronas's first ethylene plant based on naphtha feedstock while the other two existing plants are operating with ethane-based crackers. Unlike Petronas, Titan Chemicals possess a long history and experience in operating naphtha cracker in Malaysia. There are many similarities can be observed between Petronas's RAPID project and Titan Chemicals in terms of project location, cracker type and business nature except feedstock availability. Emergence of RAPID poses significant threats to South Korea based Titan Chemicals as the company rely on buying naphtha feedstock from others.

In order to eliminate the industry view of Titan Chemicals as a competitor, Petronas should consider the potential partnership with Titan Chemicals, particularly in the downstream sector. On the positive side, the participation of Titan Chemicals will indirectly bring in the technological expertise from Honam Petrochemicals. This would not only benefit the new generation of oil and petrochemicals professionals, but also the new breed of product scientists, engineers and businessmen who would

further drive the growth of the sector. However, if the rival between Petronas and Titan Chemicals sustain, it will most likely create negative impression among the investors. The competitive threats will also hinder South Korean companies for future business cooperation opportunities.

4.5 SWOT Analysis of South Korea & Malaysia Cooperation

In line with the purpose of study, a comprehensive SWOT analysis was performed in Table 4.7 to evaluate the Strengths, Weaknesses, Opportunities, and Threats of petrochemicals business cooperation between Malaysia and South Korea. In this case, the author would like to take the case of Titan Chemicals and Petronas's RAPID project as an example to better illustrate the cooperation between South Korea and Malaysia. In order to establish a complimentary relationship, a possible cooperation framework is proposed in such a way that Petronas operates the upstream facilities while Titan Chemicals focus on the downstream processing.

Generally, the SWOT analysis will serve as a guidance to better comprehend the pros and cons of the cooperation outcome. From here, the country players should be able to draft the possibility of continuous business integration between Malaysia and South Korea.

Table 4.7: Summary of SWOT Analysis for Malaysia - South Korea Business Cooperation in Petrochemicals Sector

Strengths	Weaknesses
▪ South Korea extensive experience with downstream technological edge. ▪ Malaysia is rich oil and gas reserves. ▪ Both countries have high interest in cooperation. ▪ Good business nature fit. ▪ Technology transfer from South Korea to Malaysia. ▪ Boost Malaysia's petrochemicals capacity and improve export performance. ▪ Proven ability to attract foreign investment. ▪ Enhance investor relations with Asian and Far East countries.	▪ Conflicts occur due to different communication background. ▪ Malaysia is concentrated in upstream refining rather than downstream. ▪ Surplus in supply local market and need to export.
Opportunities	**Threats**
▪ Ongoing cooperation programmes between South Korea and Malaysia. ▪ High motivation from South Korean cooperation partner. ▪ Invites new business opportunities to partner with major international petrochemical players. ▪ Promote the employment of local workforce and create training ground for locals. ▪ Improvement to Malaysia's business environment due to freer markets.	▪ Exports weaken due to expanded production in China and Middle East. ▪ Execution risks associated with new businesses cooperation. ▪ Status of ownership for a project will be affected.

4.5.1 Strengths

For over 40 years of experience in petrochemical industry, South Korea has emerged into a mature, competitive and highly integrated petrochemical producer principally proficient in downstream sector. South Korean petrochemical players possess the highest level of facility management and downstream operational knowledge which is lacking in Malaysia. However, South Korea is facing the constraint of limited oil and gas reserves, prompting feedstock cost disadvantage problem. On the contrary, Malaysia is rich in oil and gas reserve which provide easy availability of feedstock. Though, Malaysia is concentrated in upstream refining rather than downstream industries over the years. Considering the shortcomings of both countries, it is worth noting that a complimentary cooperation is best fit into the petrochemical industry for South Korea and Malaysia. In other words, complimentary cooperation refers to a mutually benefit relationship where South Korea is able to compensate the areas where Malaysia is weak in and Malaysia is able to contribute to the areas where South Korea is lacking.

Over the years, a lot of positive cooperation undergone in other sectors has proven a good business nature fit between South Korea and Malaysia. On top of that, South Korean petrochemical companies show a high interest in expanding in Asia while Malaysia is keen in attracting foreign investment. Therefore, the common interest has reassured the cooperation confidence. Typically, the petrochemical business cooperation will boost Malaysia's petrochemicals capacity and thus improve export performance. At the same time, South Korean petrochemical companies can strengthen the country's foothold as well as extend its reach in other parts of Asia. In essence, South Korea is proven to be a major player in the Far East olefins market while Malaysia has established investor-friendly economies in South East Asia. The cooperation between South Korea and Malaysia will definitely explore greater unrealized potential by mutually enhanced their investor relations with Asian and Far East markets.

4.5.2 Weaknesses

The prevalent weakness for successful cooperation patterns are the generally observed communication background barrier. In fact, South Korean investors tend to converse in Korea language while labour in Malaysia are more proficient in either Bahasa Melayu or English language. Hence, conflicts might be occurred due to different communication background and various forms of problem are expected for the cooperation between South Korea and Malaysia. For instance, South Korea will bring in their technology by conducting training to local workforce. In most cases, the training will be conducted by South Korean with their mother tongue and the local workforce might face the problem in understanding. Therefore, market analyst suggested that the cooperation between South Korea and Malaysia has to overcome the communication barrier prior to proceed.

Albeit Malaysia has proven oil and gas reserves, the country only explore upstream processing especially concentrated in refining sector rather than downstream industries over the decades. Typically, the government is paying attention to endorse foreign investment which is associated to oil refining projects. The lacklustre downstream developments and government supports have resulted in lesser extent of confidence towards cooperation with South Korea in order to support a vibrant petrochemicals industry.

On the other hand, many observers predicted that the participation of South Korea and other petrochemicals companies in Petronas's RAPID project will ramping up the domestic capacity rapidly and excess the oversupply situation might be occurred. If surplus is witnessed in the domestic market, the petrochemicals products are required to be exported. For this reason, the cooperation poses a weakness to both countries since the export market is fluctuated in recent years due to massive expansions in China and Middle East come on-stream.

4.5.3 Opportunities

There are numerous opportunities can be observed from the cooperation between South Korea and Malaysia in petrochemicals industry. First of all, if the business cooperation outcome turns out to be positive, ongoing cooperation programmes between South Korea and Malaysia can be expected. Since South Korea has high interest in expansion, high motivation from South Korean cooperation partner is likely to be seen in the long term. This will definitely opens up a new chapter to explore new business opportunities in terms of partnership with major international petrochemical players. The participation of international companies will further improve Malaysia's business environment due to freer markets status. In addition, the cooperation is prone to promote the employment of local workforce and thus create an excellent training ground for locals. In brief, the cooperation between South Korea and Malaysia is anticipated to establish a mutually beneficial and future-oriented strategic partnership.

4.5.4 Threats

In principle, the threats are directly derived from the weaknesses previously identified. The most common threats to the petrochemicals business cooperation realization are the exports market is expected to be weakening due to expanded production in China and Middle East. The market analysts addressed the reliance on China exports market can be risky since China is approaching self-sufficient level with several large-scale expansion projects under way (BMI, 2011f).

As far as the business cooperation is concerned, the execution of the project will be more or less poses some risks since their cooperation in petrochemical sector is considerably new. In particular, problems like vary sales and marketing strategies, different culture of management approaches and language problem could occur in a new cooperation. On top of that, some of the project ownership status will be affected if new business cooperation is introduced to the project. In other words,

local’s petrochemical players which previously hold a full ownership of a project will be affected by the new business cooperation.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

In a nutshell, the recent petrochemicals outlook has proven that South Korean petrochemical industries was moving into diversifying of their petrochemicals products and various efforts were placed on producing high-value grades of petrochemicals products. In addition, South Korea petrochemicals players were actively participate in restructuring programmes and keeping eyes for more M&A opportunities in Asia.

Over the years, the production capacity for olefins grew at healthy pace and the growth is forecasted to continue in slower term for the following years. To date, only several small scales capacity additions were announced to be come on-stream in the period from 2012 to 2013 while there is unlikely to see any new investment from 2014 to 2015. The supply and demand of the olefins product was increasing steadily from 2000 to 2011. However, supply and demand trend is forecasted to show a tightening of supply and demand balance, particularly from 2013 to 2015.

Recently, the acquisition of Malaysia's Titan Chemicals by South Korea's Honam Petrochemical has gained widespread attention. Typically, the acquisition is likely benefitted Malaysia's petrochemical industry in terms of capacity additions, technology transfer and better facility management with their long experience in downstream sector. Meanwhile, Malaysia's stated-owned company Petronas has announced to embark on a RAPID complex in Johor, Malaysia. In fact, the RAPID

project shares many similarities with Titan Chemicals operation in terms of cracker type, plant location and business nature. Therefore, conflict of interest among the two companies is likely to be observed.

In order to mitigate the negative view of Titan Chemicals as a competitor, complimentary business cooperation between Malaysia's Petronas and South Korean based Titan Chemicals is recommended as a prominent solution. In considering the shortcomings of each side, Petronas should concentrates on the upstream refining sector while Titan Chemicals practices its expertise in downstream processing sector to consolidate each other. In this sense, a win-win situation can be achieved. It is worth keeping in mind that if the rival between Petronas and Titan Chemicals sustain, many downside risks will be brought in to the market and the threats will hinder South Korean companies for future business cooperation. Ultimately, Malaysia will fail to attract other foreign investments as the investor might lose confidence to the country.

5.2 Recommendations

In order to maintain the competitiveness of South Korea's petrochemical industry, several recommendations are suggested:

a) South Korea's petrochemical manufacturers should reduce naphtha feedstock dependency by diversifying the feedstock slate to crack liquefied petroleum gas (LPG) and slowly transform to methanol-to-olefins (MTO) route to have alternative petrochemical feedstock in the long run.
b) South Korea's petrochemical players should move away from production of commodity grades petrochemicals products and focus on value-added grades of polyolefin.
c) South Korean petrochemical companies should look for more M&A to extend its reach in other parts of Asian countries to open up new opportunities.
d) South Korea should explore new export market instead of heavily rely on China for petrochemical exports.

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APPENDICES

APPENDIX A: South Korea Map