THE UNIVERSITY OF HULL

Sungai Liang Industrial Park (SPARK): can Brunei achieve its sustainable industrial development?

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by

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Abstract

As Brunei is moving towards the diversification of its economy away from an overdependence on the oil and gas industry, the country is now putting much effort into developing additional industrial activities. At the same time, the country is also committed to develop sustainably without putting pressure on the environment and without harming the population. The SPARK project development in the petrochemical industry is one of the diversification efforts carried out by Brunei by adding value to the main economic sources i.e. oil and gas. Because developing sustainably is also important in line with the importance of diversifying the economy, this research investigates the issues involved in developing the SPARK, and to find out whether this economic diversification effort by Brunei can be developed economically, while making sure that the environment is protected and that the health and safety of the population is still prioritised.

A range of methods of data collection were employed during the study, which include 1) an initial exploratory forum and meeting; 2) direct observation of the industrial area and the surrounding areas; 3) site visits to the industrial park; 4) questionnaire interviews with the local communities living near to the development; 5) formal in-depth and semi-structured interviews with the project proponent of the petrochemical industry, government officials and village heads; and 6) secondary sources using EIS of the SPARK project, SLA's reports, investment incentives booklets for FDI to Brunei were also used for references and other unpublished information about SPARK from internal presentations. Data collected during the fieldwork were analysed qualitatively in order to find themes in the study.

Based upon the data analysis, it can be said that more challenges than benefits are posed from the socio-economic impacts of petrochemical development at SPARK. The main challenges are 1) the development may require a long period to receive back revenues because of the small GDP contribution from the industrial project, the lengthy tax holiday, and high level of government subsidies; 2) little benefit from spin-off activities; 3) substantial competition from other petrochemical industries in the ASEAN states; and 4) possible impacts upon the health and safety of the local communities and industrial workers.

There is also a minimal level of awareness and understanding about SPARK as well as a low level of public participation in the development project. In addition, there are differing priorities of various stakeholders at and around the industrial area which leads to the occurrence of some conflict over resources present at SPARK such as conflict over priorities and the space surrounding the industrial area as well as disputes over the opinions regarding the impacts from the project. To date, there are no serious environmental impacts that are occurring at and around SPARK. However, there is potential for the development to affect the local population and the environment near to it as there is a likelihood of emissions of environmental pollutants, presence of vibration or noise pollution, risk of industrial accidents from the handling and storage of petrochemicals. This is exacerbated by the lack of competence of an environmental agency to manage and monitor SPARK and also up until now there is an absence of environmental law in Brunei.

Dedications

To my mother and father, siblings, families, cats, close friends, BruHull, and HullIsoc

– this thesis is for you.

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List of Abbreviations

4W	What, Where, Who, When
AFPM	American Fuel & Petrochemical Manufacturers
APIC	Asia Petrochemical Industry Conference
APLA	Latin American Petrochemical and Chemical Association
APPE	Association of Petrochemicals Producers in Europe
As	Arsenic
ASEAN	Association of South-East Asian Nation
ATA	Anti-thyroid anti bodies
BEDB	Brunei Economic Development Board
BFL	Brunei Fishery Limit
BLNG	Brunei Liquefied Natural Gas
BMC	Brunei Methanol Company
BOD	Biochemical Oxygen Demand
BPG	Brunei Pollution Guidelines
BSP	Brunei Shell Petroleum
BSU	Brunei Students Unit
BTU	British Thermal Unit
Ca	Calcium
CC	Corporate Citizenship
CCTV	Close Circuit Television
Cd	Cadmium
CH_4	Methane
Cl	Chlorine

CO_2	Carbon dioxide
COD	Chemical Oxygen Demand
CPI	Consumer Price Index
Cr	Chromium
CSR	Corporate Social Responsibility
DEPD	Department of Economic Planning and Development
DEPR	Department of Environment, Parks and Recreation
DO	Dissolved Oxygen
DoE	Department of Environment
DoF	Department of Fisheries
EAPIC	East Asia Petrochemical Industry Conference
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EM	Ecological Modernisation
EM	Ecological Modernisation
EMP	Environmental Management Plan
EMS	Environmental Management System
EPA	Environmental Protection Agency
E-PRTR	Regulation on the European Pollutant Release and Transfer Register
ERP	Emergency Response Plan
ETS	European Trading Scheme
EU	European Union
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GEMS	Global Energy Management System

GHG	Greenhouse Gas
GHGs	Greenhouse Gases
GM	General Motor
GPCA	Gulf Petrochemicals and Chemicals Association
GPS	Global Product Strategy
Hg	Mercury
HoB	Heart of Borneo
HR	Human Resource
HRD	Human Resource Development
HSE	Health, Safety and Environmental
HSSE	Health, Safety, Security and Environment
HT	Hashimoto's thyroiditis
ICCA	International Council of Chemical Associations
ICM	Integrated Coastal Management
ICM	Integrated Coastal Management
ICT	Information and Communication Technology
IED	Industrial Emissions Directive
IPPC	Integrated Pollution Prevention and Control Directive
ISMS	Integrated Safety Management System
ISO	International Standard Organisation
ISO	International Organisation for Standardisation
JPCA	Japan Petrochemical Industry Association
JPKE	Jabatan Perancangan dan Kemajuan Ekonomi
JRCC	Japan Responsible Care Council
KFC	Kentucky Fried Chicken

KPIA	Korea Petrochemical Industry Association
LCA	Life Cycle Assessment
LNG	Liquefied Natural Gas
LTI	Loss Time Incident
MARS	Major Accident Reporting System
MBTU	Million British Thermal Unit
MEF	Methanol Export Facilities
Mg	Magnesium
MGC	Mitsubishi Gas Chemical Company
MIPR	Ministry of Industry and Primary Resources
Mn	Manganese
Na	Sodium
NDMC	National Disaster Management Centre
NDP	National Development Plan
NGOs	Non-Governmental Organisations
NH_4OH	Ammonium hydroxide
Ni	Nickel
NO_x	Nitrogen oxides
OBG	Oxford Business Group
OECD	Organisation for Economic Cooperation and Development
OHSAS	Occupational Health and Safety Management Systems
OIMS	Operations Integrity Management System
OPEC	Organization of Petroleum Exporting Countries
PAHs	Polycyclic Aromatic Hydrocarbons
Pb	Lead

PB	Petroleum Brunei
PIAT	Petrochemical Industry Association of Taiwan
PM_{10}	Particulate matter
R&D	Research and Development
RC	Responsible Care
RCMS	Responsible Care Management System
REACH	Registration, Evaluation and Authorisation of Chemicals
RFID	Radio Frequency Identification
Sb	Antimony
Se	Selenium
SEA	South-East Asia
SID	Sustainable Industrial Development
SID	Sustainable Industrial Development
SiO_2	Silicon dioxide
SLA	Sungai Liang Authority
SMEs	Small and Medium Enterprises
SO_2	Sulphur dioxide
SO_4	Sulphate
SO_4	Sulphate
SP	Social Performance
SPARK	Sungai Liang Industrial Park
SS	Suspended Solids
TDS	Dissolved solids
TEIs	Technological Environmental Innovations
TSP	Total Suspended Particles

UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNCSD	United Nations Commission on Sustainable Development
UNEP	United Nations Environment Programme
US	United States
USA	United States of America
V	Vanadium
VOCs	Volatile Organic Compounds
WCED	World Commission on Environment and Development

CHAPTER 1 – INTRODUCTION

1.0. Brief overview of Brunei Darussalam

Brunei Darussalam, hereafter referred to as Brunei, is a very small country that is located in Southeast Asia. It can be found on the northwestern coast of Island of Borneo, and borders with one of the Malaysian states of Borneo, Sarawak. It lies between longitudes of 114^{o} 23’ East and 115^{o} 23’ and between latitudes of 4^{o} and 5^{o} 5’ North. Figure 1 shows the geographical location of Brunei Darussalam.

Figure 1 Map of Brunei
Source: Google Map, 2010

Brunei has a land area of 5,765 km^2 and about 60 per cent of the country is still covered with dense tropical rainforest, which mainly consists of secondary growth vegetation (Department of Fishery (DoF), 1992). Forest conservation is the concern of the Heart of Borneo (HoB) project, which is undertaken by three countries of the Association of South-East Asian Nations (ASEAN) (i.e. Brunei, Malaysia and Indonesia). The project has conserved 220,000 km^2 of rainforest in Borneo. Malaysia has the land territories of Sabah and Sarawak in the island and Kalimantan belongs to Indonesia. Offshore, the area of the continental shelf of Brunei is 9,400 km^2 and beyond it is the Brunei Fishery Limit (BFL), which measures about 38,600 km^2 (DoF, 1992). Brunei has a coastline of 161 km bordering the South China Sea and has a narrow area of shallow water (DoF, 1992). The coastline has a fine sandy beach and has some coastal resources that have not been overexploited such as mangroves and other ecologically significant flora and fauna, such as fish and shrimps, small areas of coral reefs and mineral resources (DoF, 1992).

Being located near to the equator, Brunei has an equatorial climate and is hot and wet throughout the year. It has an average temperature of 27^{o}C (81^{o}F), with a maximum temperature of 32^{o}C (90^{o}F) and a minimum temperature of 23^{o}C (74^{o}F) (McIlroy and Elder, 2008). The relative humidity of the country is about 78 per cent and every year, Brunei also receives a very large amount of rainfall especially in the coastal areas (McIlroy and Elder, 2008). There is no seasonality in Brunei, but there are two major monsoon winds, the northeast monsoon that blows from November to March and the southwest monsoon, from April until October (McIlroy and Elder, 2008). The wettest month is December with May to July being the second wettest months and the dry period is from February to April (McIlroy and Elder, 2008).

Brunei is divided into four districts, i.e. Brunei-Muara, Tutong, Belait and Temburong. The largest district is the Belait District at about 2,696 km^2 and the Brunei-Muara District is the smallest district in Brunei with a land area of 563 km^2. The capital city of Brunei, Bandar Seri Begawan, is located in the Brunei-Muara District. The population is small, only about 422, 700 people (JPKE, 2012). Malays form the majority (two thirds) of the country's population, followed by Chinese with 11 per cent and the rest are other nationalities such as Indians and other indigenous groups, and foreigners (JPKE, 2012). Among the four districts, Brunei-Muara has the largest number of population with 296,500 people, followed by Belait, with 69,600 people, Tutong with 46,300 people and lastly, Temburong has the smallest population with 10,300 people (JPKE, 2012). Brunei is a coastal state where the majority of the population (85 per cent) lives within 100 km of the coastal zone and almost all of the social, cultural and economic activities are concentrated on this narrow strip of land.

Brunei has been ruled based on the concept of 'Melayu Islam Beraja' (Malay Islamic Monarchy) ever since Brunei gained her independence from the Britain on the 1st of January 1984. The country is ruled by a Sultan (king) and currently His Majesty Sultan Haji Hassanal Bolkiah, the 29th sultan of Brunei is the head of the country and he also acts as the Prime Minister, Minister of Defense as well as Minister of Finance. The official religion in Brunei is Islam and the official language is Malay (Bahasa Melayu), but English is also widely spoken among the population since English is the medium of study in Government schools from Year 4 (primary 4).

1.1. Economic profile of the Sultanate

Brunei is endowed with abundant natural resources of crude oil and natural gas that have become the backbone of the state's wealth and development. The production of oil and gas is the main economic activity in the country and other small industries such as small scale manufacturing (mainly furniture and textiles), and primary production (agriculture, fisheries and forestry) make up the rest of Brunei economy. Brunei is the third largest oil producer in South East Asia (SEA) (producing approximately 180,000 barrels per day) and also the fourth largest producer of Liquefied Natural Gas (LNG) in the world. In the period from 2007 to 2012, the average production of crude oil was 174,617 barrels per day and LNG accounts for 996,132 million British Thermal Unit (BTU) per day (JPKE, 2012).

In 2012, it was estimated that the Gross Domestic Product (GDP) of Brunei was US$16.95 billion which is very high since Brunei is a small country and has very small population (The World Bank, 2014). The oil and gas sector alone contributes to more than half of the GDP (i.e. 65.4 per cent) while the government sector (e.g. through taxes) accounted for 12.2 per cent and the private sector from non-oil and gas industry for 22.3 per cent in 2012 (JPKE, 2012). In terms of the total exports of the country, revenues from crude oil and LNG production alone account for 90.5 per cent of the total export revenues (48 per cent oil; 42.5 per cent gas), compared to only 5.9 per cent from methanol, garments 0.1 per cent and others account for 3.5 per cent. Figures 2 and 3 show the percentage composition of GDP with respect to the main sectors and the percentage of total export revenues of Brunei respectively.

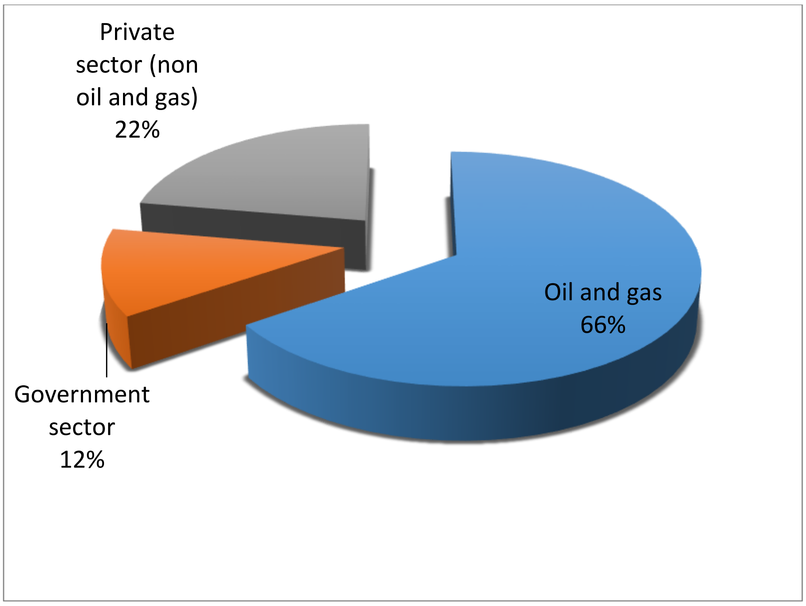

Figure 2 Percentage composition of GDP with respect to the main sectors
Source: JPKE, 2012

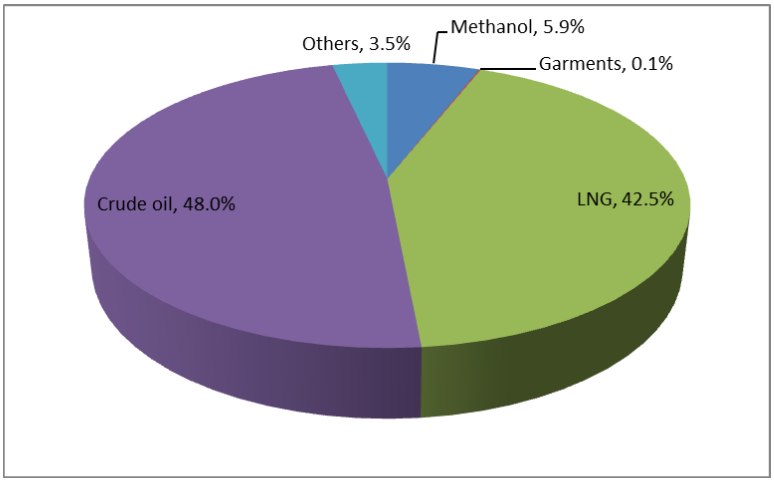

Figure 3 Percentage of total export revenues of Brunei
Source: JPKE, 2012

According to the United Nations Human Development Index (HDI), Brunei is ranked in 33rd position out of 187 countries, which means Brunei is classified at the 'Very High Human Development' level. Since the discovery of oil in 1929, Brunei has earned much wealth from its production and has become able to develop the country. In 1963, Brunei could afford to pay off the outstanding balance of her loan from the Federated Malay States. The surplus of the revenue was invested locally and abroad and used in the development of projects for improving communication and setting up law and order (Asia Trade Hub, 2011). Bruneians enjoy a high standard of living that is supported by a comprehensive welfare system that provides free education and medical care and highly subsidized housing, transport, petrol and food (e.g. rice is 50 per cent subsidized by the Government) (Jeffreys, 2011). In addition, there is no personal income tax and the inflation rate that is measured by the Consumer Price Index (CPI) is low, at 1.3 per cent per year in the period of 2007 to 2011 (Jeffreys, 2011).

With respect to the regional economic engagement of Brunei with other countries, the country has formed good economic relations with others, especially with members of the ASEAN and other Asian countries. Since in 1972, Brunei became the first country in Asia to establish trade links with Japan in order to supply LNG, Brunei has played a significant role in exporting and importing to and from Japan and other countries in East Asia (Saiful, 2011). Brunei also exports oil and gas to countries like Indonesia, South Korea, and Australia (JPKE, 2012). In addition, the country imports other goods from other countries; the main import commodities of Brunei are machinery, transport equipment and factory goods (JPKE, 2012). FDI into the country has improved recently rising by 30.8 per cent between 2007 and 2011 (JPKE, 2012). This is a good sign of Brunei's success in its effort to improve the ease of doing business in the country.

1.2. Brunei: developed or developing?

Brunei is very unique as it is not clear that the country is neither a developed nor a developing state. By definition, a developed country means a country that has highly developed economy as well as technological infrastructure that is advanced compared to other less developed countries (Differencebetween.info, 2014). Meanwhile, a developing nation is a country that has a lower standard of living and has underdeveloped industrial base, with low HDI in comparison with other countries (Differencebetween.info, 2014). As mentioned earlier, Brunei has a high GDP and ranked at the 33rd position out of 187 countries in the HDI, high standard of living, highly subsidized housing, transport, petrol and food, no personal income tax and the inflation rate by CPI is low. All of these seem to indicate that Brunei is a developed country. Moreover, Brunei satisfies 11 out of 19 generalized characteristics of developed countries e.g. good housing conditions, safe water supplies, and good health care (Differencebetween.info, 2014).

In addition, for the generalized characteristics of developing countries, only two out of 19 of the characteristics match Brunei i.e. still in the process of industrialization, and limited technological capacity. This again indicates that Brunei can be categorized as a developed country. However, having said these, Brunei is still left behind with the advancement of technological innovations and the government is still mostly based on the top-down approach. With that, Brunei cannot be labelled as fully developed because of the lack of the qualities mentioned above. Therefore, Brunei can be said as in between 'developed' and 'developing'.

1.3. Economic diversification away from oil and gas

The wealth from oil and gas has enabled the country to enjoy a high standard of living through free education and healthcare as well as highly subsidized staple food and petrol, etc. However, being solely dependent on the production of oil and gas may not secure the growth of the economy in the long term as there are some implications from being highly dependent on one source of economy. Not only oil and gas a non-renewable resources within a human planning horizon, but also the ease of extracting them will decrease as fields age (Lawrey, 2010). Secondary and tertiary methods such as injecting water and carbon dioxide are required in order to extract the resources and will incur extra cost. When the production cost is more than the market price of the resources, extraction becomes uneconomic and the reserves will have no economic value unless the market price increases in order to cover the extraction cost or new technologies are developed which increase the ease of extracting the resources. In Brunei, 'snake wells' are used in order to extract difficult-to-get pockets of oil through horizontal drilling (Lawrey, 2010). This method is expensive and even if, over time, this method continues to extract hydrocarbon resources, Brunei urgently needs to find other economic activities in order to generate economic growth (Lawrey, 2010).

In addition, over-dependence on hydrocarbon resources makes the economy vulnerable to the volatility of oil prices. Brunei's share of oil and gas within world markets is not that significant and the price of hydrocarbons is determined by the Organization of Petroleum Exporting Countries (OPEC) in which Brunei is a member (JPKE, 1993). For example, in 2002, the price of oil fell from US$24.36 per barrel to US$94.45 in 2008 (OPEC, 2014). However, in 2009, the price went down to US$61.06 per barrel and in 2014 the price increased to US$104.62. If the economy of Brunei were diversified, the impact from the fluctuation of hydrocarbon prices would not heavily affect changes in GDP and hence the revenue of the Government. Furthermore, revenues from oil and gas in Brunei are also determined by the performance of the US dollar, because the price is based on that currency. This means that if there is a drop in the value of the US dollar, this will have a negative impact on the oil price and hence the revenue of the country.

Apart from that, the potential longer term reduction of oil and gas production to reduce the global amount of GHGs as a source of global warming may also affect the revenues of the country. For instance, the production of crude oil was 240,000 barrels per day in 1980 but the amount was decreased to 168,000 in 1985 and then further reduced to about 150,000 in 1990 (JPKE, 1993). Even though the production of crude oil subsequently increased in 1991, 1994 and 1995, the increase was not substantial, only 162,000, 179,000 and 175,000 barrel per day respectively (JPKE, 1996). Now, Brunei is producing about 174,000 barrels per day (JPKE, 2012). Lastly, overreliance on one source of economy creates limited direct employment opportunities for the population, especially in the hydrocarbon industry, which is capital-intensive (Lawrey, 2010).

Based upon the above reasons, Brunei urgently needs to diversify its economy away from being over-dependent on the production of oil and gas alone. Since the third series of five-year NDP in 1975, economic diversification away from the production of oil and gas has been a major goal for the country (JPKE, 1993). However, it was only in the 1990s that the effort to diversify Brunei's economy was strongly expressed through policy (Baskharan, 2010). Various niches were identified in the NDP, such as food processing in the agricultural sector in order to reduce the country's reliance on imported food, production of cement, manufacturing of textiles and garments, as well as service industries such as eco-tourism (Baskharan, 2010). However, Brunei has still not succeeded in making any significant progress towards diversification. The composition of GDP and FDI over the last decade is still dominated by the oil and gas sector, which indicates a lack of progress in the diversification of the economy.

Due to realization of this fact, the Brunei Economic Development Board (BEDB) was formed in November 2001, its aim being to stimulate the expansion and development of the economy of Brunei by promoting the country to become an investment destination as well as facilitating diversification projects (BEDB, 2012). BEDB promotes FDI in several areas in export-oriented manufacturing and services as well as collaboration in research in Brunei (BEDB slide presentation, 2012). It has identified several key industrial groups in the export-oriented manufacturing sector as well as some service sectors that have the potential to create value added activities in Brunei along with spin-off opportunities. One of the industrial clusters includes manufacturing of pharmaceuticals and food ingredients as well as petrochemicals, refining and renewable energy. Services like Information and Communication Technology (ICT) and supporting industries such as logistics and oil field support services are also included, as well as emerging new technologies in the industrial clusters (BEDB, 2012). Figure 4 shows the current and future development of industrial clusters in Brunei as planned by BEDB and one of them is the production of petrochemical in Sungai Liang at the Belait district.

Figure 4 Map of the current and future industrial clusters as developed and proposed by BEDB
Source: BEDB, 2012

1.4. Economic diversification and sustainable development

As mentioned earlier that Brunei is moving towards the diversification of its economy away from an overdependence on the oil and gas industry and is now putting much effort into developing additional industrial activities, the country is also committed to developing sustainably without putting pressure on the environment and without harming the population at the same time. For Brunei, the overall objective of its economic diversification policy is to achieve a steady balance between economic growth and stability, employment creation, equity, as well as risk management, while still maintaining Brunei's unique religious and cultural traditions (Baskharan, 2007) as well as its natural environment. In order to achieve this, the concept of sustainable development has become a goal for the national development strategy. This is in line with the response to the United Nations Agenda 21 in 1992, whereby a National Environmental Strategy for Brunei was designed with the following main objectives:

- Natural resources should be sustainably utilised;
- Negative impacts towards the environment as a result from population growth and settlement should be minimised; and
- Socio-economic development and environmental quality should be balanced.

(Jurutera Tempatan, et al., 2008)

This effort to develop sustainably is also stated in the National Development Plan (NDP) of Brunei which states that while trying to diversify the economy, environmental protection and the welfare of the people will not be neglected. For example, in the fifth NDP, it was stated that in the country's effort towards industrialization, much effort would be carried out in protecting and maintaining the quality of the environment (JPKE, 1993). Since then, in every NDP, environmental management and awareness issues as well as the concept of sustainable development have been mentioned and the attention devoted to these issues has increasingly become more comprehensive. For instance, in the fifth NDP, it was just stated that the country should make an effort to protect the environment with respect towards the industrialization effort (JPKE, 1993) but in the eighth NDP, there was a list of things-to-do in protecting the land, air and water of Brunei (JPKE, 2001). This shows that there is an increasing effort to balance the development between the economy and the environment.

The concept of sustainable development was also included in the Brunei's National Land Use Master Plan for 2006-2025 of Brunei where it is stated that "[n]ational growth and development shall be based upon principles of sustainability" (Jurutera Tempatan, et al., 2008, p. 4-11). In that report, it is also stated that there are four guiding principles for achieving sustainable development in Brunei that are outlined in the National Land Use Master Plan (2006-2025) prepared by Jurutera Tempatan, et al. (2008). These guiding principles include:

- Integration of both short and long term economic, social, environmental and equity considerations;
- Development of a strong and growing, as well as diversified, economy which at the same time still enhances capacity for the protection of the environment;
- Recognition of the need to maintain, as well as improve, competitiveness in an environmentally friendly manner; and
- Acknowledgement of the spatial dimension of environmental effects beyond the contexts of local, district as well as national.

In order to achieve the sustainability of development, guided by the principles above, there are seven important strategies. The main strategies are:

- Protection of environmental and natural resources;
- Management of future growth and settlement;
- Facilitation of economic development and employment opportunities;
- Enhancement of communities' amenities and identity;
- Land use efficiency improvement;
- Provision of infrastructures and services; and
- Integration of land use, transport as well as economic activities.

(Jurutera Tempatan, et al., 2008)

In addition, the implementation of an Environmental Impact Assessment (EIA) before the commencement of any development project was also made obligatory from 2010 and this indicates the effort of the Government to pursue the concept of sustainable development. Recently, in the Brunei Vision 2035, environmental strategies are also put forward as essential for realizing the country's aim to become a nation that will be known around the world for its population's high quality of education and skills, as a high standard of living and an economy that is dynamic and sustainable (JPKE, 2012). In the environmental strategies of the vision, the hope is expressed that all industries in Brunei will be following International Standards (ISOs) in the future and environmental regulations will be enforced in order to protect the environment, which has an impact upon the health and safety of the population (JPKE, 2012).

1.5. Sungai Liang Industrial Park (SPARK) – case study

Given the fact that Brunei is now trying to diversify its economy intensively, while still maintaining the environment as well as the health and safety of the population, this research aims to investigate whether the economic diversification efforts in Brunei can be developed sustainably so that not only could Brunei develop the economy through economic diversification, but the country will also be able to protect the environment and to maintain the social welfare of the population. One of the economic diversification efforts is to develop the petrochemical industry in Brunei at a location known as Sungai Liang Industrial Park (SPARK). This project is used as a case study for this research, i.e. to investigate whether Brunei can develop its industrial development sustainably or the opposite. The Brunei Economic Development Board (BEDB) is the authority which is responsible for initiating this project, which proposes the use of country's gas resources to establish downstream industries upon a 271 hectares site in Sungai Liang in Belait District of Brunei. The project is massive in scale and will attract Foreign Direct Investment (FDI) into the country and is planned to eventually benefit the socio-economic development of the country. This section will describe SPARK as the site-specific area and the current sole tenant only present at the industrial park, Brunei Methanol Company for methanol production.

1.5.1. The SPARK project

SPARK was established on the 6th April 2007 by His Majesty Sultan (King) of Brunei and it is now administered by the Sungai Liang Authority (SLA) which is a semi-government body. SLA is committed to develop SPARK into an internationally competitive petrochemical hub, with high end facilities and also streamlined administrative system (BEDB, 2012). One of the objectives of SPARK is to provide a Single Point Access for facilities, amenities as well as services for business activities of the local and international investors. In addition, it acts as a liaison point for businesses by creating opportunities and facilitating, as well as supporting, investments of local and international businesses. It is constantly improving the quality of staff and infrastructure so as to enhance its sustainability and efficiency.

1.5.2. The Site and the surroundings

SPARK is located right next to the BLNG plant and Total gas filtration plant in Sungai Liang in the Belait District. The site is basically flat, ranging from about 2.3 metres above the Brunei State Datum (BSD) near the front of the sea to about +3.5 m BSD along the southern edge (SPARK EIS, 2001). Part of the site is covered with forest land and some is scrub land, while the eastern part is a formerly swampy area that has now been filled with sand (SPARK EIS, 2001). The Sungai Liang River runs through the Sungai Liang village along the east of the site and it exits at the northern side of the village into the sea (SPARK EIS, 2001). There are a number of drainage channels that cross the site from south and north and exit into the river and there are also channel extending east to west (SPARK EIS, 2001).

To the north edge of SPARK are residential properties (both wooden and concrete types of house) and vacant land which spreads out along Jalan Sungai Liang Kecil (Sungai Liang Kecil Street) from the coastal road through the east of the Sungai Liang Village. The vacant land consists of a thick belt of trees along the sea front. The eastern part of

SPARK consists of the village area of Sungai Liang, which has a primary school, clinic, surau (prayer room), post office, police and ambulance stations as well as a recreational area. Figure 5 shows the SPARK site before the project was developed and Figure 6 shows the public facilities surrounding the industrial park.

Figure 5 SPARK site at Sungai Liang, Belait
Source: BEDB, 2010b

Figure 6 Public amenities found surrounding SPARK
[From top left to bottom: Sungai Liang Primary School; residential houses; Sungai Liang Recreational Beach; and Sungai Liang Beach Street]
Source: Fieldwork, 2012

The industrial development comprises a methanol plant (land area of 24 hectares), ammonia and urea plant (90 hectares), methanol derivative plant (8 hectares) and land for another future downstream project for spin-off industries (20 hectares). In addition, common facilities that are found at the industrial park are the following:

- a jetty;
- power plant of a generating capacity of 200 MW;
- water treatment plant with a capacity of about 40Ml/day;
- sewage treatment plant;
- internal roads;
- drainage system; and

- landscaping and zone village (administrative office, fire station, medical unit, canteen, and prayer room).

Figure 7 shows the current and proposed development of industries at SPARK. As can be seen from both figures 5 and 6, and also from Figure 7, the methanol plant which is currently operated by BMC is located at the western end of SPARK while an ammonia/urea plant is proposed to be located in the eastern part. Future downstream projects and the methanol derivatives project will be located between the methanol plant and the ammonia/urea project.

In addition, there is also a Zone Village which comprises the administration zone called the SPARK Centre and a multi-purpose hall (for weddings and other functions). The SPARK Centre offers the tenants of SPARK and the public various amenities and services such as a discovery center, mini theatre, exhibition hall, conference and meeting rooms, offices, canteens, retail outlets, large event and sports hall as well as indoor badminton courts (SLA slide presentation, 2012). Apart from that, infrastructure such as single and dual carriageway roads, ancillary works [i.e. Close Circuit Television (CCTV) and Radio Frequency Identification (RFID)], street lighting, wastewater treatment plant of 40Ml/day capacity, surface water drainage, connections to utilities, fire department with industrial and hazardous material firefighting and Hazmat equipment, a canteen and surau can also be found at SPARK.

In the near future, a common jetty, water treatment facilities and a power plant will be built in order to meet the needs of the tenants at SPARK and to manage the development sustainably. The purpose of the jetty is to serve both the ammonia and urea plant as well as another potential industry to the east. The power plant will be located at the southwest of the site. Figure 8 shows some of the facilities and infrastructures found at SPARK.

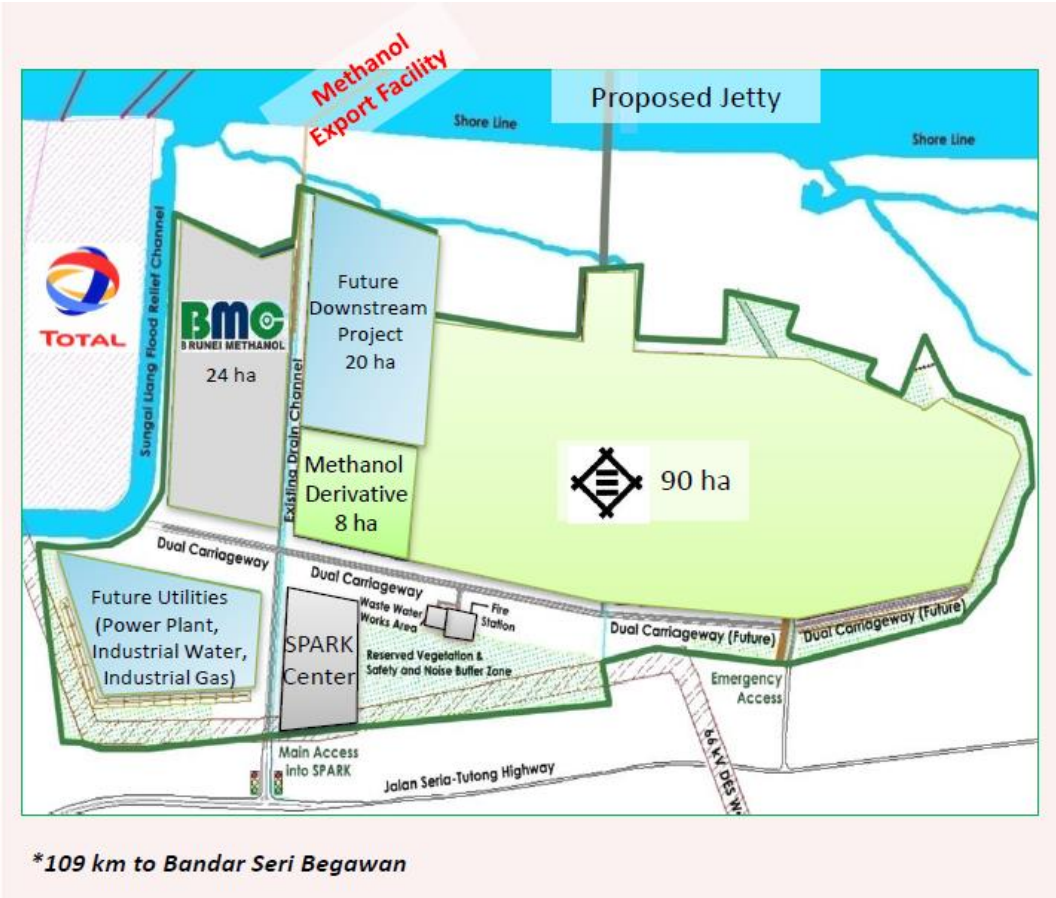

Figure 7 Proposed industrial development at SPARK
Source: SLA slide presentation, 2012

Figure 8 Facilities and infrastructures at SPARK
[From top left to bottom: SPARK Centre; Multipurpose Hall, cable connectors (1); cable connectors (2); and SPARK Fire Department
Source: Fieldwork, 2012

1.5.3. Methanol Production

As mentioned earlier, to date only the methanol plant at a cost of about US$450 million has been built; it began its operation in April 2010. The plant was developed by the BMC, a joint venture between PB and two leading Japanese companies (Mitsubishi Gas

Chemical and Itochu) (BEDB, 2010a). The methanol plant has a Single Mooring System which transports methanol to offshore tankers; it has been in operation since May 2010 (BEDB, 2010). It has a capacity of 2,500 metric tonnes of Federal Grade AA Methanol per day (a key chemical and petrochemical industry product in the acetic acid (solvents), MTBE (octane enhancer), formaldehyde (resins, adhesives) production) (BMC, 2010). Annually, the plant is targeted to produce at least 850,000 metric tonnes of methanol for export. The synthesis and production of methanol in this plant is undertaken by the Mitsubishi Methanol Process technology which is licensed and jointly owned by Mitsubishi Gas Chemical Company, Inc. and Mitsubishi Heavy Industries, Ltd. The methanol produced is planned for export to markets in North East Asia, South East Asia, as well as to more distant markets in India and the United States. With the aim of facilitation of export of methanol, the BEDB is providing the Methanol Export Facilities (MEF), which is expected to stand for a period of 22 years, under a commercial Lease Agreement. Figure 9 shows the methanol plant which is currently operated at the SPARK site and Figure 10 shows how the methanol product is directed to an offshore tanker.

Figure 9 Methanol plants at SPARK
Source: BEDB, 2010a

Figure 10 Methanol product is directed to an offshore tanker
Source: BEDB, 2010a

1.6. Research questions

This research therefore, attempts to answer research questions on the issues present in the development of the petrochemical industry in Brunei Darussalam. The main research questions are as below:

Q1: Will there be likely more socio-economic benefits or drawbacks from SPARK that will eventually determine the sustainability of the industrial development?

Q2: Will there be an issue of coastal resources' conflicts between the SPARK project and other stakeholders at and around the SPARK area that may affect the priorities and well-being of the stakeholders?

Q3: Will there be likely that the impacts created from the project affect the environment and may challenge the effort of Brunei to protect the environment and to develop sustainably?

Q4: Are the monitoring and enforcement of environmental policies and regulations (if any) at SPARK effective in maintaining the sustainability of the industry?

1.7. Aims and objectives of the study

The aims of the study are to investigate the issues involved in developing the Sungai Liang Industrial Park (SPARK) and to find out whether this economic diversification effort made by Brunei can be developed economically, while making sure that the environment is protected and that the health and safety of the population is still prioritized. The basis on which the development is sustainable or the opposite is looked at the impacts towards the socio-economy and environment from such development i.e. if there are more positive impacts from the development on the society, economy and environment, it can be concluded that the development can be carried out sustainably and if the opposite scenario happen, the development may not be sustainable.

Given the aims of the research, therefore, the objectives of the study are:

1) To find out and discuss what are the current and likely socio-economic impacts from the development of the project;

2) To examine the public participation in the development project and to investigate whether there will be an issue of coastal resources' conflicts between the SPARK project and other stakeholders at and around the SPARK area;

3) To discuss whether the project is likely to lead to positive and/or negative impacts upon the environment; and

4) To assess the likely efficiency and effectiveness of any monitoring, mitigation of impacts and other environmental management of the project.

1.8. Expected outcome and significance of the research

At the end of the research, it is hoped that by identifying and evaluating the main impacts upon the economy, society and environment from the SPARK development, it can reach a conclusion whether the project may lead to the sustainability of industrial development in Brunei or not.

This study is important as it helps decision makers to understand the current and likely impacts on socio-economic development and the environment resulting from this industrial project and may offer guidelines for future development projects in Brunei. There is a lack of studies on industrial development and the environment in Brunei. Thus, it is hoped that this research could contribute to fill in the gap of existing knowledge about economic diversification and sustainable industrial development and it is also aims to benefit those within Brunei who are concerned about sustainable development and environmental protection and management. Moreover, in the country's effort to diversify its economy through developing the downstream industry of oil and gas and to move towards sustainable development, it is important that there is a study that relates to this matter so that the 2035 Vision of Brunei of maintaining the quality of life of the people, enhancing the growth of the economy as well as protecting the environment could be achieved.

1.9. Organisation of chapters

There are 10 chapters in this thesis. Following this introductory chapter, Chapter 2 is the literature review I and it reviews literature on the impacts created as a result of the development of the petrochemical industry as well as Foreign Direct Investment (FDI). This chapter is divided into two major sections: 1) impacts from the petrochemical industry upon the environment and the health of people living close to the industry, as well as the workers who work at the development; and 2) the positive and negative effects that FDI has on socio-economic development, as well as the environment of a host country with a particular attention upon the situation in developing countries. The literature review II in Chapter 3 reviews secondary literature on five global petrochemical companies that have practised sustainable development in their operations, as well as petrochemical associations from five different continents. Chapter 4 outlines the theoretical frameworks that will be used in the thesis. The three theoretical frameworks are 1) Sustainable Industrial Development (SID); 2) Ecological Modernization (EM); and 3) resource use conflict management in Integrated Coastal Management (ICM). The frameworks introduced in this chapter are intended to answer the overall research question, i.e. can industrial development be made sustainable by maintaining the economic development of the industry while still conserving the environment and protecting the social welfare of the society?

The research approaches and methodologies are presented in Chapter 5. These are derived from the aims and objectives of this research. The key issue for the development of the petrochemical industry in Brunei is sustainability and it is the main aim for this research to investigate the extent to which such an industry can be developed sustainably. A variety of methods of data collection as well as data analysis are described and justification for choosing those methods is also provided in this chapter. The general data sampling of the research as well as the reliability and validity of research are also addressed in this chapter. This chapter also discusses some of the ethical issues that can be found in the research and as well as, the problems encountered during the study.

Chapters 6 and 7 represent the findings from the data collected from the research with discussions of these in each chapter. Chapter 6 discusses the socio-economic issues from the development and is sub-divided into five parts. This chapter firstly discusses the awareness and opinions of local communities towards the development of SPARK and secondly it studies issues on public participation at SPARK. After that, this chapter explains the current and potential benefits that can be gained from the development of SPARK. In addition, it also discusses both the current and potential challenges for the socio-economic situation of the local communities and the country. The final part of this chapter presents an overall discussion on the socio-economic issues that are present as a result of the SPARK development. The interpretation of results and issues on the benefits and drawbacks to the environment and ecology from SPARK can be found in Chapter 7.

This chapter also discusses environmental management and monitoring, environmental impact mitigation and control, as well as environmental laws and regulations.

There are many of the issues raised in both Chapter 6 and 7 that are social, economic and environmental in nature. However, the reason on dividing the chapters into two (Socio-economic impact and environmental impact) instead of combining those chapters is to avoid to have a long chapter in the thesis. Moreover, the division of the chapters is dependent upon the research questions because there are two research questions that are answered in each chapter. The implication of this is that there is an overlapped of issues in both chapters for examples on the issues of health and safety impacts and disputes over opinions between developers and local communities. However, these issues are discussed again in Chapter 8 in this thesis which is helpful to find out the important findings from both chapters 6 and 7.

The issues that are covered in this Chapter 8 are 1) local benefits and challenges to sustainability; 2) SPARK and regional sustainability; and 3) the national context of sustainability. Chapter 9 relates the findings and discussions of the research back to the three theoretical perspectives – SD, SID, EM, and resource use conflict in ICM. Lastly, an overall summary, conclusion and evaluation of the contribution of the research to the subject of sustainability, as well as recommendations for better sustainability in the industrial development of Brunei and suggestions for further research are given in the last chapter of this thesis, Chapter 10.

CHAPTER 2 – LITERATURE REVIEW I

2.0. Introduction

This chapter reviews the literature on the impacts created as a result of the development of the petrochemical industry, as well as that of Foreign Direct Investment (FDI). The reason for reviewing this literature on the impacts of FDI is because the petrochemical industry at SPARK has been developed through FDI. This chapter is divided into two major sections. The first section discusses the impacts that the petrochemical industry has had upon the environment and the health of people living close to the industry as well as upon the workers who work at such developments. The second part of this chapter discusses the positive and negative effects that FDI can have for socio-economic development as well as its impact upon the environment of a host country, with a particular attention given to developing countries.

2.1. Impacts from petrochemical industry

Negative impacts have been identified as resulting from the development of the petrochemical industry. They are the impacts upon the physical health and psychological well-being of people, as well as those on the natural environment. This section of the chapter analyses briefly the common forms of physical health problems and the psychological issues that residents who live close to petrochemical complexes are experiencing, as well as the types of environmental pollution that the industry has caused.

2.1.1. Physical health problems of residents

As mentioned earlier, the occurrence of some physical health problems is believed to be caused by the pollutants emitted through activities involved in the petrochemical industry. For example, studies conducted in Taiwan suggest that the physical health problems experienced by the subject respondents are related to the impacts of the country's petrochemical industry. One of these studies, on the evaluation of potential hazards to air pollution exposure near industrial installations, shows an association between pre-term delivery of infants and air pollution emitted from an oil refinery (Yang, et al., 2004). Similarly, Liu, et al. (2008) discovered that people who lived in the municipalities with the highest levels of air pollutants caused as a result of petrochemical development were likely to have a higher risk of brain cancer than those living away from the industry and who experienced less air pollution. It was recorded on the death certificates of those people who died from cancer that their 'usual place of residence' was in the residential municipality most affected by pollution. Moreover, the majority of the subject respondents were aged below 19 years old, which suggests that that most of their time was spent at home and many were still living at home and studying; they were therefore unlikely to have lived in other locations, given their age and domestic situation and were also more vulnerable to pollution.

Another study in Taiwan conducted by Tsai, et al. (2008) also concluded that respondents who lived in those municipalities with a high exposure index of petrochemical air pollution have a significantly increased risk of death due to bladder cancer compared to those groups of residents living in the municipalities which had the lowest index of petrochemical air pollutants. In addition, there was also a higher chance of children developing leukaemia in those municipalities with high levels of petrochemical air pollutant than in those areas with lower levels (Yu, et al., 2006; Weng, et al., 2008).

Apart from these studies in Taiwan, there is research evidence to suggest that petrochemical industrial activities may have also affected populations living in other parts of the world. For example, according to a study carried out in Tarragona, Spain, the population who live in municipalities close to petrochemical plants may be exposed to chemicals released during the production process, as well as at the crude oil and derivatives refining stages, thus leading to increased physical health problems (Nadal, Schuhmachera and Domingo, 2004). However, according to the same study, oil refineries are also co-located in industrial areas together with other potentially polluting stationary sources, such as chemical companies, as well as mobile pollutant sources, such as, for example, heavy-duty traffic. Therefore, it is difficult to link directly the source of pollution from petrochemical industry with the specific impacts upon health in the local area. Since the 1960s, the Tarragona area has been an important area for industrial activities, which include a huge oil refinery, a chloro-alkali plant, plastics manufacture, chemical companies, a waste incinerator and a municipal waste incinerator. Approximately half a million residents live in the city and close to the industrial area and during the summer the number of inhabitants of the area may reach 750, 000, which then poses higher numbers at risk of exposure to the chemicals. In addition to that, traffic is also very dense through motorways and highways crossing the area and with this there will be more emissions of chemical pollutants to air, soil and water, which would eventually pose an even greater health risk to the local population of the area.

Finally, another study conducted in Capuava, Brazil also revealed that residents who reside in the areas surrounding the petrochemical complex have a higher occurrence and risk of developing Hashimoto's thyroiditis (HT) and anti-thyroid anti bodies (ATA) (de Freitas, et al., 2010). Based upon this study, the authors concluded that the incidence of both HT (9.3 per cent) and ATA (17.6 per cent) were higher in the petrochemical complex area than in the control area (Serraria in Diadema), which were 3.9 and 10.3 per cent respectively for HT and ATA.

2.1.2. Exposed risk of industrial workers

It is not only residents who are affected from the release of pollutants from the industry, but the workers within these petrochemical plants are even more exposed to the risk from the pollutants. For example, according to a study by Lee, et al. (2007) on 1,236 workers at a large petrochemical distillation factory in Korea, it was discovered that cumulative exposure to an organic solvent (benzene) can lead to acquired dyschromatopsia (dysfunction of the nervous system). This was validated within the research study by using the loss of colour-vision as an early marker of neutrotoxic damage. Workers at the petrochemical plants were also exposed to greater risks of industrial accidents (fires, explosions and substance release) which would also affect the health and safety of the employees.

According to a study by Nivolianitou, Konstandinidou and Michalis (2006) on the statistical analysis of major accidents in petrochemical industry notified to the Major Accident Reporting System (MARS), the main causes of industrial fires and explosions were human error (40 per cent of the cases) and equipment malfunctions (44 per cent of the cases). Even though there is an availability of knowledge needed to prevent major accidents as well as to minimise the impacts, there is a lack of safety culture for this knowledge to be effectively used and the communication system to diffuse the knowledge is also not structured and because of these factors, industrial accidents could easily occur. Similarly, in Greece between 1997 and 2003, an analysis of accidental incidence records also concluded that human error and equipment malfunctions are the main causes for industrial accidents, rather than other causal factors (Konstandinidou, et al., 2011). In Korea, also, it is also agreed that human error is the major cause of industrial accidents (Kim, et al., 2002) and it has been suggested that systematic research should be made to prevent human errors and to raise awareness on the seriousness of accidents as well as the risk management activities that should be developed in order to reduce industrial accidents in the future.

In contrast to this evidence of negative impacts that have resulted from petrochemical development upon the health and safety of the population who live close to the industry, as well as workers at the industrial plants, some studies show relatively few impacts. For example, research in Stenungsund, Sweden showed that this was not the case in this location. According to Axelsson, et al. (2010), even though there is a higher incidence of lung cancer among women in that area, upon an examination of their addresses, it was found that the majority of them had been living in the municipality for less than eight years. This research suggested that it is unlikely that the incidence of lung cancer in the area can be directly associated with the petrochemical industry. Furthermore, even though the level of liver cancer in this area was higher between the year 1994 and 2005, only two cases out of seven who had this type of cancer had lived for more than 10 years in the municipality and, due to the fact that the exposure level to vinyl chloride was low, it can be said there is no causal association that living near to the petrochemical industry may lead to an increased risk of cancer.

This may suggest that safety and environmental standards for the petrochemical industry are more sophisticated in Sweden than in Taiwan and Spain, given that there is no strong correlation between the health problems and distance from the industrial area. It seems that the health problems caused by petrochemical operation may be dependent upon the standard of management in operation. Health problems caused by petrochemical pollutants may be inevitable but with proper management such as in Health, Safety, Security and Environment (HSSE), Corporate Social Responsibility (CSR), and the adherence to environmental standards and law such negative impacts could be avoided and thus, sustainable development can be achieved.

Moreover, while the largest petrochemical industries are located in the USA and Western Europe, rapid and major growth of the development is currently occurring in the Middle East and Asia (Cefic, 2011). Because of the rapid growth of the industry in Asia, such as in Taiwan, the negative effects from the petrochemical industry can be more readily observed than in the European countries such as Sweden.

2.1.3. Psychological effects upon residents

Apart from those physical health problems that have been resulted from petrochemical industry, there are also some positive correlations between the incidence of living next to the petrochemical plants and negative psychological effects i.e. the closer people live to petrochemical sources, the more people report concern. According to Luginaah, et al.

(2002), residents who were not satisfied with the presence of oil refineries (i.e. they believed that the refinery may cause health problems and provides few benefits to the community) in the municipalities and parents whose children had symptoms or chronic health problems were more likely to experience perceived stress and odour annoyance by living close to petrochemical sources. Even though most of the relevant odour reduction measures had been implemented, residents were continuously anxious about the impacts of the oil refinery. This is because this anxiety was reinforced by some occasional past odour incidents and visual cues such as smoke emitted from the refinery stacks.

However, based on the study carried out by Cutchin, et al. (2008) on the concerns of people living in Texas before and after the explosion of oil refineries, respondents in the study perceived that physical health of the local population was better if they lived closer to the petrochemical industry (where the fence line = one kilometre from the plant). This was thought to be mostly due to the fact that most respondents had more concern about their health generally and were also younger (i.e. they were less likely to have chronic diseases and were more mobile and did not just stay at home). The study also showed a correlation between the personal background of respondents and perceived concern about their environmental health risks, both before and after accidental explosions from the local petrochemical industry. Ethnic minorities and younger adults, as well as those who were less economically sufficient, showed greater concern about their environmental health risk than other sections of the population. Also, younger, foreign-born Hispanics and non-Hispanic blacks reported more concern about their local environmental health risk than the other groups. The main reason for this was thought to be that immigrants from the less technologically developed world, such as Mexico, would have less awareness about the impact of the environment and pollution upon their health. Moreover, the reason why lower income households displayed greater awareness regarding their environmental health risk was due to the fact that they had been living near to the industry, due to the lower cost of living. Therefore, they had a greater understanding about those petrochemical facilities where the explosion took place. Similarly, according to the authors, there was also a correlation between respondents' personal backgrounds and their perceived risk about the petrochemical industry after accidents had occurred. Less educated respondents perceived risks to be at a lower level than the more educated ones. Finally, there was no strong correlation between the sex of the respondents and the perceived risk.

2.1.4. Environmental impacts

Another important impact caused by the activities of the petrochemical industry is the occurrence of environmental pollution through the medium of air, water or soil. According to a study carried out by Nadal, Schuhmachera and Domingo (2004) on the determination of the concentrations of Arsenic (As), Cadmium (Cd), Chromium (Cr), Mercury (Hg), Manganese (Mn), Lead (Pb), and Vanadium (V) in soil in various petrochemical industrial sites within Tarragona county in Spain, it was revealed that As, Cr and V are the main sources of metal pollution. Moreover, based upon a more recent study by the same authors between 2002 and 2009 in four types of area (those that had chemical industries, petrochemical industries, or were either urban/residential area or unpolluted areas), it was discovered that a substantially higher level of Polycyclic Aromatic Hydrocarbons (PAHs) and some metals were found in vegetation that had come from the petrochemical complex. Similarly, based upon the study by Bosco, Varrica and Dongarra (2005), there is also evidence for the occurrence of heavy metal pollution from the petrochemical industry. They discovered that pollution from the sector can lead to high levels of Nickel (Ni), V, As, Selenium (Se), Pb and Antimony (Sb) and, there was a correlation between presence of these and areas surrounding petrochemical plants. Furthermore, this study also indicated that there was an increased level of air pollution surrounding the area of the petrochemical industry under study and there was a concentration of some elements in pine needles that posed potential hazards for the local population.

In addition, there can also be risks of seawater contamination resulting from the disposal of waste into the seawater from the petrochemical industry. According to a study undertaken by Nafissa, Bouzern and Chettibi (2005) to assess petrochemical pollution in Skikda Bay in Algeria, it was revealed that the highest levels of concentration of different chemicals in the six sampling sites were found to be well above the tolerable values for clean and safe water. Similarly, a study by Botalova, et al. (2009) on petrochemical wastewater analysis revealed the presence of organic compounds, some of which are known to be pollutants that have risk potential towards eco-toxicological or toxicological effects.

Field studies by Wake (2005) also reveal that effluents from oil refineries often have an impact on the local fauna, especially in those areas close to the outfall, although the extent is dependent on the composition of effluent, the position of the outfall and the state of recipient environment. It was discovered that there was an absence of all or most aquatic species which indicates that the toxicity was present at the outfall and possibly at a high level. Furthermore, there is also an enrichment effect that is distinguishable as a peak in the abundance of biomass. However, as with the health problems mentioned above, it is often difficult to distinguish these effects from those of other pollution sources, as other types of pollution may also have similar kinds of impacts. Moreover, the resultant pollution may again reflect poor management rather than reflecting an inevitable consequence from the petrochemical industry.

2.2. Impacts from Foreign Direct Investment (FDI)

For the purposes of this research, there are some important effects that are important consequences of FDI for host countries, especially developing countries, such as Brunei. This section firstly outlines some of the benefits that FDI has created and then it also discusses some of the negative impacts that FDI has had on the host developing countries.

2.2.1. Benefits from FDI

One of the benefits that can be derived from FDI to the receiving host countries is the transfer of capital and skills, as well as technology. According to Bwalya (2006), multinational corporations possess assets which could benefit the host countries, including technology and managerial skills, as well as export contacts and a good reputation. All of these may potentially improve managerial knowledge and skills in the host countries, increase efficiency and productivity, and also provide a wide array of goods and services to the recipient economy. Similarly, studies by Acharyya (2009) and Muhammad, Samia and Talat (2011) also share the same opinion that some of the benefits of FDI to the host country include capital and skills, as well as technology transfer, production innovation techniques, market access and export promotion by means of training programmes, as well as the process of learning in the host country.

In addition, another benefit that FDI may generate for the host countries is the high level of employment opportunities that it may create. Based upon the study by Adiningsih, et al. (2009), it was found that respondents from the community who live in the vicinity of the factories in Banten, Indonesia perceived substantial benefits from the development of the factories as a source of employment opportunities (albeit unskilled and non-managerial in nature) for the local community. Most respondents in the research were satisfied with the presence of the industry in their area because it attracted many people to live within the vicinity of the factories. According to the study, the in-migrant employees at the factories, in general, have a higher level of skills than the local population. The increasing number of non-local factory workers have become a source of income for the local community through the provision of parking services, as well as washing and houses for rent. Similarly, according to Muhammad, Samia and Talat (2011), FDI inflows provide both skilled and unskilled labour employment opportunities in the host country and hence benefits the population in the country.

Apart from those benefits, another advantage from the inflows of FDI is the growth of GDP and any increase in the export rate that it may generate. In a study on FDI inflows into the Macedonian economy by Krstevska and Petrovska (2012), it was shown that FDI inflows was an important factor for the growth in GDP and export performance of the Macedonian economy, even though that the average FDI net inflows in the country were relatively lower when compared to some other transitional economies. However, it is interesting to note that there was a stronger positive impact on exports than the impact on the overall GDP.

2.2.2. Negative impacts from FDI

Despite the positive impacts that FDI have on the host economies, there are however, some challenges or negative impacts that FDI can have upon the host countries. According to Hanson’s (2001) study of three cases of Ford and General Motor (GM) investment in Brazil and Intel in Costa Rica, there is only weak evidence that FDI may generate positive spillovers for host countries. There also seemed to be little evidence that FDI may raise the productivity of domestic companies either at the firm or plant level. In fact, what seems to occur is that industrial plants with a larger multinational appearance tend to enjoy lower productivity growth over time. Moreover, according to Hanson’s study, subsidies given to foreign multinational corporations have actually lowered the national welfare of the case study countries, notably in the case of Brazil. Furthermore, some markets in some developing countries are underdeveloped and also have not reached a certain level of education as well as infrastructural development. Thus, they will be unable to benefit from the effects of FDI on their economic growth. Conversely, in East Asia, developing countries have used FDI to formulate and implement national as well as technological development policies and they have been successful in their efforts (Herman, Chisholm and Leavell, 2004).

In addition, the lack of laws, regulations, as well as policies, in many developing countries, has meant that some foreign transnational companies have been profligate with resource use and may carry out their production in an unsustainable manner (Herman, Chisholm and Leavell, 2004). A study carried out on the relationship between the scale of FDI and local air pollution in China by Liang (2006) also notes that as an increasing amount of manufacturing production is going to the developing countries, there is a concern about the environmental consequences that FDI may generate. This is because the environmental policies in some of the host developing countries are lenient, which may give multinational companies a comparative advantage in pollution intensive goods, while openness to trade and FDI might harm the environment of the host country. Another study by Muhammad, Samia and Talat (2011) also agrees that with the relaxation or non-enforcement of regulation in order to attract foreign investment, developing countries have a tendency to disregard environmental concerns which is termed as the ‘pollution haven hypothesis’. Consequently, multinational companies usually like to shift their operations to these developing countries in order to take advantage of lower production costs which is termed as the ‘industrial flight hypothesis’. Both of these hypotheses may eventually lead to environmental pollution and degradation in the host countries.

2.3. Summary

The first section of this chapter has briefly analysed some studies that have been conducted on the impacts on the health and safety of people and the environment that are likely to have potential links with the petrochemical industry. Some physical health problems and negative psychological effects that are mentioned above have impacted the people who live close to the petrochemical sources, as well as those workers who work at the petrochemical industry. Similarly, the development of the petrochemical industry is also causing some pollution to the environment. However, it is hard to identify direct cause and effect from the studies reviewed. This is due to the fact that other possible factors such as other stationary (e.g. oil refineries) and mobile (e.g. heavy road traffic) pollutant sources may have also caused the occurrence of those physical health problems, negative psychological effects and environmental pollution. Another possible factor that may have caused the negative impacts is the poor management of the petrochemical industry; for example such impacts maybe a result of industrial accidents in the industry as a result of human error.

CHAPTER 3 - LITERATURE REVIEW II

3.0. Introduction

There are three sections in this chapter. This chapter firstly reviews efforts by five leading global petrochemical companies to address sustainable development within their own operations. It also reviews initiatives carried out by petrochemical associations from five different continents to encourage and incorporate sustainability. In addition, this chapter also provides some critical comments on the sustainability of petrochemical companies in their operations. The aim of this chapter is to gain a greater understanding of the attempts that have been made by the sector to address the challenges of incorporating sustainability aims into their operations. However, it could also be argued that there are also some challenges for a carbon-based sector to achieve any form of sustainability and this is shown in the third section of this chapter even though those companies have increasingly had to respond to the global environmental policy agenda.

3.1. Sustainable development in five global petrochemical companies

This section analyses the efforts of five large global petrochemical companies to develop their petrochemical industry in a more sustainable way. One petrochemical company was chosen from each continent, in order to generate a broader analysis about the efforts that have been made to develop the industry sustainably. Each company was chosen based upon the levels of chemical sales and profits that the company gained in 2012. Table 1 shows the top ten petrochemical industries in 2012 based on the chemical sales. The full list of the top global petrochemical companies based on the chemical sales and profits can be obtained at http://pubs.acs.org/subscribe/cen/datatables/globaltop50.html

Table 1 Top ten petrochemical companies based from chemical sales in 2012

RANK (2012) Petrochemical Industry	COMPANY	HEADQUARTER	CHEMICAL SALES (USD millions)
1	Sinopec	China	56,442
2	Shell	Netherlands	42,715
3	SABIC	Saudi Arabia	42,201
4	ExxonMobil	United States	38,726
5	Formosa Plastics	Taiwan	36,412
6	Lyondell Basell Industries	Netherlands	32,847
7	Braskem	Brazil	18,179
8	Reliance Industries	India	17,646
9	Lotte Chemical	South Korea	14,121
10	Chevron Phillips	United States	13,307

Source : ACS Publications, 2014

The five petrochemical companies that are used in this literature review are Braskem (Brazil, South America); Shell (the Netherlands, Europe); SABIC (Saudi Arabia, Middle-East); Exxon Mobil (North America); and Sinopec (China, Asia).

3.1.1. Brief background of the petrochemical companies

BRASKEM is a petrochemical company that was founded in Brazil. The main headquarters of the company is located in Sao Paolo, Brazil and its industrial units can also be found in the United States, as well as Germany (Braskem, 2014j). The business strategy of Braskem is stated by the company as being to provide a highly qualified service to clients all around the world in terms on the premise of responsible, as well as active, operations in line with sustainable development (Braskem, 2014j). The Shell

Company is headquartered in the Netherlands and has experience of over 80 years in the chemical industry, with more than 18 million tonnes of high quality chemical products sold in 2012 to over 1,000 customers and the company earned about $1.4 billion in the same year (Braskem, 2014d). SABIC stands for the Saudi Basic Industries Corporation. It is one of the world's leading manufacturers of metals, chemicals and plastics, as well as fertilisers (SABIC, 2014c). SABIC was created in 1976 when there was a marked move to add value to oil for exports such as in processing into chemicals and polymers, as well as fertilisers in order to help Saudi Arabia diversify its economy away from an overreliance on oil (SABIC, 2014c).

ExxonMobil Chemical is a petrochemical company that is based in the United States. It is one of the largest petrochemical companies in the world that uses proprietary technology in order to create products that the company claims could improve the quality of people's life around the world (ExxonMobil Chemical, 2014c). It has a global network of manufacturing facilities and technology centres, as well as other businesses, which has enabled it to become the leader in some of the highest growth and largest volume petrochemical markets (ExxonMobil Chemical, 2014c). The mission of ExxonMobil Chemical is to provide petrochemical products and services in the most efficient, as well as responsible manner, in order to create outstanding customer, as well as shareholder, value while at the same time being committed to develop sustainably (ExxonMobil Chemical, 2014k). Finally, China Petrochemical Corporation (Sinopec Group) is another mega-petroleum and petrochemical enterprise group that was established in 1998 from the former China Petrochemical Corporation (Sinopec, 2013a). It is headquartered in Beijing, China and has a registered capital of about RMB 182 billion (Sinopec, 2013a).

3.1.2. Commitment towards sustainable industrial development

In their corporate statements all five companies agree that in order to meet the world's need and at the same time address sustainability challenges, it is important to balance economic growth, social development as well as environmental protection. In addressing this, the five companies have put emphasis on their commitment towards reaching that goal. This can be seen through their efforts to protect and manage the environment such as their obligation to prioritise the Health, Safety, Security and Environment (HSSE) components of their operations, as well as their efforts to adopt environmental innovation in their technologies. The efficient use of resources and energy in their operations, as well as adherence to the relevant environmental regulations and laws in order to reduce and avoid negative impacts upon the environment and people are also practised in the petrochemical firms. In addition, in order to improve the social welfare of the people, philanthropic activities through the Corporate Social Responsibility (CSR) are also carried out by those petrochemical companies.

For example, in supporting the effort of the United Nations Commission on Sustainable Development (UNCSD), Braskem claims to be strengthening the role of private enterprise within the economy in the pursuit of sustainable development (Braskem, 2014k). Braskem also participated in Rio+20 which is the second most important sustainable development event organised by the United Nations (UN) after the Earth Summit in 1992 in Rio de Janeiro, Brazil (Braskem, 2014j). During the event, 50, 000 eco bags and another 50, 000 squeeze bottles were made available to participants, both of which were produced from Braskem's polyethylene, which is derived from the renewable raw material, sugarcane ethanol (Braskem, 2014j).

Braskem has set seven major objectives that link its development with sustainability (Braskem, 2014e). They are, 1) becoming a benchmark for Chemistry Safety; 2) minimising Greenhouse Gas (GHG) emissions; 3) increasing energy efficiency; 4) increasing efficiency in the usage of water; 5) being the largest producer of thermoplastic resins that are made from renewable sources; 6) reducing the effects of post-consumption of plastic waste; and 7) being recognised as a significant agent of human development (Braskem, 2014e).

Similarly, Shell is also integrating the principles of sustainable development into its business activities (Shell, 2014d). Shell is committed to develop economically while at the same time trying to 1) pursue the goal not to harm people; 2) protect the environment, 3) efficiently use resources and energy for their products and services; 4) publicly report the performance of the company; 5) promote best practice in their industries; 6) manage HSSE and Social Performance (SP) matters; and 7) promote a culture where all employees at Shell share this commitment (Shell, 2014d).

ExxonMobil Chemical also focuses on sustainable solutions in its business activities. This includes, 1) focusing on delivering operational excellence – production and efficiency is increased while at the same time still preserving product quality excellence; 2) building technology leadership – leading to new product development and improving existing products via technological innovation; 3) integration of resources and opportunities – integrating chemical capacity with their refining and natural gas operations; and 4) investing with intelligence and discipline – identifying long-term trends in the market fluctuations that will shape the petrochemical industry (ExxonMobil Chemical, 2014c).

In addition, for ExxonMobil Chemical, its sustainability philosophy can be outlined in five major areas. They are; 1) environmental – improving energy efficiency and minimising pollutant emissions; 2) management systems – putting serious commitment into their HSSE; 3) product safety and stewardship – carrying out product safety tests and evaluations for safety purposes; 4) a science-based approach – subscribing to environmentally conscious lifecycle methods for product testing; and 5) technology – focusing on efficient manufacturing processes that have lower negative impact on the environment and on technological innovation to support product development with environmentally preferred characteristics (ExxonMobil Chemical, 2014i).

3.1.3. Health, Safety, Security and Environment (HSSE)

In order to maintain a high productivity standard and guarantee the quality of the operations and products, it is important that the petrochemical companies have a strong commitment to the HSSE issues. This is also to ensure the protection of the workers in their petrochemical plants as well as the public (especially those who live in the vicinity of the industrial plants) and also for the protection of the natural environment. Analysis of corporate literature reveals that this is a key issue for all five petrochemical companies examined here.

For example, Shell is committed to put safety in first place in their business operation. As part of a good business practice, Shell is putting a strong HSSE performance in place and focuses on learning from past incidents and developing a much stronger safety culture with contractors as well as customers (Shell, 2014d). Sinopec is also continuously improving its HSSE, which covers the entire production process as well as operators from the top to bottom (Sinopec, 2013b). Some of the types of the HSSE initiatives that are used by most of the five companies are 1) Responsible Care (RC) programmes; 2) Registration, Evaluation and Authorisation of Chemicals (REACH); 3) Operations Integrity Management System (OIMS); 4) intrinsic safety; and 5) emergency response plans.

a) Responsible Care (RC) programmes

The Responsible Care (RC) programme is "the chemical industry's unique global initiative that drives continuous improvement in Health, Safety and Environmental (HSE) performance, together with open and transparent communication with stakeholders" (http://www.icca-chem.org/en/Home/Responsible-care/). It embraces the development, as well as application, of sustainable chemistry in order to develop sustainably while still allowing companies to meet the increasing need for essential chemicals as well as the products those chemicals make [International Council of Chemical Associations (ICCA), 2014a]. The main aim of RC is to improve the environmental management of the chemical companies and their supply chain and among the items that are being observed are 1) the safety of industrial units; 2) chemical processes and products; 3) the protection of health of workers and the environment (ICCA, 2014a). Through the RC programme, the duties of the chemical industries sector is to report and track their progress on critical elements of product stewardship and then to make further improvements to their current processes in the chemical industry (ICCA, 2014a).

In Braskem, each of the individuals in that company has a responsibility for the HSSE of the company through the RC programme (Braskem, 2014k). It is the corporate management leaders' responsibility to make sure that their members take care of that responsibility through providing an example and through educational activities (Braskem, 2014k). They are also encouraging people to achieve and surpass the company's objectives and highlighting the importance of the HSSE when considering any decisions that will be taken by the company (Braskem, 2014k). For Braskem, it is vital that the HSSE must be exercised starting from the extraction of natural resources until the disposal of the petrochemical products and that the prevention of risks as well as mitigation plans are also implemented appropriately (Braskem, 2014k).

Similarly, other petrochemical companies such as ExxonMobil have also emphasised the RC programme in the operation of the company. Under the RC, it is the CEO-level commitments to uphold the programme elements of 1) measuring and sharing the reporting performance with the public; 2) implementing the RC security code; 3) putting on the modern management system of RC to achieve and verify results; and 4) getting third party certification that a management system is in place and functions in line with professional standards (ExxonMobil Chemical, 2014i). After nearly 20 years of dedication towards the adherence to the guiding principles and codes of the RC's management practices, ExxonMobil Chemical argues that it has become a leader in RC (ExxonMobil Chemical, 2014i).

In addition, as part of a good business practice in terms of improving the HSSE performance, in late 2009, the Shell Executive Committee approved revisions to the first HSSE commitment and policy adopted in 1997 (Shell, 2014d). The Shell Group is also committed towards implementing the RC programme, whereby in February, 2006, the RC Global Charter was signed (Shell, 2014d). It was recognised by the United Nations

Environment Programme (UNEP) as making an important contribution to sustainable development at the World Summit on sustainable development in 2002 (Shell, 2014d). By implementing the RC charter, the company will continue to improve its HSSE performance and be able to facilitate the appropriate extension of RC across the value chain of business as well as to address the expectations of the stakeholders in continuing the development of the RC (Shell, 2014d). The safety of all chemical products is checked and the assessment of any potential harmful effects on people as well as property and the environment is also carried out (Shell, 2014d). There are four main steps that are followed to assess the chemical products (Shell, 2014d). They are 1) identify – information of the potential hazards and uses about any product is recorded; 2) assess – the potential health and safety risks of any product is assessed; 3) control – procedures to address any risks are implemented; and 4) review – the three steps are repeated regularly, or when new information becomes available (Shell, 2014d).

b) Operations Integrity Management System (OIMS)

Operations Integrity Management System (OIMS) is another type of HSSE programme that is designed with the intention of creating an incident-free workplace. It is the internal safety, security, health and environmental framework that is used worldwide in order to measure the progress and accountability in the operation of the chemical industry (ExxonMobil Chemical, 2014j). For example, as part of its HSSE programme, ExxonMobil is committed to carrying out OIMS for the safety of the workers and other people as well as for a safe environment since 1992 (ExxonMobil Chemical, 2014j; ExxonMobil Chemical, 2014f).

OIMS is guided by an in-depth understanding of the environmental effects of the company's operations along with the social and economic needs of the public communities in which they operate (ExxonMobil Chemical, 2014j). It is a framework that is used to manage safety, security, health and environmental risks (ExxonMobil Chemical, 2014f). It enables the measurement of progress as well as ensuring management accountability for results together with establishing worldwide standard expectations for controlling integrity risks of the company's operations (ExxonMobil Chemical, 2014f). It is believed by the company that there is a genuine working relationship based on mutual trust as well as respect for the communities who are involved in the industry (ExxonMobil Chemical, 2014j).

In addition, engagement with the communities that are involved in the industrial operations is also carried out, such as conducting social and environmental impact assessments for new projects (ExxonMobil Chemical, 2014f). In OIMS, emissions reduction and the development of more efficient processes that save energy are being focused upon and this is believed to be achieved by adopting appropriate technologies (ExxonMobil Chemical, 2014j). This will be explained in further detail in a later section of this chapter (***section 3.1.5.***).

c) Registration, Evaluation and Authorisation of Chemicals (REACH)

Registration, Evaluation and Authorisation of Chemicals (REACH) is the European Union regulation that requires companies to provide detailed information regarding chemicals (ExxonMobil Europe, 2014). Since 2006, ExxonMobil has been committed to complying with REACH (ExxonMobil Europe, 2014). According to the legislation, chemical companies must provide information about the properties and risks of the chemical products and must register that data with a central agency (ExxonMobil Europe, 2014). The responsibility for ensuring the safety of the chemicals rests with the manufacturers as well as importers of the chemicals (ExxonMobil Europe, 2014). The main aim of REACH is to provide a higher protection level for humans and the environment by ensuring the availability of appropriate information on the handling, storage, chemical composition as well as risk management measures (ExxonMobil Europe, 2014). Following the introduction of REACH into force on the 1st June 2007, ExxonMobil successfully registered about 200 substances before the 1st December 2010 deadline (ExxonMobil Europe, 2014).

d) Intrinsic safety – "I Safe", on-site safety management, potential hazard control

The intrinsic safety programme is an enormous effort established by the Chinese giant petrochemical company Sinopec that is used to enhance safety awareness among staff, site safety management as well as potential hazard control (Sinopec, 2013b). "I Safe" is a campaign whereby Sinopec compiled a collection of good examples that every employee should follow and by doing this, employees' awareness has been enhanced and their sense of responsibility is improved (Sinopec, 2013b). In 2011, the number of reported accidents and deaths fell by 38.9 per cent and 57.1 per cent respectively compared to 2008 (Sinopec, 2013b).

In the on-site safety management plan, Sinopec has developed and carries out a ban on irregular behaviour in production by following strict regulations on operation licences and safety checking, as well taking solid measures to prevent industrial accidents occurring (Sinopec, 2013b). In 2011, supervision of key facilities and locations at times of special periods and operations were strengthened and as well as that, the "Seven Remembers and Seven Don'ts" were also implemented for site operations (Sinopec, 2013b).

For potential hazard control, the '4W' management is applied, i.e. *what* should be done for safety management improvement, *where* will the funds come from, *who* will be in charge and finally *when* will the project be completed (Sinopec, 2013b). In 2011, the focus of the control was placed on the "control devices, liquid hydrocarbon spheres, instruments, emergency response system, tank depot fire-fighting system, thermal oil pump sealing, loading of light oil and chemical products, and long-distance pipelines" (http://english.sinopec.com/environment_society/greenoperation/). In 2011, Sinopec invested about RMB 425 million in 125 potential projects to control hazards (Sinopec, 2013c). Some of those major projects include "controlling oily sand, waste water in oil and gas production, aquifer pollution, biochemical sludge/bottom sludge/top scum, air pollution, water body risk and at improving environment monitoring system" (Sinopec, 2013c).

In addition, Sinopec is also purchasing high quality materials to ensure safe production (Sinopec, 2013b). Sinopec has implemented online procurement in an all-round way, as well as keeping strict control of suppliers in terms of the supplier admittance, assessment, as well as alternation and disqualifications (Sinopec, 2013b). Sinopec also uses the concept of 'Three Unified' which means unified management, standards and requirements for contractors in order to regulate contractors' behaviour (Sinopec, 2013b).

e) Global Product Strategy (GPS)

As part of the initiative to communicate the industrial risks to the communities involved in the industry and the public as a whole, some petrochemical companies also use the Global Product Strategy (GPS). GPS is actually a policy framework which was launched by the International ICCA in 2006 with the aim of advancing the performance of product stewardship of individual companies as well as the global chemical industry as a whole (ICCA, 2014b). According to that policy framework, by 2020, companies should ensure that chemicals are produced and also used in ways that will minimize significant adverse impacts on human health as well as on the environment (ICCA, 2014b). Braskem is leading this project of GPS in South America, which aims to communicate risks to humans and the environment from the use of chemical products (Braskem, 2014d).

f) Emergency response plans

For the purpose of prevention, a single emergency command system should be developed and this has been implemented by most of the petrochemical companies. For instance, in Sinopec, the emergency response system and professional multifunctional rescue teams have been built up and in 2011, this was expanded to the offshore oil spill and emergency rescue teams (Sinopec, 2013b). To enhance the collaboration among regional emergency teams, joint fire drills are often organised on a regular basis. Sinopec also has invested an amount of RMB 200 million to improve the fire control equipment of some subsidiaries (Sinopec, 2013b).

3.1.4. Environmental protection and management

In order to control the emission of pollutants from petrochemical industry, it is important to ensure that the petrochemical products are produced in a clean way and that pollutants discharged from the downstream industries will also be minimised. For example, Sinopec is committed to treating waste gas, wastewater, and industrial residue effectively (Sinopec, 2013c). Sinopec is also trying to meet emission and discharge standards as well as mitigating negative impacts upon the environment (Sinopec, 2013c). In 2011, EIA and follow-up assessment of many subsidiaries were set up in order to identify the main problems and try to mitigate their impacts (Sinopec, 2013c). A number of environmental measures are discussed in the following sub-sections.

a) Life Cycle Assessment (LCA)

In order to improve the understanding of the environmental impacts of a petrochemical product over its life cycle as well as its relevance in the value chain, most petrochemical companies have conducted LCA on their products. According to UNEP (2014), LCA is a tool that is used to evaluate systematically the environmental aspects of a product or service system throughout every stages of its life cycle. A reliable LCA performance is very important in order to achieve a life-cycle economy and the International Organisation for Standardisation (ISO) has actually standardised this framework within the series of ISO 14040 on LCA (UNEP, 2014).

For instance, Braskem has been using this tool since 2005 and has carried out 22 assessments with the help of specialised consulting firms (Braskem, 2014i). The LCA study in Braskem is focusing on three fronts, i.e. 1) operational focus – identifying process improvement; 2) strategic focus – deciding on new products, applications as well as technologies; and 3) commercial focus – adding value to products by demonstrating that plastic is more sustainable than alternative materials (Braskem, 2014i). Braskem has also exerted effort to create the LCA Brazilian Business Network which is a forum that links the voluntary participation of companies together to discuss LCA concept and spread best practices in the use of the concept in the business environment (Braskem, 2014i).

Similarly, ExxonMobil is also carrying out an LCA as outlined by the ISO (ExxonMobil Chemical, 2014e). The LCA that is adopted by ExxonMobil consists of four phases, i.e. 1) goal and scope – definition of product, process, environmental effects; 2) inventory analysis – identification of the relevant input flows (i.e. resources and energy use) and output flows (i.e. emission and solid waste) associated with the lifecycle of the product; 3) impact assessment – identification of potential environmental impacts; and 4) interpretation – environmental improvement opportunities are identified and conclusions are made relative to study objectives (ExxonMobil Chemical, 2014e).

b) Resource use and energy efficiency

Another effective way to protect and manage the environment is by using resources and energy efficiently. Most petrochemical companies are trying to produce products that are green and sustainable from bio-based and renewable feedstock. For example, in Braskem, the production of biopolymers (polymers that are produced from renewable raw materials) has been the highest in the world since September 2010 onwards (Braskem, 2014c). Since 2002, there has been a continuous effort to search for eco-efficient operations and this has produced important results (Braskem, 2014c). In addition, Braskem is also the world leader in Green Polyethylene (obtained from a renewable resource of sugarcane ethanol, instead of fossil fuel) (Braskem, 2014k). It has recognised worldwide for its very positive environmental balance because it can remove up to 2.5 metric tonnes of carbon dioxide from the atmosphere for every tonne that is produced (Braskem, 2014k).

In addition, ExxonMobil is also committed to the contribution towards sustainability in its products. ExxonMobil is making sure that its automobile products are meeting the needs of the automotive industry as well as trying to improve fuel efficiency and reduce the emission levels of greenhouse gases, as well as lowering manufacturing costs (ExxonMobil Chemical, 2014b). For example, ExxonMobil carefully considers the efficient use of resources in its petrochemical production, for example, plastics whereby the five-step model used by authorities such as the European Union (EU) is used (ExxonMobil Chemical, 2014h). They are 1) reduce – avoid the generation of waste; 2) reuse – use again the finished product; 3) recycle – recycle the product when reusing it becomes impossible; 4) recover – products can be used as an energy source through incineration; and 5) dispose – landfill the unwanted products. In addition, ExxonMobil Chemical is also practising plastic downgauging, which is reducing material amount contained in a product, but still maintaining or even improving the quality of the material (ExxonMobil Chemical, 2014g).

Sinopec is also active in its effort to increase resource efficiency and activities of recycling as well as promoting utilisation of by-products with low energy consumption, low emissions and high efficiency (Sinopec, 2013c). Sinopec has made significant progress in saving the consumption of water by measures such as leak checking and fixing, condensate recovery, use of low temperature residual heat, as well as reutilisation of waste water (Sinopec, 2013c). In 2011, Sinopec saved a total amount of 19.95 million tonnes of water usage (an amount equivalent to 1.4 times of the volume of the West Lake (14.29 million m^3) in Hangzhou in the Zhejiang province (Sinopec, 2013c).

In terms of energy efficiency, the ExxonMobil Chemical Company has improved its energy efficiency by more than one per cent annually since the ExxonMobil Corporation's Global Energy Management System (GEMS) was implemented (ExxonMobil Chemical, 2014d). In addition, ExxonMobil is also continuously promoting and developing cogeneration projects (ExxonMobil Chemical, 2014d). This means the simultaneous production of both electricity and useful heat in one single process, in order to effectively reduce energy consumption and improve efficiency (ExxonMobil Chemical, 2014d). Many of the major chemical facilities that are located close to refineries are involved in cogeneration of the electric power consumed within the industrial complex (ExxonMobil Chemical, 2014d). ExxonMobil has invested more than $1.5 billion in cogeneration projects in more than 30 locations around the world (ExxonMobil Chemical, 2014d). The projects have successfully reduced global emissions of carbon dioxide by more than 10.5 million metric tonnes per year (ExxonMobil Chemical, 2014d).

In addition, ExxonMobil is also committed to reducing emissions of Volatile Organic Compounds (VOCs) as well as sulphur dioxide (SO_2) and nitrogen oxides (NO_x) from its operations (ExxonMobil Chemical, 2014a). ExxonMobil has implemented cost-effective new technologies and is new operating practices for air emissions reduction (ExxonMobil

Chemical, 2014a). Since the year 2005, global chemical operations have been effectively reduced by at least five per cent annually for both emissions of VOCs and NO_x per unit of production (ExxonMobil Chemical, 2014d).

Apart from that, Sinopec has also successfully achieved energy saving as well as a cut in energy consumption with the new improvement in the technologies and energy saving emphasis in the production process (Sinopec, 2013c). Sinopec is studying methods to recover carbon dioxide (CO_2) in order to reduce GHG emissions and be better able to fight climate change (Sinopec, 2013c). In 2011, there was a reduction of the energy intensity of refining and ethylene production by 2.0 and 4.3 per cent respectively (Sinopec, 2013c). Moreover, Sinopec is also developing low carbon energy as well as improving its energy structure (Sinopec, 2013c). By the year 2020, low-carbon energy capacities will be built up that can supplement the main business operations, as well as contributing to the long-term sustainable development of the company (Sinopec, 2013c).

Sinopec is also focusing on the Research and Development (R&D) of technologies that will help with "energy saving and efficiency improvement, development of renewable and alternative energy sources, emission control, treatment and utili[s]ation of GHG[s] like [CO_2 and methane (CH_4)], biological and engineering carbon sequestration, clean and efficient development and utili[s]ation of coal, oil and natural gas, [CO_2] capturing and sequestration, [CO_2] flooding, comprehensive utili[s]ation of high purity [CO_2] and fuel production via microalgal [CO_2] fixation" (http://english.sinopec.com/environment_society/lowcarbon).

3.1.5. Environmental technological innovation

As part of their initiatives in reducing the negative impacts from the petrochemical industry on the environment, most petrochemical companies have adopted environmental technological innovations. For example, at Braskem, technological innovation is mainly focussed on the remanufacturing and recycling chains (Braskem, 2014j). Similarly, innovation is also claimed to be at the heart of everything that the Shell Company does in its operations. Shell claims to be continuously seeking to improve manufacturing processes, maximise industrial yields, and reduce energy use, as well as minimise waste generation (Shell, 2014d). Not only does Shell claim to create innovative products and technical solutions, it is also investing to develop next-generation technologies that are using new feedstock sources, at a lower cost with minimised effects on the environment (Shell, 2014d). Shell has process technology advantages where it has experience in processing a huge range of hydrocarbon feedstock and market-leading proprietary technologies as well as new technology development capability (Shell, 2014a). In addition, ExxonMobil is also focusing on efficient manufacturing processes that will lead to a minimised impact upon the environment and on innovation to support the development of environmental-friendly products (ExxonMobil, 2014i).

SABIC is also constantly investing heavily in the technological innovation of its operation with the continuous development of new patents as well as certifications (SABIC, 2014c). SABIC has research resources with 17 facilities in technology and innovation in Saudi Arabia, United States, Holland, Spain, Japan, India as well as South Korea that are backed by more than 8,000 patents (SABIC, 2014c). SABIC is also working with universities and international research centres as well as other public and private sectors partners in order to develop research capacities and remain at the forefront of technological innovation in its business (SABIC, 2014c). Sinopec is also intensifying R&D in technological innovation. Sinopec has conducted four projects in waste gas control as well as five flagship R&D projects on waste water treatment (Sinopec, 2013c). Moreover, the company is also making progress on a PO/SM waste gas control project as well as odour control projects of “refineries and chemical plants, FCC regenerator flue gas de-SO_x, and de-NO_x and dust removal projects and waste water control projects of key plants” (http://english.sinopec.com/environment_society/lowcarbon).

3.1.6. Environmental policy, regulatory compliance and environmental certification

In order to ensure the protection of the environment, these five petrochemical companies are committed to complying with environmental laws and regulations. For example, in 2011, Sinopec signed responsibility documents for a major reduction target of pollutant discharge with the government of China, as well as devolving the target among its subsidiaries (Sinopec, 2013c). The 12th Five Year Plan for Sinopec Environmental Protection Work was also developed, which deploys important environment-related tasks in the future (Sinopec, 2013c). During the same year, Sinopec also continued to improve regulations in environmental protection, as well as tighten environmental performance assessment (Sinopec, 2013c). Sinopec has carried out EIA for all projects that strictly followed regulation, such that HSE facilities and the projects are synchronised in terms of the design as well as construction and commissioning, together with promoting clean production and utilisation of resources (Sinopec, 2013c).

At the same time, there was also an intensification of pollution control and as a result, a positive outcome was achieved (Sinopec, 2013c). Compared with the 2010 figure, industrial effluent discharge at Sinopec has been reduced by 8.7 per cent and COD discharge dropped by 16.7 per cent. Emissions of SO_2, NO_x, and NH_x also declined by 9.8, 3.4 and 34.9 per cent respectively (Sinopec, 2013c). In 2011, four regulations were developed and implemented, which include management onsite guidance (Sinopec, 2013b). Sinopec has put into practice the 'Seven Remembers and Seven Don'ts' for site operations as well as working with experts in HSSE to assist in the identification of any safety problems and try to solve the problems (Sinopec, 2013b). Furthermore, Sinopec also sent those experts to provide support and advice to those subsidiaries that were weak in HSSE management or had only just established it in their operation (Sinopec, 2013b).

In addition, Braskem is also committed to disseminating much cleaner production policies as well as more sustainable production and consumption practices and has taken a public stance on doing so by signing the declaration that is part of the UNEP in 2006 (Braskem, 2014d). In addition, all of the company's units are certified under the ISO 9001 for quality management, ISO 14001/Responsible Care Management System (RCMS) for environmental management and many of them are certified under the Occupational Health and Safety Management Systems (OHSAS) 18001 standard for health and safety management (Braskem, 2014d).

Finally, the Shell Company has a systematic approach to management of the HSSE and SP (Shell, 2014d). It also has set improvement targets and measures, and appraises as well as reports performance (Shell, 2014d). It also requires contractors to manage HSSE as well as SP together with the policy and engages effectively with industrial neighbours and communities that are affected (Shell, 2014d). In addition, Shell is also complying product regulatory legislation such as REACH (Shell, 2014d).

3.1.7. Corporate Social Responsibility (CSR)

Most of the petrochemical companies are also engaging in CSR activities. For example, Sinopec has been very active in making positive contributions to philanthropic activities in a number of areas. For a Chinese company, the tradition of appreciation that is taught through generations is said to be engraved into Sinopec's development values (Sinopec, 2013d). During its development over more than 30 years, Sinopec has always remembered the concept of rewarding society, and hence starts to do good things, albeit small ones (Sinopec, 2013d).

In 2011, Sinopec was involved in "building harmonious communities, disaster relief, poverty alleviation and aiding Tibet, health care, donation for education and supporting poor students, and helping to develop national sports and promoting health" (Sinopec, 2013d). In the same year, Sinopec donated RMB150 million and it was awarded the 'China Philanthropy Prize' as well as the 'Special Prize for Brightness Service' in both 2010 and 2011 (Sinopec, 2013d). In 2011, Sinopec invested RMB12.8 million in four poverty-hit counties and implemented 15 poverty relief projects (Sinopec, 2013d). Another CSR activity that Sinopec has carried out was in the aftermath of the Wenchuan Earthquake that occurred in China in 2008, Sinopec made a commitment to supply natural gas to each affected house and provided gasoline and diesel to each machine for the purpose of reconstruction (Sinopec, 2013d).

In addition, Sinopec is also encouraging its staff to take part in activities such as a tree planting campaign for example; in 2011, about 520,000 person days in Sinopec were devoted to the campaign and 1.56 million trees were planted (Sinopec, 2011). Information about climate change is also disseminated among employees, consumers, contractors, suppliers and other stakeholders so that they are more aware about more sustainable modes of production, as well as sustainable ways of living and their own consumption habits, together with giving employees a stronger sense of social responsibility in order to protect the environment (Sinopec, 2013c).

Similarly, Braskem is also committed to carrying out CSR activities. It has been a signatory of the United Nations programme of the Global Pact since 2007 in order to strengthen the application of CSR around the world (Braskem, 2014d). In 2008, Braskem joined the Global Pact Committee of Brazil (Braskem, 2014d). Some examples of the CSR activities that Braskem has undertaken are 1) ecological recovery of Atlantic Forest of the northern coast of Bahia; 2) environmental restoration and conservation through environmental education and training workshop; 3) recycling projects in order to improve solid waste management in Sao Pailo, Alagoas, Bahia as well as Rio Grande do Sul (Braskem, 2014k).

3.2. Petrochemical associations from five different world continents

This section will discuss efforts made by five petrochemical associations from different continents worldwide in order to encourage the management of petrochemical industries sustainably. Those five petrochemical associations are 1) the Gulf Petrochemicals and Chemicals Association (GPCA); 2) the Association of Petrochemicals Producers in

Europe (APPE); 3) the American Fuel & Petrochemical Manufacturers (AFPM); 4) the Asia Petrochemical Industry Conference (APIC); and 5) the Latin American Petrochemical and Chemical Association (APLA).

3.2.1. Brief background of the petrochemical associations

The GPCA is a non-profit association that was formed in March 2006 that serves its members through the provision of industrial data and information resources (GPCA, 2012a). It is the first association that represents the interests of the Arabian Gulf petrochemical and chemical industries and it has created a forum for discussions and so that people can meet and share concepts and ideas in the industry (GPCA, 2012a). The members of the GPCA consist of leading regional petrochemical as well chemical producers (GPCA, 2012a).

APPE is the voice of the European petrochemical industry, which brings together companies that manufacture raw materials i.e. "ethylene and propylene from steam cracking and/or other olefins, and/or aromatics for chemical use, and/or major first stage petrochemical derivatives (excluding polymers)" (http://www.petrochemistry.eu/about-petrochemistry/petrochemistry-in-europe.html). Its main mission is to promote the best possible, socio-economic and environmental conditions in order to maintain and develop the petrochemical industry in Europe by reflecting its benefits to the economy and society as well as its commitment to improve safety, health and environmental performance (Petrochemicals Europe, 2014h). Meanwhile, the objectives of APPE mainly focus on issues relating to 1) HSSE (e.g. REACH, chemical management, RC, and Product Stewardship); 2) regulatory issues; 3) trade and market competitiveness; energy and issues on climate change; 4) logistics issues; 5) market intelligence; and 6) integration of Western and Eastern petrochemical activities (Petrochemicals Europe, 2014h). APPE is prioritising the achievement of efficient co-ordination along the industry chain so that a consistent message to stakeholders can be delivered (Petrochemicals Europe, 2014h). APPE represents companies that manufacture ethylene and propylene for chemical use (Petrochemicals Europe, 2014h).

AFPM is a trade association representing manufacturers of the “US supply of gasoline, diesel, jet fuel, other fuels and home heating oil, as well as the petrochemicals used as building blocks for thousands of vital products in daily life” (http://www.afpm.org/policy-positions-environmental-regulations/). AFPM serves to manufacture vital products for everyday life while strengthening the economy and national security of America (AFPM, 2014c).

APIC is a conference that was renamed in the year 2000 after it was originally founded in 1979 as the East Asia Petrochemical Industry Conference (EAPIC) by the petrochemical associations in East Asia [i.e. Japan Petrochemical Industry Association (JPCA), Korea Petrochemical Industry Association (KPIA) and Petrochemical Industry Association of Taiwan (PIAT)] (APIC, 2014). APIC serves to facilitate information exchange, and sharing of issues of common concern, as well as providing a networking platform for industry professionals worldwide (APIC, 2014). The main objective of the conference is to create mutual friendship among Asian players in the petrochemical industry around the world and thereby contribute to advancement in the Asian petrochemical industry (APIC, 2014).

APLA is actually a business forum that promotes business in the chemical and petrochemical sectors (APLA, 2014). The objectives of APLA are focused on 1) promoting mutual cooperation among companies; 2) providing a means to facilitate business and contacts in petrochemical industry; 3) promoting personal relationships to facilitate friendly links among officers in companies; 4) organising meetings, symposiums and others; 5) elaborating analytical market studies and reports; 6) training and developing human resources that are needed by the petrochemical industry in Latin America; and 7) encouraging the production of papers as well as research work for the sector (APLA, 2014). The members of APLA consist of four types, i.e. 1) active members – petrochemical or chemical companies that have headquarters or subsidiaries as well as manufacturing facilities in Latin America; 2) associated members – petrochemical or chemical companies not located in Latin America, companies related to the Latin American petrochemical or chemical industries, logistic service providers, associations of petrochemical and chemical sectors, and scientific, technological and professional institutions that have relations to the petrochemical or chemical industry; 3) personal members – individuals who have experience in the Latin American sectors with no current activities in the petrochemical or chemical industry; and 4) honorary members – people named by the Ordinary General Meeting who have contributed in the Latin American sectors (APLA, 2014).

3.2.2. HSSE

Petrochemical associations are committed to focusing on HSSE so their group members put an emphasis on this management in their business operations. For example, GPCA has developed an initiative to adopt RC since 2009 and thus has brought an important initiative to the Gulf and Middle-Eastern countries.

APPE is also encouraging all petrochemical sectors in Europe to implement and develop best practice procedures to maximise work safety as much as possible and also the safety of those communities who are involved in the operation (Petrochemicals Europe, 2014d). APPE is looking for any possibility for the cross-fertilisation in all issues and one of them is in the HSSE (Petrochemicals Europe, 2014h). Similar to GPCA, APPE has also adopted RC among the association members (Petrochemicals Europe, 2014k). In addition, REACH entered into force on the 1st June 2007 across the 27 member states of the European Union (EU) (Petrochemicals Europe, 2014i). APPE and its sector groups are supporting the petrochemical industry and downstream users to implement and comply with the REACH legislative framework (Petrochemicals Europe, 2014i).

AFPM is continuously looking for opportunities to enhance safety and recognises that the effective way in order to improve industrial process safety performance is to learn from each other (AFPM, 2014c). Every year, AFPM collects occupational injury and illness data from all its members (AFPM, 2014c). AFPM has been supportive of industry and government cooperation with the Voluntary Protection Programme of the Occupational Safety and Health Administration (OSHA) (AFPM, 2014e). In this programme, fatalities, injuries, and illnesses are prevented through a system that focused on hazard prevention and control as well as worksite analysis and training (AFPM, 2014e). OSHA inspects as well as regulates refineries under the General Industry Standards, which involve a number of potential risks in the workplace, such as those that are related to “walking and working surfaces, occupational noise exposure, hazardous materials and personal protective equipment" (AFPM, 2014b). Fuel and petrochemical manufacturers are continuously improving their safety records even though the work involves hazardous materials and handling of materials under high temperature and pressure, as well as complex equipment (AFPM, 2014e).

In addition, refining and petrochemical sites are also monitored regularly so that their processes are managed in accordance with the law (AFPM, 2014d). Process safety management audits are carried out regularly and the sites also submit risk management plans every five years to comply with regulations (AFPM, 2014d). Fuel manufacturers also comply with some additional process safety standards and audits to promote a safe working environment (AFPM, 2014d).

3.2.3. Resource use and energy efficiency

In order to continuously move towards resource use and energy efficiency, the petrochemical sector is focusing on the creation of products that enhance performance and which reduce energy consumption during their lifetime (Petrochemicals Europe, 2014f). The European chemical industry has reduced its carbon dioxide emissions by half between 1990 and 2009 (Petrochemicals Europe, 2014b). Furthermore, Greenhouse Gases (GHGs) emissions have also been reduced since 1994 at the same time as the chemical industry as a whole has increased its production by 60 per cent (Petrochemicals Europe, 2014g). The European Union (EU) petrochemical sector is committed to minimising its environmental footprint for a greener world with lower emissions of GHGs and increased energy efficiency (Petrochemicals Europe, 2014g).

Since 2005, the European Trading Scheme (ETS) has become an important tool in order to curb the emission of CO_2 (Petrochemicals Europe, 2014c). It is mandatory for companies in the petrochemical sector to participate in the EU ETS (European Commission, 2014). The ETS is committed to reducing GHG emissions by 20 per cent by 2020 and by 2050, it strives to achieve reduction of 80 to 95 per cent from 1990 levels (Petrochemicals Europe, 2014c). Also, by the same year, renewable energies should make up 20 per cent of the EU energy consumption (Petrochemicals Europe, 2014j) and 27 per cent in 2030 (European Commission, 2014). In addition, in 2011, the European Commission adopted the 'Energy Efficiency Plan 2011' and has targeted saving 20 per cent of its primary energy consumption (Petrochemicals Europe, 2014a).

APPE is using the 'E4Water' concept which is decoupling economic growth from an increased use of water (Petrochemicals Europe, 2014b). It is basically a concept that develops, tests and validates new integrated approaches as well as methodologies and process technologies for water management in the chemical industry (Petrochemicals Europe, 2014f). It also investigates how those approaches could be applied across other sectors (Petrochemicals Europe, 2014f). The objective is to reduce the usage of water by 20 to 40 per cent, wastewater production by about 30 to 70 per cent and use of energy by 15 to 40 per cent (Petrochemicals Europe, 2014b).

3.2.4. Environmental regulations

Petrochemical associations are also supporting good environmental regulations. For example, AFPM members are strongly committed to "clean air, water and waste reduction, have an outstanding record of compliance with Environmental Protection

Agency [(EPA)] and other regulations, and have invested hundreds of billions of dollars to dramatically reduce emissions as measured by EPA" (AFPM, 2014a).

APPE is committed to supporting environmental regulations in order to reduce the negative impacts from the petrochemical industry on the environment. One example of the regulation that the members of APPE is following is the Industrial Emissions Directive (IED) which came into force in January 2011, which aims to minimise pollutant emissions from various industrial sources throughout the EU (Petrochemicals Europe, 2014e). The main forms of legislation are 1) Integrated Pollution Prevention and Control Directive (IPPC); 2) directives for specific industrial activities; 3) Regulation on the European Pollutant Release and Transfer Register (E-PRTR) (Petrochemicals Europe, 2014e). The EID basically regulates emissions from industrial installations and sets the framework for permitting, as well targeting important atmospheric pollutants and other key environmental impacts (Petrochemicals Europe, 2014e).

3.2.5. Awards and incentives for petrochemical companies

In order to promote the culture of safety in petrochemical operations, some petrochemical associations have introduced awards and incentives schemes for their members. For example, GPCA has introduced the Responsible Care Awards Programme in order to recognise and share experience of the petrochemical companies that exemplify leadership as well as excellent performance with respect to the implementation and execution of the RC programme (GPCA, 2012c). This includes awards for the Best RC Company; Champion and Project (GPCA, 2012c).

Similarly, the AFPM also has introduced awards and recognitions, i.e. for example, the AFPM Safety Awards Programme in promoting prevention of accident in the petroleum refining as well as petrochemical manufacturing industries and contractors that are supporting them (AFPM, 2014c). The award qualification is based on the records obtained from the OSHA 300A Summary as well as the American Petroleum Institute (API) 754 Process Safety Collection (AFPM, 2014c).

3.3. Some criticisms of petrochemical companies on their industrial sustainability

Despite the outstanding performance of the five petrochemical companies in managing their petrochemical operations as shown through their companies' websites, there is no doubt that the companies may also facing some challenges in developing their industrial operations sustainably. This can be shown from some evidences from newspaper articles and other studies that environmental pollution and other negative impacts may also be resulted from their operation.

For example, in 2012, three plants which included a small petrochemical plant located in the southern province of Guangdong were asked to be closed down for environmental checks (UPDATE 1, 2012). It was reported that one of the plants (Dongxing plant) which is owned by Sinopec was alleged by a local environmental agency in China to have been discharging industrial waste water via its rain drainage system and had been ordered previously by the agency to stop production (UPDATE 1, 2012).

In addition, Energy Tribune (2012) also reported that the Sinopec companies have been alleged of serious environmental violations and safety problems at their refineries.

According to this report, Sinopec had been threatening the Government of China by claiming that what they are doing is for the economy of the country and the people's livelihood. However, the director of the environmental inspection bureau of the Environmental Protection Department of Guangdong replied that the environment is actually the people's livelihood. The local environmental authorities of China charged Sinopec fines of only 10, 000 Yuan (USD1, 586) which Sinopec would not be mind of paying those small fines and continues to pour polluted water into the China's river. There is a need for the country to increase the strictness of penalties so that the company would not continue to deteriorate the environment even further.

In addition, the report also reveals that Sinopec has spanned a story and claim that they are environmentally friendly on the corporate website but the truth is they are not. Nine out of 26 reported cases of environmental pollution in China during the first half of the year 2012 were from Sinopec and has violated new Chinese environmental regulations since 2009. Sinopec is a massive company that has revenue of USD402 billion in 2011 and because of this, they are very influential that even some local governments in China did not dare to make inspection and supervision even after Sinopec was found out that the company has discharging excessive pollutants. At the same time, local monitoring and enforcement agencies in China also have inadequate budgets and local officials are forced to act in balance between promoting industrial growth and enforcing strict standard on the environment. However, Chinese population have subsequently protest against Sinopec for the serious industrial air and water pollution that the company has created. For example, people were protesting against the development of coal-fired power plant in Hainan, China.

Similarly, in 2013, it was also reported that China has suspended environmental approval of Sinopec due to its non-compliance to pollution targets in that country (Esther, 2013). Sinopec Group failed to meet the targeted emission levels of nitric oxide which is a source for air pollution. The Ministry of Environmental Protection (MEP) of China had suspended approvals of EIAs for new refining projects and renovation and expansion of existing refineries.

Apart from Sinopec, Shell Petrochemical Company is also criticised by their polluting behaviour. For example, in 2010, Shell Norco Plant in North Carolina, US, emitted 480,000 pounds of hazardous pollutants into the atmosphere, including the chemicals known to cancer and birth defects cause (Sturgis, 2012). It was also reported that the company was blamed for the serious health problems that they have created to the residents of an African-American neighbourhood who are living right on the plant's fence line after the expansion of the plants. In 2013, the Shell Company was also fined USD2.6 million for their pollution problem created at the refinery and petrochemical plant along the channel of the Houston Ship in the United States (US) (Fuel fix, 2013). As a matter of a solution, Shell will take steps in reducing the emissions of benzene, sulphur dioxide, as well as other hazardous air pollutants and the company shall install a system that enable the public to view data on pollution level so that the information could be made transparent to the population living next to the industry.

In addition, according to Shogren and Benincasa (2013), ExxonMobil has also been polluting the environment for example from 2008 to 2011 the ExxonMobil Baton Rouge complex in Louisiana, US has pumped out nearly four million pounds of Volatile Organic Compounds (VOCs) which could contribute to the formation of ground-level ozone that can cause respiratory problems such as asthma attack. Furthermore, there have been major serious accidents that occurred by the company such as a leakage of more than 10 pounds of benzene and 1,000 pounds of toluene in June, 2012 that had affected the residents who lived nearby with headaches, coughs, as well as nausea. It was also reported that ExxonMobil has failed to report known leaks and failed to maintain its facility which have put its workers and the local communities at risk.

Similarly, SABIC has been doing the same thing as the other petrochemical companies that it has polluted the environment. For example, in 2012, the US Environmental Protection Agency (EPA) fined nearly USD1 million for failing to adequately monitor and maintain valves and pipes that are leaking by the SABIC Innovative Plastics in Mount Vernon, US.

3.4. Conclusion

This chapter has summarised the background of five leading international petrochemical companies and has analysed the efforts taken so far by these five global petrochemical companies towards engaging with sustainability and environmental issues. The five petrochemical companies are Braskem (Brazil, South America); Shell (the Netherlands, Europe); SABIC (Saudi Arabia, Middle-East); ExxonMobil (North America); and Sinopec (China, Asia).

Most of the five companies have developed a clear commitment towards the sustainable industrial development of petrochemical production. They have put an emphasis on the HSSE of their companies. Some of the programmes that they have implemented are, 1)

RC programme; 2) OIMS; 3) “I-Safe”; GPS; and 4) emergency response plans. In addition, most of the companies are also active in the protection and management of the environment, for example through LCA as well as resource use and energy efficiency. Apart from that, the companies also have invested in the innovation of environmental technologies in order to reduce or avoid the negative impacts from their operations. Environmental policies and regulations are also complied with, as well as environmental certification put in place in order to manage their petrochemical production sustainably. Lastly, most of the companies are also engaging in the CSR activities so as to contribute some benefits to society, especially local communities who live close to their industry and also to the environment.

This chapter has also analysed the efforts carried out by five petrochemical associations from five different world continents in order to manage sustainably petrochemical companies in their regions. The five petrochemical associations are, 1) GPCA; 2) APPE; 3) AFPM; 4) APIC; and 5) APLA. The chapter has given a brief background of those petrochemical associations as well as outlining some strategies that those petrochemical associations have carried out for the encouragement and development of sustainability measures for the petrochemical industry. These include emphasizing the HSSE operation in petrochemical companies as well as encouraging the use of resources and energy efficiently. In addition, petrochemical associations have also encouraged petrochemical companies to adhere to environmental regulations and in order to encourage petrochemical companies to develop sustainably, awards and incentives are given to the companies as well.

Despite the outstanding strategies that the petrochemical companies have put in trying to develop their industrial operations in a sustainable manner, there are however, some criticisms that have been made on the last section before the conclusion of this chapter. The petrochemical companies were criticised such that there are still issues concerning their polluting habit to the environment that have affected the nature and the health of the people and thus question their sustainability in industrial development. It was demonstrated that those companies not only pollute the environment but also failed to follow environmental standards and regulations. This raised an issue on whether the petrochemical companies are really following what they have put on their corporate websites or simply to spin the stories around and in reality they are doing the opposite way.

There seems to be a tension between economic development and environmental protection for example in the case of Sinopec that the company claimed that what they are doing is for the economic growth and that they have reasons to pollute the environment for economic gain that will benefit the livelihood of the people. However, the people also needs a healthy environment in order to survive. Another issue that can be looked at this matter is the difference in the strictness of imposition of fines and penalties for the pollution that the companies have done. It seems that developing countries like China has been imposed with lenient and small amount of fines than the ones in the developed countries such as in the US. Developed countries like the US have also the capacities to monitor and supervise petrochemical companies more than in countries like China so that such irresponsible act of polluting will be taken seriously. It is thus, important to realise that a strict form of environmental law and regulation and third body monitoring are essential to develop petrochemical industry in a sustainable way apart from having good strategies in HSSE, resource and energy efficiency, CSR, and so on because petrochemical companies may not be trusted until they are monitored adequately and warned with strict environmental laws and regulations.

CHAPTER 4 - THEORETICAL FRAMEWORKS OF THE STUDY

4.0. Introduction

The aim of this chapter is to outline and discuss the theoretical frameworks that will be used in the thesis. The three theoretical frameworks are, 1) Sustainable Industrial Development (SID); 2) Ecological Modernisation (EM); and 3) Resource use conflict management in Integrated Coastal Management (ICM). The first two theories form the main basis of the approach adopted in this research. They address the application of technological innovation, transformation and improvement to the management of industrial production in order to achieve ecological sustainability, but they do so from a perspective that envisages continued economic development. The third theory of ICM is used in this thesis specifically in order to help explore and understand stakeholders' conflict issues at SPARK. These particular frameworks are used in this thesis as a means to structure answers to the overall research question, i.e. can industrial development be made sustainable by maintaining the economic development of the industry, while still conserving the environment and protecting the social welfare of the society.

This chapter begins by explaining briefly the concept of sustainable development and then discusses the two main frameworks that are used in this research, as well as providing a brief explanation of the theory on resource use conflict management in ICM as an additional framework for the thesis. A discussion on the researcher's position on those approaches will be given i.e. what approach will actually be taken throughout the thesis.

4.1. Sustainable development

Sustainable development as a concept is widely debated and contested as it remains vague and implementation has proven problematic (Drexhage and Murphy, 2010). This is because unsustainable trends of development still continue and sustainable development has not found its political entry points to make actual progress. However, 20 years after its implementation is a relatively short period of time in order to see the changes especially to developing countries where advancement in technological innovation is still lacking in those countries. For developing countries, much concentration is given for the growth of economy and if they wanted to develop sustainably i.e. putting balance between economic development and environmental protection, much capital is also needed for environmental technologies which many of them cannot afford to have. The absence of competent equipment and people for supervision and monitoring as well as the lack of stringency in environmental laws and regulation for example in the case of China also become the reasons on why 20 years is considered to be a short period of time. Unlike the developed countries such as Sweden where it was shown earlier in Chapter 2 that there seems to be better management in their petrochemical industry, a period of 20 years may be considered a long time. This is because they have established and acquired technologies that are capable to reduce pollutant emission, using more efficient resources and energy and so on. Moreover, environmental standards and laws are more stringent in comparison with the ones in other developing regions. This may be the reasons on why sustainability can be more achieved in the developed nations within a period of 20 years, a period on which developing nations may still consider it as short.

There is a need for a systemic change in the way the world does business which will affect lifestyles and consumption patterns (Drexhage and Murphy, 2010). However, due to its flexibility, sustainable development continues to act as a universal guiding principle as it allows various stakeholders to adapt the concept to their own purposes, which is both a strength and a weakness. However, while sustainable development forms a useful conceptual background, this thesis draws upon the two more detailed theoretical frameworks of SID and EM, because the theories are more specific and relevant to the study of the sustainable development of the petrochemical industry at SPARK.

This section briefly explains the definition of sustainable development and its historical context as well as discussing briefly the concept of sustainable development in developing countries. This section also explains the interdependent components found in the concept, i.e. environment, economy and society.

4.1.1. Definition and historical context

There is no single unified philosophy of sustainable development. However, in broad terms, the concept of sustainable development can be defined as an attempt to combine growing concern about both environmental issues as well as socio-economic issues (Hopwood, et al., 2005). Elliott (2006) also added that literally, sustainable development is a concept that refers to maintaining development over time. A well-known definition by the World Commission on Environment and Development (WCED) in 1987 (p. 43) defines sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”. Basically, it has two key concepts. The first one is the concept of ‘needs’, which refers to essential needs such as food, clothing, shelter, jobs and so on. The second concept is the idea of limitations imposed by technology and social organisation on the ability of the environment to meet the present and future needs of generations.

According to the World Commission on Environment and Development (WECD) (1987), sustainable development is not only about the environment but it reconciles the tension between concerns of the development and environment on the global scale (Langhelle, 2000). Moreover, it is also not only a concept, but a process that will help society make decisions about the balance of needs for the environment, economy and society. In addition, it is also a concept that integrates the importance of environmental protection along with economic development and social responsibility.

Sustainable development as a concept was popularized from 1983 onwards when the UN established an initiative to set up the World Commission on Environment and Development. Following the initiative, in 1987, the UN General Assembly called for the United Nations Conference on Environment and Development (UNCED). Informally known as the Earth Summit, it was held from the 3rd to 14th of June 1992 in Rio de Janeiro, Brazil. The main focus of the conference was basically on the principal themes of environment and sustainable development (United Nations, 1997). The primary goals of the Summit were to encourage a "development" that would support socio-economic development, but still protect the environment from continued deterioration, and to set a foundation for global co-operation between the developing and the more industrialized countries, based on mutual needs and common interests, that would ensure a positive future for the planet.

There were three major agreements adopted by 108 states during the conference. They are 1) Agenda 21; 2) The Rio Declaration on Environment and Development; and 3) The Statement of Forest Principles. The agreements were aimed at changing the traditional approach to development. Agenda 21 is basically a comprehensive global action programme in all areas of sustainable development, The Rio Declaration on Environment and Development is actually a series of principles that define the rights and responsibilities of States and the Statement of Forest Principles is a set of principles underlying the sustainable management of forests all around the world.

In addition, the Rio+20 conference took place in Brazil on the 20^{th}-22^{nd} June 2012 to mark the 20^{th} anniversary of UNCED, which was held in 1992 [United Nation Conference on Sustainable Development (UNCSD), 2014]. During the conference, world leaders, private sector, and NGOs came together to discuss issues regarding poverty reduction as well as social equity and environmental protection as the world's population continues to increase rapidly. The themes that were put into focus at the conference are 1) green economy in the sustainable poverty eradication; and 2) institutional framework for sustainable development. There are seven priority areas that were discussed at the conference and they include 1) decent jobs; 2) energy; 3) water; 4) sustainable cities 5) sustainable agriculture and food security; and 6) oceans and disaster readiness.

4.1.2. Sustainable development in developing countries

It was mentioned earlier in the introduction that the concept of sustainable development has become a universal guiding principle due to its flexibility and because of this the concept has travelled from the developed world to the developing countries. According to Drexhage and Murphy (2010), many developing countries see the concept of sustainable development as a means for developed nations to impose stricter rules on development aid and international trade. Moreover, some developing countries also argue that due to their lack of financial and technological resources, as well as unfair terms of trade, this has hindered them from implementing sustainable development in their countries. Many poor developing countries also do not have adequate access to technology, lack of resources and infrastructure, have a poor quality of governance, and an unfavourable business environment necessary to motivate sustainable development to be implemented in those countries (Economic Commission for Africa, 2002, cited in Drexhage and Murphy, 2010).

It is also argued that the developed nations have not met their commitments to developing countries, generating a lack of trust between the developed and developing nations (Drexhage and Murphy, 2010). It was stated in the Rio Summit that the developing countries would follow the sustainable development agenda if the developed nations increased their development assistance (Drexhage and Murphy, 2010). However, most developed countries are not meeting their financial and technology transfer commitments to developing countries (Drexhage and Murphy, 2010).

As mentioned earlier in Chapter 1, Brunei is neither a developed nor developing country because even though it is described as 'developing' yet it is a wealthy country that has a high GDP per capita and the country is enjoying a high standard of living. However, the country itself cannot be labelled as 'developed' as there are some areas such as its status in the advancement of technological innovations is not satisfactory. For the purpose of this research, there are also discussions on the applicability of the theoretical approaches with respect to developing countries so as to see whether Brunei fit into that category or the opposite or there is a need to consider a different way.

4.1.3. Environment, economy and society: interdependent pillars of sustainable development

The idea of sustainable development encompasses three interdependent components: environmental, economic and social (Elliott, 2006). Barbier (1987, cited in Elliott, 2006) presented the three components as three interlocking circles, as in Figure 11.

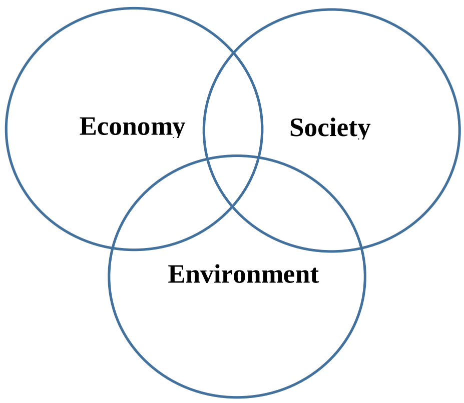

Figure 11 Interlocking circles in the sustainable development concept. Source: Adapted from Barbier (1987, as cited in Elliott, 2006)

The main objective of sustainable development is to maximise the goals across all the three components that are illustrated by the interlocking circles as shown in Figure 11. The model shows that there are trade-offs between environmental and social issues and therefore, choices have to be made at a particular time and scale as to development choices, as sustainable development recognises the costs involved for particular interests and different groups of people (Barbier, 1987, as cited in Elliott, 2006; Hopwood, et al., 2005). For example, a decision may need to be made whether a loss of some wetland for a housing development is acceptable or not. The human component of socio-economic development is dependent on the environment and humans depend on it for survival and thus, the environment should not be ignored.

Fava, et al. (1998) also presented the concept of sustainable development in terms of the related set of interrelated components that are shown in Figure 12. From the figure, it can be seen that economic health, environmental protection and social responsibility should be integrated together in order to achieve a development that is sustainable.

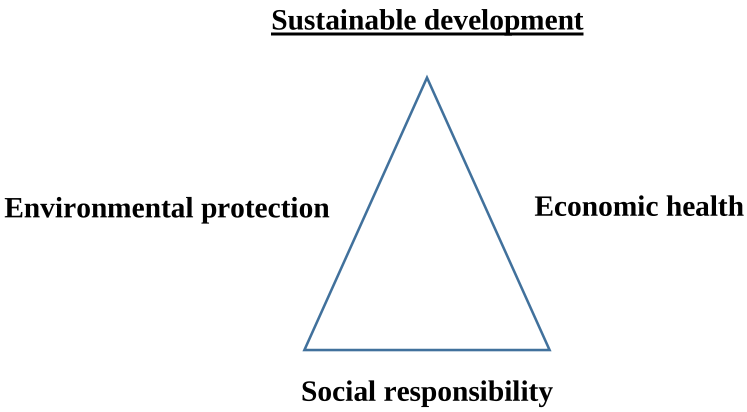

Figure 12 Sustainable component model.
Source: Fava, et al. (1998)

4.1.4. Environmental protection

Industrial development is seen as destructive to the environment as resources are considered to be finite and thus the environment cannot cope with sustained and growing pressure from economic development (Elliott, 2006). It can be recognised that there are two new global environmental issues: firstly, those industrial impacts on the environment that occur at a ‘supranational’ level such as global climate warming and ozone depletion. Secondly, local or national issues such as deforestation, soil erosion or loss in accessing clean water are also occurring and repeated in some of the worldwide locations, which eventually pose threats to the resources on which increasingly more of the people of the world are dependent.

In sustainable development, protection of the environment from those industrial activities means that there should be a minimisation or avoidance of the use of hazardous substances, resources and energy (Fava, et al., 1998; Glavič and Lukman, 2007). Environmental protection requires an approach that includes the entire lifecycle of the product or service (i.e. the 'cradle to grave' principle) (Fava, et al., 1998). This means that a consideration of the environment should start from raw material acquisition through to the process and to final disposal. It is important that the environment will not be degraded through pollution (Gibson, 2000) or at least, the impact will be made less so as not to the damage the environment totally. Environmental loads should be identified and quantified, for instance the amount of energy and raw materials consumed as well as the level of pollutant emissions and the amount of waste generation (Glavič and Lukman, 2007). Furthermore, the potential environmental effects of these loads should also be evaluated and available options for avoiding or reducing these environmental effects must be assessed.

In order to safeguard the environment, every resource material and energy that a company uses should be from a non-depletable (i.e. renewable) resource (Gibson, 2000; Glavič and Lukman, 2007). Energy should not rely on the use of fossil fuels which are finite stocks (Glavič and Lukman, 2007), but rather on renewable resources such as wind, solar, wave, and hydroelectric energy. However, this is a long term goal given that we are currently living in an industrialised economy where almost all energy used by business is derived from non-renewable sources, such as oil and other fossil fuels (Gibson, 2000). If oil and gas are used continuously, they will run out eventually. Pollutants released from the burning of fossil fuel may also affect the quality of air and this is not sustainable.

In addition, the usage of resources should also be minimised in terms of raw materials, as well water, energy and other natural resources, for instance forestry and fishing. Another important effort towards protecting the environment is dematerialisation (source reduction) i.e. to reduce the volume of source material and energy used in order to serve economic functions as well as for environmental reasons (Glavič and Lukman, 2007). The advantages of dematerialisation are it lowers the costs of disposal and handling of waste because it avoids the costs of recycling, composting, landfilling, as well as combustion. Also, it helps in resource conservation and pollution reduction, including Greenhouse Gases (GHGs) that contribute to global warming.

The ‘3R’ concept of reduce, reuse and recycle is also important in order to protect the environment and eventually to develop sustainably. A company’s products should be operated sustainably, and at the end of the life, they can be reused or recycled (Gibson, 2000). It is moreover, hard to maintain landfill in the long run as it will be filled up quickly unless the generation of waste to landfill is reduced dramatically. Emission of methane from landfill sites may also contribute to climate change as it is a potent gas that has a similar greenhouse effect to carbon dioxide.

Apart from that, regeneration of material to return to its original form for the same or different usage can also helped to minimise the negative effects of industry upon the environment. Moreover, the recovery of materials, energy and waste can also be used for this purpose, such as by combusting waste in order to convert it to some usable energy, such as using methane gas for electricity generation (albeit with the GHG impacts as noted above). Another way is the disassembly of machinery, cleaning and rebuilding as well as replacing the components of the machines through the remanufacturing process. In addition, purification which is the removal of unwanted mechanical particles and organic compounds, as well as treating pollutants at the end of production process, i.e. end-of-pipe, may also contribute to the minimisation of environmental destruction. However, this approach may only delay the cause of environmental problems because sometimes it may transmit the pollutants from one medium to another.

4.1.5. Economic health

Apart from the protection of the environment, economic development of industry must also be achieved in order to develop sustainably. The health of the economy can be achieved by "assessing and improving the organisation's current economic conditions through processes that consider and implement programmes to effect competitive advantage from which a flow of short- and long-term benefits for the entity" (Fava, et al., 1998, p. 544). In order to achieve the healthiness of the economy, market needs should be understood and forecasted as well as understanding what is available in terms of resources, investing capital responsibly and managing overall employment and growth. A company should operate profitably, while being environmentally benign and helping to maintain the social fabric of society (Gibson, 2000).

4.1.6. Social responsibility

Social responsibility in sustainable development considers the importance of the impacts created from an organisation or industry upon society either directly or indirectly (Fava, et al., 1998). The impacts should be looked at through their effect upon demography, economy, finance, socio-political system, society, community, family, socio-cultural issues and psychology. A more detailed explanation of the specific form of Corporate Social Responsibility (CSR) will be discussed in a later section of this chapter.

4.2. Sustainable Industrial Development (SID)

This section discusses the concept of sustainable industrial development and approaches to the concept. In addition, corporate social responsibility as well as the constraints that are hindering the sustainability of industrial development are discussed.

4.2.1. Definition of SID

It has been argued that environmental constraints are increasingly controlling the progress of business and industry as increasing pressures from legislation, insurance and finance, as well as stakeholders, all demand environmental excellence (Boron and Murray, 2004). At the same time, however, the economic system is also predominantly driving business and industry in an unsustainable way. This is especially true for manufacturing industry, which is often cited as the main cause of many environmental, as well as social, problems (Baldwin, et al., 2005). Because of this, it is important for businesses and industries to move towards sustainable industrial development in order to progress economically while still adhering to environmental standards and laws. It is stated in Agenda 21, Chapter 30 that "[b]usiness and industry, including transnational corporations and their representative organisations should be full participants in the implementation and evaluation of activities related to Agenda 21" (http://www.unep.org/documents.multilingual/default.asp?DocumentID=52&ArticleID=78&l=en). This shows that businesses should also pay particular attention to environmental management in carrying out their daily activities, from the extraction of resources until the treatment of their wastes. Business and industry may have negative impacts upon the environment but by adopting a more sustainable practices in business operations, the negative impacts can be avoided or at least minimised.

Based on the definition by the Organisation for Economic Cooperation and Development (OECD), sustainable industrial development may be defined as the constant innovation and improvement as well as use of environmental technologies in order to reduce levels of pollution and consumption of resources (as cited in Jenck, Agterberg and Droescher, 2004). In practical terms, it basically means employing technologies and technical know-how to use less material and energy, as well as maximising renewable resources as inputs, reducing pollutants or harmful waste generation during the manufacture and use of products, and producing biodegradable and recyclable products (Jenck, Agterberg and Droescher, 2004).

4.2.2. Promoting sustainability in industry

According to the World Council for Sustainable Development's 'Business case for Sustainable Development', there are a number of reasons why businesses and industries should promote sustainability in their operations (as cited in Jenck, Agterberg and Droescher, 2004). One of them is that profitability in itself is a driver for industrial sustainability. This is because if environmental deterioration is continued as a result from industrial pollution, businesses and industries may also be affected in the long run as they are dependent on the environment, as most of the raw material resources and energy are acquired from nature. In addition, pressure from environmental integrity, legislation and regulations also drives industries to promote sustainability in their business. Furthermore, there are also concerns from business shareholders, as well as employees and customers, about the importance of developing sustainably and it is also important for the business company to have a good image in the eyes of the public in order to have sustainability in their business operation.

4.2.3. Approaches in SID: the case of chemical industry

There are several approaches in Sustainable Industrial Development (SID) that can be utilised in order to achieve sustainability in the industrial production process. This sub-section illustrates a number of approaches that are potentially relevant to SID in petrochemical development in Brunei. This is because these approaches have been used to manage the production of chemical industry in a sustainable way. In order to achieve this, new technologies should be put in place so as to reduce or avoid the negative impacts from their operations. The approaches that are outlined in subsequent sections are: 1) ‘Green Chemistry’ and ‘Green Engineering’; 2) emissions reduction; 3) ‘benign by design’; 4) distributed manufacturing; and 5) industrial ecology.

a) <u>'Green Chemistry' and 'Green Engineering'</u>

One of the approaches to SID is by using the principle of 'Green Chemistry' which is a framework that is designed to reduce the environmental impact of products, process and system levels (Jenck, Agterberg and Droescher, 2004). In other words, chemical products and processes are designed so as to eliminate or reduce the use and generation of harmful substances (Glavič and Lukman, 2007). It relies on efforts to minimise waste, to increase the use of renewable resources, and to encourage eco-efficiency, as well as improved health and safety. Green chemistry emphasises the selections of feedstock, reagents as well as reaction pathways and the use of alternative solvents in order to reduce the amount of hazardous materials used.

'Green engineering' is also another approach that can be used, which aims to achieve improvement in industrial sustainability through technology (Jenck, Agterberg and Droescher, 2004). This is relevant to petrochemical development in Brunei as the approach relies upon technological change in order to achieve sustainability in production and could be readily incorporated. 'Green engineering' can be defined as the design, construction, operation as well as use of techniques that are practicable and economical while minimising the generation of pollutants at source, as well as risk to human health and the environment (Glavič and Lukman, 2007). It incorporates 12 principles that consider environmental, economic, as well as social, factors in designing new materials, products or processes (Jenck, Agterberg and Droescher, 2004). They are the following:

- Mass and energy in as well as outputs should not be hazardous;
- Waste prevention is better than clean up;

- Energy in the separation or purification processes should be minimised;
- Mass, energy, volume as well as time efficiency in the product or process should be maximised;
- Output-pull is much preferred to inputs;
- Energy is the main criterion when deciding between recycle, reuse or disposal;
- Durability must be targeted, i.e. no eternal life;
- 'One-size-fits-all' must be avoided and excess should be minimised;
- Industrial ecology can be achieved by integration and interconnectivity;
- Plan for performance in a commercial 'after-life'; and
- Favour mass and energy inputs rather than renewable sources.

b) Emissions reduction

Another way to achieve industrial sustainable development and one which is also relevant to the petrochemical industry in Brunei is to reduce the level of pollutants emitted to the environment. This can be achieved by increasing energy efficiency and use of renewable energy sources that will eventually reduce the industry's carbon dioxide emissions (Jenck, Agterberg and Droescher, 2004). However, it is estimated that 40 per cent of the Volatile Organic Compounds (VOCs) emitted to the atmosphere (i.e. about 15 per cent of global anthropogenic GHGs) come from organic solvents (some are flammable or toxic) that are widely used in the chemical and related industries. Some industries have made an effort to replace them by alternative solvents, for instance water, super-critical solvents, ionic liquids and 'neoteric solvents' (Jenck, Agterberg and Droescher, 2004).

c) ‘Benign by design’

Another important approach that is relevant to the petrochemical industry in Brunei is benign by design. A systematic approach to risk assessment and management can ensure the safe use of new technologies (Jenck, Agterberg and Droescher, 2004). ‘Benign-by-design’ processes will only use passive controls without any human interference being needed, which introduces the concept of ‘inherent safety’ (Jenck, Agterberg and Droescher, 2004). It is basically a cost-effective and pro-active methodology trying to remove hazards in the first place. The principles of the concept are as follows:

- Intensification, by which hazardous materials are being reduced in quantity;
- Substitution of much safer materials;
- Attenuation, i.e. run under much safer operating conditions;
- Effect limitation, where design and operation is changed for less severe impacts;
- Simplification, i.e. avoiding multi-product or multi-unit operations; and
- Error tolerance such as tougher equipment and fault tolerant processes.

(Jenck, Agterberg and Droescher, 2004)

d) Distributed manufacturing

Distributed manufacturing is also relevant to the SID of petrochemical development in Brunei as it is a strategy where smaller volumes of manufacturing are produced at a variety of remote sites which avoids the transportation of toxic, flammable materials as well as storage with high safety risks, and distributes the possible environmental effects

(Jenck, Agterberg and Droescher, 2004). Rather than manufacturing a product in one location and then transporting it to different customers, this approach is considered to be sustainable as it avoids the above mentioned risks to the environment.

e) Industrial ecology

The last approach of SID which is relevant to petrochemical development in Brunei is industrial ecology. Industrial ecology is aimed at incorporating the cyclical patterns of ecosystems into designs for the processes of industrial production that will work in harmony with nature (Jenck, Agterberg and Droescher, 2004). Most industries today are still using a strictly linear production process, i.e. extracting raw materials and fossil fuel and then processing the material and energy, and eventually returning the waste back into natural systems (Jenck, Agterberg and Droescher, 2004). The important article, 'Industrial Ecology: An Environmental Agenda for Industry' in 1993 (as cited in Jenck, Agterberg and Droescher, 2004) outlined six major elements in industrial ecology. They are as follows;

- Waste from one industry can be used as a feedstock for another industry (to create industrial ecosystems);
- Safe boundary of industry with nature, in terms of its location, intensity, as well as timing, and developing real-time monitoring indicators;
- Reduction of the intensity of materials and energy in industrial production (dematerialisation);
- Efficiency improvement in industrial processes, through re-design of the production processes and patterns for maximum resource conservation;

- Development of the supplies of renewable energy for industrial production; and
- Adoption of new national as well as international economic development policies.

Industrial ecology has influenced the establishment of eco-industrial parks (Glavič and Lukman, 2007). These are basically communities of businesses, manufacturing and services, located close together in a common property with the aim of seeking enhanced environmental and socio-economic performance via environmental and resource issues management, which includes information, infrastructure, materials, energy, water, and natural habitats (Glavič and Lukman, 2007).

4.2.4. Business and the environment: CSR

Apart from the responsibility to ensure the protection and management of the environment, businesses and industries should also adopt Corporate Social Responsibility or Corporate Citizenship (CC). CSR suggests that the business sector is beginning to reorganise its connection with both the environment and multiple stakeholders (Utting, 2000). This situation is in sharp contrast to the past scenario when big business was insensitive to the needs of certain stakeholders and responsible for much environmental damage. There is a rising number of large firms adopting such policies and practices in order to promote sustainable industrial development, especially in developing countries. According to Desjardins (2007), CSR means a firm has positive duties towards prevention of harm to the ecology or to do environmental good. Society in the form of consumers can through their demand direct business towards social and environmental goals in the marketplace and can also require such action through pressure towards legislative change.

As a definition, CSR can be defined as philanthropy or outside relationships with stakeholders in order to address social problems (Miller, 1998, as cited in Rondinelli and Berry, 2000). Some of the types of CSR include providing incentives for employees to work with the community in projects for natural resource conservation and protection, and giving donations and gifts for environmental programmes. Furthermore, CSR may also include the assessment of the quality of local environmental conditions as well as local environmental sustainability and carrying capacity, contribution to environmental infrastructure development or improvement, education and training programmes, sponsorship for teachers on environmental issues, funding community-initiated environmental initiatives and lastly, establishment of formal stakeholder relationship with environmental interest groups, non-profit organisations, as well as local governments in order to prevent or solve serious environmental problems.

4.2.5. Barriers and challenges in SID

Like any other approaches towards the sustainability of development, there are also some barriers and challenges in SID. It is important to take into account those challenges so that they can be compared to barriers and challenges that the petrochemical industry at SPARK is facing. One of the main challenges to achieve sustainable industrial development is not solely due to the lack of strategies as well as models and tools, but it is the question of how to implement them, and more importantly, how to introduce them into existing practices and at the same time improve the competitiveness of production (Baldwin, et al., 2005). The relationship between existing and sustainable industrial technologies and practices includes barriers in psychological, organisational, and institutional, as well as economic, terms that exist for the adoption of sustainable technologies. Moreover, there should also be an accurate calculation of costs and benefits and risks that need to be tackled, as well as assurances regarding whether the benefits of introducing environmental technologies and practices are of a short- or long-run nature.

In addition, there is also another important factor that needs to be considered in order to achieve sustainability in industrial development, i.e. socio-political factors (Jenck, Agterberg and Droescher, 2004). One challenge lies in the improvement of the chemistry, as well as the selection of raw and supplementary materials as well as in the smarter design of chemical manufacturing facilities. But in addition, the correct framework conditions are needed in order to enable successful investment in sustainable industrial development. These include incentives to increase research and access to finance for new innovation, cost-effective regulation that does not hinder change through over regulation, and lastly, appreciation by society, i.e. a real demand for new products and system.

Another set of constraints in the shift of industry to become sustainable are related to Human Resource Development (HRD) issues, mainly the rising rate of population, which leads to poor educational quality and alternative main services (Amin, 2001). Furthermore, some obstacles are also technical, e.g. limited technical knowledge, expense of conducting research, expensive price of imported pollution prevention technologies, lack of trained technical staff, and non-utilisation of cleaner production technologies in manufacturing industries. Another constraint is legislative, e.g. lack of coordination between authorities accountable for monitoring of pollution. Lastly, there are economic constraints, such as limitations in hard currency, raw material market prices fluctuations, government control over the exchange rate of foreign currency, as well as lack of global market companies.

4.3. Ecological Modernisation (EM)

Apart from the SID approach that can be relevant to the study of SPARK, this chapter also uses Ecological Modernisation (EM) as an approach to answer the research questions. This section, therefore, describes the history of ecological modernisation and explains the concept in detail. Some case studies of the concept are also presented and lastly, some strengths and limitation of the approach are discussed.

4.3.1. History of EM

Ecological Modernisation (EM) is a concept that originated from a number of European countries – Germany, Holland, and some Scandinavian countries. It was initially developed by German social scientists in the early 1980s, in particular in the works of Joseph Huber (1982) and Martin Janicke (1985) (as cited in Mol and Sonnenfeld, 2000). Some authors (Mol and Sonnenfeld, 2000; Revell, 2005) also argue that the theory was also developed by Udo Simonis in 1988 and in UK research. Today, the concept is gaining popularity and became widely known in the policy arena of other developed countries in the 1990s and 2000s (Zhang, Mol and Sonnenfeld, 2007), as well as in the field of environmental social science studies (Pataki, 2009). The theory arose so as to challenge the traditional ideas of environmental movements and counter-productivity theorists that environmental damage inevitably results from economic growth and the capitalist order. Huber (1982; 1985) argued that industrial society should undertake a transition towards sustainable production, i.e. combining environmental or ecological protection and economic growth together in order to achieve it (as cited in Gibbs, 2006).

Basically, there are three stages in the development and maturation of the EM school of thought (Mol and Sonnenfeld, 2000). The first one was characterised by "a heavy emphasis on the role of technological innovations in environmental reform, especially in industrial production, a critical attitude on the bureaucratic state, a favourable attitude towards the role of market actors and dynamics in environmental reforms, a systems-theoretical and rather evolutionary perspective with limited notion of human agency and social struggles, and an orientation towards analyses at the level of the nation-state" (Mol and Sonnenfeld, 2000, p. 4-5). The second stage (from the late 1980s to the mid-1990s) showed a more balanced view on the roles of states and 'the market' in ecological transformation and more attention was given to the institutional and cultural dynamics of ecological modernisation. Subsequently (the third stage), the theory has broadened not only theoretically but also geographically, to include studies on the ecological transformation of consumption, ecological modernisation in the non-European countries and to include global processes.

4.3.2. Interpretations of EM: a theoretical review

In brief definition, EM can be defined as an approach of technology based and innovation-oriented to environmental policy (Janicke, 2008). It can also be called strategic environmental management, industrial ecology, and eco-restructuring. (Buttel, 2000). It basically carries a positive message that ecological sustainability can be achieved by some transformations in society and institutions without leaving the modernisation path (Mol and Spaargaren, 1993; Pataki, 2009). It promotes the application of environmental policy to positively influence economic efficiency and technological innovation while still being able to harness the forces of business for environmental gain. In modern institutions, environmental issues are taken seriously and the emphasis of the incorporation of the environment is marked by some forms of modernization, such as optimism, progress belief in science and technology, and so on (Seippel, 2000).

The approach of EM can be used at two levels. It can be used as a theoretical concept to analyse changes in the modern society's central institutions in order to solve ecological crisis (Gibbs, 2000). According to Gouldson and Roberts (2000), modern society is seen as responding increasingly towards awareness of, and anxiety towards ecological risks associated with industrialism and increasingly analysing emerging discourses in the debate on the environment and industrialism. Also, EM is also used in a prescriptive way to guide programmes of policy reform. It offers a positive approach to solve environmental problems, with central role assigned to science, technology and the country (Gibbs, 2000).

According to Weale (1992), EM is an ideology based on the assumptions that the character of environmental problems is such that they can be handled separately and that end of-pipe technologies are adequate to solve them (as cited in Seippel, 2000). EM challenged the belief that there was a null trade-off between economic growth and environmental concerns. In fact, it is argued that environmental protection is needed for the potential source of economic profit and vice versa. Before, economic and environmental concerns were viewed as two separate entities, but in EM, they are considered to have mutual relationships.

Meanwhile, according to Hajer (1995), EM is a form of a policy strategy based on a fundamental belief that modern techniques and skills of social engineering have the capacity to progress and in problem solving (as cited in Seippel, 2000). EM assumes that the existing economic, social and political institutions can internalise care for the environment. Dryzek (1997) explains that EM has benefits for business in terms of pollution prevention and in the future, it also becomes much more expensive to solve environmental problems (as cited in Seippel, 2000). Moreover, a better state of the environment could be achieved from EM and more money is created by selling green goods.

Mol and Spaargaren (1993) also added that EM offers a constructive approach in dealing with environmental problems that depends on science, technology and the state. In EM, environmental interests are free from political and ideological interests as well as economic interests (Dryzek, 1997, as cited in Seippel, 2000). The processes of production and consumption can be rearranged on ecological terms via the institutionalization of ecological goals (Mol, 1994 as cited in Gibbs, 2000). In addition, according to Mol and Sonnenfeld (2000), in order to achieve a higher level of economic development and a lower level of environmental destruction, transformations are needed in terms of physical and social practices, institutional designs and societal and policy discourses, in order to maintain the basis of societies' sustenance.

Some of the important physical, social and institutional transformations that are mentioned by Mol and Sonnenfeld, 2000 are as below:

- Changing role of science and technology – science and technology are not only judged for their role in causing environmental problems but also valued for their role in curing and preventing them through invention-innovation-diffusion of new and cleaner, environmental technologies;

- Increasing importance of market dynamics and economic agents (e.g. producers, customers, consumers, credit institutions, etc.) – described as carriers of ecological restructuring and reform. This means that EM may increase economic competitiveness to raise revenues by designing new sustainable products, instead of increasing production costs. Consumers nowadays are becoming more environmentally conscious and thus, this actually shapes the way business is operating. More consumers would like to purchase more sustainable products and hence business will be benefited from this;
- Change in the role of the nation state – more decentralised and flexible governance, a less top-down approach, national pro-active command-and-control environmental regulation (political modernisation);
- Modification in the position, role and ideology of social movements – a partial shift from anti-systemic, de-modernisation towards reform ideologies; and
- Changing discursive practices and emergence of new ideologies emerged – complete negligence of the environment and prioritization of economic over environmental interests are no longer accepted as legitimate positions.

4.3.3. 'Win-win' opportunities: driving force of EM

The main emphasis of EM lies on the opportunity for a 'win-win' solution between ecology and economy as economic development and environmental policy can be reconciled through the reduction of cost and innovation competition (Pataki, 2009). It recognises the idea that economic growth should not lead to higher rates of environmental degradation by increasing the environmental efficiency of the economy (Janicke, 2008).

According to Janicke (2008), at present, there are two driving forces of EM, namely, the role of 'smart' government regulation (environmental regulation) as well as a growing risks of business for polluters in the multi-level environmental governance. The 'smart' regulation and the growing constellation of complex actors in multi-level governance force 'dirty' industries to innovate. Eventually, this leads to the global process of 'ecological modernisation'. Environmental pressure and the competition for innovation as well as the market potential of global environmental needs offer solutions for environmental problems.

4.3.4. EM as a political programme

As a political programme, EM can be used to provide compensation for any environmental damage caused and the use of additional technologies in order to minimise the impacts of growing production and consumption towards the environment (Gibbs, 2000). In addition, it is also used to alter the processes of production and consumption through clean technologies and use of economic valuation. Lastly, there is also a transformation on small-scale units of economies and a closer relation between production and consumption. As a practical political programme, EM will be supported by business because it involves financial advantage as it responds through environmental issues to the concept of profitable enterprise (Harvey, 1996; Weale, 1992, as cited in Gibbs, 2000). This can come firstly, through the reduction of pollution level and waste production that will result in greater business efficiency and secondly, via avoiding financial liabilities in the future, for instance possible cost of cleaning contaminated water or land. In addition, this can come also through creating a better environment that will attract a company's workforce and via the sale of products and services that are environmentally friendly, as well as through the sale of pollution prevention and abatement technologies (Dryzek, 1997, as cited in Gibbs, 2000).

4.3.5. Key features of EM

There are various key features of EM that are believed to be relevant to petrochemical development at SPARK. The key features that are used in the thesis are, 1) Technological Environmental Innovations (TEIs); and 2) stringent regulation in eco-innovation.

a) <u>Technological Environmental Innovations (TEIs)</u>

One of the most important element in EM is to have Technological Environmental Innovations (TEIs) such as sustainable resource management, clean technologies, substitution of harmful substances, environmental friendly product design, product stewardship, low emission processes, and etc. (Huber, 2008). The invention-innovation-diffusion of new and cleaner technologies is heavily emphasized in technology advancement (Pataki, 2009). According to Spaargaren and Mol (1992), environmental problems are best solved by further advancement in technology and industrialisation. This is different from other established theories of environment-society relationships that tend to view technological innovation and economic growth as the cause of environmental damage and unable to provide environmental preservation (Fisher and Freudenburg, 2001). Cohen (2000) mentioned in his work that in order for a country to embrace the components of EM, public commitment to science and a strong environmental consciousness must be achieved (as cited in Fisher and Freudenburg, 2001).

It is important that the new technology should contribute to significantly increased eco-efficiency so that the reduction and even avoidance of environmental disruption can be achieved. Huber (2008) has identified typical areas of TEIs as the following:

- Regenerative and fuel-less type of energy e.g. solar, wind, tidal and wave;
- Substituting clean electrochemical fuel cells from power stations to vehicle propulsion;
- Clean coal in zero-emission power plants;
- White transgenic that replaces the high temperature and pressure that creates more damage to the environment;
- Replacing harmful chemicals with low-impact substances;
- Replacing fossil fuel as raw materials in bio-feedstocks;
- Using new ultra-light and ultra-strong materials for the reduction of the materials and energy; and
- Nanotechnology that causes less environmental effects.

b) <u>Stringent regulation in eco-innovation</u>

Stringency in this kind of regulation of eco-innovation is different from a typical command-and-control type of regulation that usually leads to very difficult application procedures or prescribes some best available technologies that must be implemented (Huber, 2008).

4.3.6. Global diffusion of eco-innovations through internationally active companies

Companies are very important to environmental governance as they are part of the value chains and take the major decisions on developing, producing and using TEIs (Levy and Newell, 2005, as cited in Huber, 2008). This is how EM is coming to ground in Brunei through transnational petrochemical companies from Japan. Transnational companies and medium-sized internationally active companies are the key operative agencies to introduce those technologies in the pioneer countries (Huber, 2008). This can be done by foreign sales, international co-production, industrial joint ventures, research and development cross-border, outsourcing and subcontracting as well as licensing (Giroud, 2003, as cited in Huber, 2008). The majority of the innovation benefits (80 per cent) of EM accrue to domestic and foreign partners, tax collectors, employees as well as users, whereas the original company that introduces the innovation only receives about 20 per cent of the benefits (Baumol, 2002, as cited in Huber, 2008).

4.3.7. Successful examples of EM – case studies

EM as an environmental strategy and concept may have high potential to contribute to environmental improvement in some ways. Below are a few successful examples of the adoption of EM in improving the state of the environment. These examples are important to the thesis's case study in order to compare whether petrochemical development at SPARK experiences the same success of EM as these examples or otherwise.

a) EM experience in petrochemical plant in Hungary (Pataki, 2009)

The Hungarian petrochemical firm was established in 1953 for the manufacturing of plastic and later during the 1980s, several polyethylene and polypropylene plants started their operations, which contributed to the increasing market share of the chemical firm (Pataki, 2009). In 2000, the company was taken over by another company and since then, its operation has been revised to expand and sell off strictly unrelated business units. There were 2300 employees who worked in the plant and about 5000 worked for the whole business group. The aim for the new operation is to reconcile business profit and environmental protection in line with the basic criteria of EM.

The chemical firm only operates with well-known technologies whose licenses are bought from multinational corporations that have sufficient financial resources to participate in the research and development of basic petrochemical technologies. The technologies that were brought in are from flagship firms in environmental improvement and have stood the test of time. They originated from the Western European countries and developed countries.

As a result of the technologies adopted in the operation of petrochemical plants, there is an improvement in the environmental state of the country in reducing environmental pollution. Based on the environmental performance in the late 1990s, the chemical firm is excellent in complying with every relevant environmental regulation and no complaints were received from either environmental authorities or the local population. However, it should be noted as well that the chemical operations of this plant involves high environmental risks, its production is potentially dangerous and the primary raw material used in production are non-renewable resources – crude oil and natural gas, which are depletable over time. Thus, it places a burden on the biosphere.

Even though there has been an improvement of the environmental performance of the firm as a result of the adoption of such technologies, the firm has gone even further. The newly established business unit of environmental technology for the re-use of mixed plastic waste was considered to be part of the synthesis desired. This provides a synthesis between industry and ecology, which is the basic promise of EM. In addition, the environmental technology business unit also aims at closing the petrochemical cycle and developing a new method for re-manufacturing of the reuse of plastic as in the post consumption phase, the different types of plastics are mixed, and therefore, cannot be reused due to their different chemical and mechanical characteristics.

Apart from the technological innovation, environmental research capability was also established with a team dedicated to environmental research and the appointment of a university professor as the director of corporate research and development. The employees of the firm were also highly educated and the chemical plant management has also followed up the actual achievement level in relation to environmental expectations. Strict discipline and careful attention were also given to a potentially hazardous plant by organising and controlling it systematically by standards. This indicates that ecology is being integrated into industry, thus upholding the promise of EM.

To summarise, the most up-to-date technologies have been applied and are operated by the highly educated and disciplined employees at all times and ‘modern’ employees are also more environmentally conscious and more self-demanding in this respect as well.

Also, the chemical plant management has always followed the environmental expectations. With respect to the potential hazardous plant, strict discipline and careful attention are given and are systematically planned and controlled by standards.

b) Phasing out of nuclear energy (Janicke, 2004)

Nuclear energy has the potential for causing heavy risks to the health of people and the environment, and without some incremental technological risk reductions, an adequate technical solution is not available. In 2002, the German 'Atom Energy law' was amended to cut down nuclear energy by 2020 (Mez and Piening, 2002, as cited in Janicke, 2004). The first closing down was taken place in Stade in 2003 and as of 2010, there was only one nuclear power station planned for construction in the European Union (EU), in Finland. Even France, the main proponent of nuclear energy in the EU has refrained from creating new power station and in fact has announced proposals for seven gas power stations and seven wind parks and other forms of renewable energy (PLATTS, 2003, as cited in Janicke, 2004). This trend has had a positive side-effect on technological innovations, i.e. the role of renewable energy as substitute for nuclear energy was greatly improved.

4.3.8. Applicability of EM in the developing countries – case studies

Some studies found EM to be useful for analysing specific environmental reforms (Sonnenfeld, 2000, as cited in Zhang, Mol and Sonnenfeld, 2007) but others provided little evidence for its success and some are still hoping for EM inspired reforms, but viewed the hope as unrealistic (Phuong, 2002, as cited in Zhang, Mol and Sonnenfeld, 2007). Being originally developed in the advanced developed regions of Europe, EM has mostly been examined in advanced industrial societies and few studies have taken into account its applicability in the developing and Newly Industrialising Economies (NIEs). Therefore, the value and the applicability of EM for developing and NIEs is often questioned (Frijns, Phuong and Mol, 2000). According to Mol and Sonnenfeld (2001), it is too early to determine the applicability of EM to different economic, cultural, political and geographical settings and locations across the globe. According to Hannigan (1995, as cited in Fisher and Freudenburg, 2001), the concept of EM may be appropriate for countries where most of the theoretical development has taken place, such as Germany and Holland, while proving less applicable for countries such as the United States (US). This is due to the fact that for advanced industrial countries, there is a prerequisite for green industrial restructuring, for instance, the presence of a welfare state, advancement in technological development as well as a state regulated market economy and widespread consciousness of the environment (Mol, 1995, as cited in Sonnenfeld, 2000). Advanced developed nations have well-developed consumer markets as well as high wage and raw material cost and EM in these countries combines improvement of environmental performance with productivity gains and manufacturing efficiencies.

Below are some examples of EM that has been practised in the developing countries.

a) Pulp and paper manufacturing in South-East Asia (SEA) (Sonnenfeld, 2000)

Based on a study carried out by Sonnenfeld (2000) on the pulp and paper industries in the late 1980s and early 1990s in SEA, there is an improvement in efficiency, reduction of waste, and progress towards clean production. This has been a result of the adoption of cleaner production technologies that are being used to replace older technologies. Government environmental agencies in the NIEs are moving towards a collaboration with producers. It is said that the Non-Governmental Organisations (NGOs) are the key players in the process for both ‘inside’ and ‘outside’ environmental regulation and management in SEA as elsewhere in other parts of the world. One advantage of the Newly-industrialising Economies (NIEs) is that the countries have been able to use the latest and cleaner technologies from the beginning of the development of a large-scale, modern manufacturing via ‘leap-frogging’ from Finland and Sweden, which have major research and development in the pulp industry, and at the same time they are also benefiting from cheap raw materials and employees’ low wages. An industry like pulp and paper, which is resource-extractive and also export-oriented, is in a strong position to benefit from such advantages. The costs of the adoption of cleaner technologies are lower in the South, while there is a strong pull of international ‘green’ markets and standards for export-oriented industries. Producers in SEA took advantage of the downturn of the global economy as well as the reconfiguration of European trade and the closure of the USSR to negotiate low prices for the new technologies.

Pulp firms in SEA have made an important and substantial reduction of waste, in terms of its amount per tonne of product. The technologies adopted by the new pulp mills are among the most efficient in the world, although they have not been adopted by the smaller mills, and older pulp mills are still owned and kept by some governments. As well as that, modifications of the process has also been made to the previous generation of pulp mills in order to reduce the amount of waste generated. Diffusion and modification of environmental pulp and paper technologies in SEA are facilitated by firm based research and development laboratories and national industry research centres, as well as regional networking. It can be seen from the above that the SEA's pulp industries are well on the road of EM as one of the objectives of EM is on waste reduction and elimination, even though problems remain with the Small and Medium Enterprises (SMEs) of the pulp sector.

Moreover, in terms of resource recovery and reuse, there has been outstanding achievement by the SEA's pulp industries in the reduction of the usage of water per tonne of pulp produced. In addition, chemical recovery in the new mills is also highly advanced. The re-use of fibre resources and utilization of agricultural waste as well as wastepaper as raw materials are also practised but as the scale of the sector is getting larger, the industry is moving away towards greater reliance on using virgin raw materials from native forests and tree plantations (Sonnenfeld, 1998, as cited in Sonnenfeld, 2000).

In addition, governments in SEA also worked together with the pulp and industry and NGOs to encourage pulp producers to take preventive measures in their operations in order to create less harmful effects on the community and on the natural environment. Even though the environmental regulatory efforts in countries such as Indonesia and Thailand are weak, national environmental agencies were forced to stop the production of pulp mills that were thought to be damaging to the environment. National environmental officials in Malaysia pressed pulp mills more than other types of industries in the country. Governments in SEA also provided incentives for the cleaner technologies investment from the beginning. For example, in Thailand, government agencies created site-licensing and EIA review procedures to improve emission standards, and established more public participation in the project. Also, in Indonesia and Malaysia, environmental standards with site-specific licensing, auditing and environmental reviewing are imposed by government agencies.

Having said that, the pulp and paper industries in SEA failed to meet a significant criterion of EM, i.e. the dematerialisation of production that is always met in the advanced countries. In EM, dematerialisation of production can be achieved via the substitution of high technology for raw material inputs or through the substitution of recycled or recovered waste for virgin raw materials. In Indonesia, a huge volume of virgin fibre is used in greenfield pulp mills in order to maintain full production. Government policies that have awarded very large forest concessions to companies with little or no cost exacerbated the situation by accelerating the growth of the plantations. Therefore, in the long-run, pulp and paper industries in SEA have not been able to conserve natural resources and thus, they failed to meet the criterion of EM in resource conservation with regard to virgin fibrous materials. However, one critical question should be asked, whether the successful effort in dematerialisation in the North is a result of depending on materialisation elsewhere, perhaps in the South? If this is happening, then EM can never be achieved.

It seems that EM can only be applied in the large scale enterprises when compared to the SMEs of pulp industries. Many of those SMEs are older and use poorer technologies as well as being more polluting to the environment. Because it will incur so much social costs to phase out some or many of such firms, governments should devise incentives to encourage technology firms to develop more ecological, smaller-scale production.

b) EM in Viet Nam (Frijns, Phuong and Mol, 2000)

Different from the pulp and paper industries in SEA that have successfully met some of the criteria of EM, EM ideas in Viet Nam cannot really shed light on the environmental reform of the country. One of the reasons for this is that environmental monitoring in Viet Nam is not possible due to lack of financial and human resources and there has been a failure to develop and implement environmental technologies in the country. There are few independent environmental NGOs and environmental activities among economic agents are also almost absent. In addition, there is no social movement from the public to put sufficient pressure on the government and industrial organisations for ecological reform, due to the lack of awareness of the environment among the public. Furthermore, the state and social organisations are also tightly linked, which prevents the establishment of independent NGOs with free access to information and the mass media.

However, according to Frijns, Phuong and Mol (2000), there is some development in environmental transformation in Viet Nam that suggests the start of EM adoption by the country. For instance, there is an introduction of market-based instruments through the polluter-pays principle that is endorsed in the Environmental Protection Law and it is expected that there will be further diversification in the environmental policy instruments. In addition, the transition to a market-oriented economy and the slower path of privatisation will result in a change in an environmental industrial practices along the lines of EM. As well as that, the new policy of inviting Foreign Direct Investment (FDI) into the country may also help the country's industries to adopt more advanced environmental technologies and as a result meet international industrial standards. International NGOs, which have grown its numbers, may also help to redirect the course of industrial development and pave the way for national environmental NGOs. Scientists in Viet Nam are also contributing to distribute environmental information, which results in extending governmental actions and the mass media are also paying more attention to environmental problems, which helps in raising environmental awareness among the society and puts some pressure on industrial polluters.

One important fact that can be added regarding the process of EM in Viet Nam is that the process is slightly different from what is currently found in the Western literature. The first difference is the role of academic community in Viet Nam, which put the environment on the political agenda, as well as developing appropriate environmental technologies and strategies. Secondly, the economic dynamics in environmental reform is made through the state controlled orientation to a market economy, rather than through privatisation. Thirdly, pollution control is carried out by consultation with the private and public sector within the hierarchical policy of a developmental state. An increased role in environmental decision making is also being played by civil society, through community pressure and local initiatives as well as public state interaction.

4.3.9. Strengths and limitations of EM

There are some strengths that can be deduced from the concept of EM. The first one is that it draws attention to empirical shifts in social approaches towards environmental discourse which are very important (Seippel, 2000). Secondly, it also focuses explicitly on the cultural or ideological aspect of this change and EM also successfully brought attention to this field of research and stimulates interest in an important issue. In addition, according to O’Neill (1992), EM also offers an understanding of the national environmental policy in a changing international context (as cited in Fisher and Freudenburg, 2001). Moreover, according to Weale (1992, as cited in Seippel, 2000), in EM, environmental protection is not a burden on the economy, but it is in fact a precondition for sustainable growth.

However, there are also some limitations of EM. The most negative reaction towards EM is from Giddens (1998), who argues that the concept is 'too good to be true' (p. 57, as cited in Fisher and Freudenburg, 2001). According to Giddens (2001), EM skirts some of the important challenges that ecological problems pose only for the social democratic thought.

One of them is that environmental improvement can only be neutralised by economic growth if increases in economic efficiency remain below the growth rate (Janicke, 2008). EM may also meet the resistance of 'modernisation losers' that have the capabilities to limit the scope of environmental policy. In addition, factors such as limited information, shortages of managerial capacity, financial capital and risk aversion in the innovation process may also inhibit the rate of innovation of new technologies and thus limit the success of EM (Gouldson and Murphy, 1997). Moreover, marketable technological solutions are not always available to solve some relevant environmental problems such as the loss of species (Janicke, 2004; Janicke, 2008). Therefore, EM is also not sufficient to ensure long-term environmental stabilization, as it is unable to cope with all environmental problems (Janicke, 2004).

In addition, according to Janicke (2004), environmental innovations through EM cannot become the only solution for structural change; rather, the solution lies in a sectoral strategy which is beyond simple technological improvements. In fact, the most significant limitation of EM is that EM mostly reflects the experiences of the Western industrialised societies (Christoff, 1996; Dryzek, 1997, as cited in Langhelle, 2000). Therefore, EM has no relationship to global environmental problems such as global warming, acid rain, etc. or towards social justice (Langhelle, 2000). EM may only be applicable on environmental reform that is on the meso-level or national governments as well as environmental movements, enterprises and also labour organisations (Spaargaren, 1993, as cited in Langhelle, 2000). As EM develops, it must also take into account that it should not only become a marketplace for new ecological ideas and technologies, but also should act as a locus of shifting and increasing material production in the entire globe. As well as that, consideration should be given to its applicability towards the SMEs as well as developing and NIEs nations so that the theory can be used by all.

4.4. Resource use conflict management in Integrated Coastal Management (ICM)

As both concepts of SID and EM only discuss issues on the application of technological innovation and transformation as well improvement in achieving ecological sustainability, the theories did not mention about stakeholders' conflict issues at the industrial development. Because this research also involves the study of conflict issues among the stakeholders who have priorities at and surrounding SPARK, this chapter also discusses on resource use conflict management in Integrated Coastal Management (ICM). The main reason for using conflict management in ICM is due to the fact that SPARK is located on a coastal area and thus, it is relevant to use this approach in answering one of the research questions of this thesis.

This section thus, illustrates briefly the concept of resources conflict management in ICM. Firstly, it defines the concept of ICM and then later it discusses issues in conflicts in coastal resources and examines how those conflicts are managed under the concept of ICM. Lastly, this section discusses the barriers that the concept faces in managing conflicts in resource use in the coastal area.

4.4.1. Definition of ICM

As there is much development concentrated in coastal areas such as industrial activities as well as coastal and ocean development activities (e.g. building of structures, mining, dredging, and etc.), these have seriously undermined the environment and ecology of the coastal zone and significantly affected the functions of coastal and ocean processes as well as resources (Cicin-Sain and Knecht, 1998). In order to reduce or avoid the impacts from human activities on the coastal and marine areas, it is very important for the areas to be managed sustainably and this is the role of ICM. According to Cicin-Sain and Knecht (1998), ICM can be defined as a "continuous and dynamic process by which decisions are made for the sustainable use, development, and protection of coastal and marine areas and resources" (p. 39). It is called 'integrated management' because the aim of ICM is to overcome the fragmentation in both the sectoral management approach and in government authority.

The main goals of ICM are to achieve sustainability in the development of coastal and marine areas, to reduce vulnerability to natural hazards of coastal areas and their inhabitants, and to maintain crucial ecological processes, coastal life support systems, as well as biological diversity in coastal and marine areas (Cicin-Sain and Knecht, 1998).

ICM has also multi purposes. It can be used to analyse development implications, conflicting uses, as well as interrelationships of coastal physical processes and human activities. It can also be used to promote connections and harmonization between sectoral coastal as well as ocean activities.

Turner, et al. (1999) add that ICM should also include the integration of programmes and plans for regional economic development as well as environmental management and coastal management. Furthermore, there is also an integration of coastal management with various sectoral plans such as for water resources, fisheries, energy, transport, waste disposal as well as natural hazards management. Apart from those two types of integrations, there should also be an integration in responsibilities for coastal management across all different levels of government, national, regional, international as well as between public and private sectors. Integration through implementation from planning and design should also be incorporated in ICM, as well as integration among disciplines for examples, ecology, geomorphology, economics, engineering, political science and law.

4.4.2. Conflicts between stakeholders

As activities in the coastal areas have increased and new types of coastal uses are introduced, there is an increasing conflict between uses, resulting in a disruption of the ecosystem in the coastal area has been resulted (Vallega, 1999). For example, the siting of a petrochemical plant in a coastal area may have the potential to alter the coastal ecosystem by using huge space, freshwater, and infrastructure for land transport and thus, this would influence its biotic community organisation. Apart from the environmental impacts, conflicts between stakeholders may also have impacts on the socio-economy of the coastal area as one user may have a conflict over coastal resources with another user, e.g. fishermen with people spending a holiday on a beach. Similarly, according to Brody, et al. (2004), the increasing level of population growth and urban development in the coastal areas, combined with a decline in critical natural resources, is also exacerbating environmental conflicts. When the coastal resources become scarcer and more human activities become more concentrated on the coastal and marine areas, various stakeholders are brought into conflict relating to conservation and development.

In order for an ICM to address conflicts in resources successfully, it is important to understand the nature and causes of conflicts that occur among various coastal users. Figure 13 shows conflicts among coastal users in the coastal system organisation framework. The figure shows that interaction between uses by the stakeholders may create three relationships. The relationship can be beneficial, neutral, or conflicting. The latter relationship will be the one that would cause negative impacts on the coastal ecosystem and would disrupt the organisation of the coastal ecosystem and change the organizational framework.

Conflicts may arise between 1) two or more users who use the same resources or 2) existing user and potential users or 3) between existing users. Some authors (e.g. Cicin-Sain and Knecht, 1998) identify two different major types of coastal conflicts, namely, 1) conflicts among stakeholders and 2) conflicts among government agencies that administer coastal programmes. For the purpose of this research study, the focus will be only the latter type of conflict, as the study is concerned with the development of the petrochemical industry.

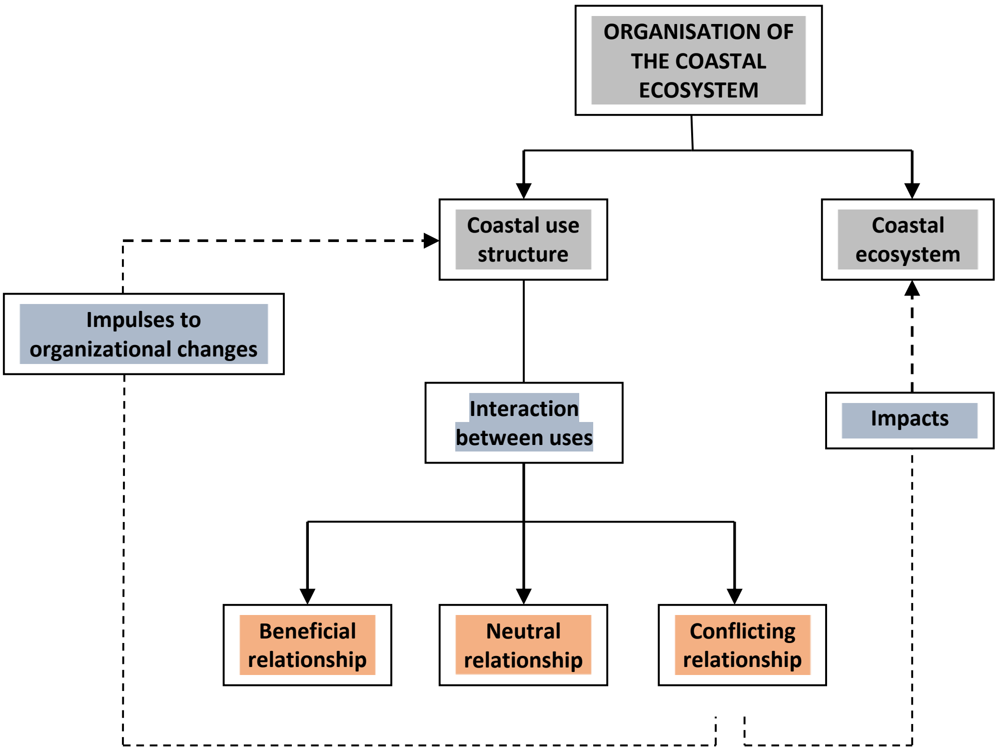

Figure 13 Conflicts between coastal stakeholders in the coastal system organisation framework Source: Vallega, 1999

There are various reasons why conflicts among users tend to occur and some of these reasons are described by Cicin-Sain and Knecht (1998). One of them is due to the competition for ocean space, such as competition in aquaculture and fishing. Another reason for the occurrence of conflicts is due to competition for the same resource, for example when commercial and recreational fishermen are catching the same species of fish. Thirdly, competition for a linked resource is another reason for resource use conflict, such as when both fishermen and marine mammals pursue salmon. Apart from those conflicts, another type of conflict may arise if there are negative effects of one use on the coastal ecosystem of another use; for instance, offshore oil development may have negative effects on the concentration and reproduction of fisheries. Lastly, competition among users for the same space onshore may also create conflicts among the users, such as when recreational activities compete for space with aquaculture.

Conflict identification in coastal resources is very important in order to evaluate whether and how conflicts may disrupt the integrity of the ecosystem, economic efficiency and social equity. A coastal use-use relationships table is a model that is used to identify conflicts between users in coastal areas (Vallega, 1999). Table 2 shows a simple example of the coastal use-use relationship. This matrix or table shows that some conflicts in resources can be identified. In addition, conflicts may also be identified from the use of the mapping method (Cicin-Sain and Knecht, 1998) where landuse indicators found from the map can be analysed in order to identify the conflicts.

Table 2 Coastal use-use relationship table

Stakeholder/Conflicts	Brunei Economic Development Board (BEDB)
Department of forest	The project would affect the ecosystem of the forest reserve that is found in the coastal area through air pollutants emission from the project
Environmentalists	The project would disrupt the ecosystem of the coastal area and this would upset the environmentalists
Local communities	The construction of the project would cause noise pollution and disrupt the everyday lives of the locals; air pollution from the project would cause health deterioration to the communities, etc.

4.4.3. Resource use conflict management

Resolving conflicts among coastal as well as ocean users and agencies is an important function of ICM (Cicin-Sain and Knecht, 1998). There are three important elements for an ICM programme to be effective in addressing those conflicts (Cicin-Sain and Knecht, 1998). The first element is the effort to understand the roots as well as causes and consequences of conflicts in the coastal and marine zones by using conflict “mapping”. For instance, to address conflicts effectively, coastal managers must understand the root causes of conflicts, such as asking the questions, ‘what values are people disagreeing over?' and 'who will get what in terms of the distribution of scarce resources or space?'. Secondly, for making decisions about resolving conflicts, there should be an established and transparent process. Lastly, it is also important for the ICM to be capable to adopt and implement measures in order to remedy any damages caused from coastal development or through the actions of other coastal and ocean users.

In order to manage conflicts between users of the coastal resources, two conflict management approaches can be undertaken. They are 1) reactive management (solving the conflicts) and 2) proactive management (preventing the conflicts). For the purpose of the research study, the latter approach will be used. Government agencies are the main players in this management approach but sometimes it may involve private sector mediators as well. A proactive approach can be developed in many ways. One of them is zoning. Zoning schemes involve locating uses in different parts of the coastal zone. Another way is prioritizing potential coastal uses by ranking them in accordance with management goals.

It is also important for managers and planners to carry out their roles in order to prevent or manage conflicts. Some of the roles of managers are to 1) monitor existing and potential conflicts; 2) classify and design the possible conflicts brought about by coastal system; 3) assess the social perception of conflicts; and 4) make or raise awareness of the local community to prevent or resolve the conflicts. In addition, some of the roles of coastal planners are to 1) focus on the crucial conflicts that may have influence on the coastal ecosystem evolution; 2) evaluate the conflict influences on the local ecosystem; 3) evaluate the conflict influences on the human community; 4) use the zoning approach to prevent conflicts; and 5) set up a monitoring system.

4.4.4. Barriers and solutions

There are some challenges and barriers that resource use conflict management in ICM may face. According to Turner, et al. (1999), one of the obstacles to the sustainability of coastal resources development is the lack of political will in governance investment in order to deal with the complex relationships found in coastal areas. By right, policy should conform to the precautionary principle, for example safe limit standards. By contrast, to date, coastal management is more often dominated by a more closed attitude in buffering any socio-economic activities and coastal resources from natural hazards and risks through hard engineering protection.

Another challenge in solving conflicts in resource use in ICM is a tug-of-war between conservation programme and development interests (Brody, et al., 2004). As coastal resources become scarcer and economic development in coastal areas intensified, conflicts between various stakeholders could transform into disputes. The best solution for this is to investigate the areas where stakeholders' priorities are most likely to result in conflict and then take action in order to prevent future disputes. This will alert policy makers to avoid those conflicts and propose actions for conflict management and techniques for dispute resolution.

4.5. Use of the theoretical approaches to the research

After looking at the two main theoretical approaches (SID and EM) as well as resource use conflict management in ICM as a secondary approach in order to answer the research question on the resource use conflict issue among stakeholders at and surrounding SPARK, there are some important points that are worth to consider and discuss.

Firstly, after looking at the main contents of SID and EM, it can be said that there is an interdependent relationship between the main components of sustainable development, i.e. environment, economy and society. The correct phrase that explains this interdependency is that there is a trade-off between those three components, that is to say, a choice must be made whether to sacrifice the loss of environmental value for some level of economic growth and benefits to society and vice versa.

In addition, what is so similar in both of the theories is the importance of technological innovation or environmental technologies. Such technologies must be installed from the start of the industrial production until the end of its life-cycle. To acquire environmental technological innovation is seen as a must for businesses and industries, if they are to achieve sustainable development. Technologies are used to avoid and reduce as well as to treat the pollutants that are emitted into the environment.

Like any other theoretical frameworks, there are also some limitations in the approaches, so that they cannot be used alone to achieve sustainability of development, for example in terms of the concept's applicability to a given time scale, across nations and within a nation. For example, as in the case of SID, there are other factors such as institutional framework and sectoral strategy which are also important in order to achieve sustainability in industrial development, apart from acquiring advanced environmental technologies for that purpose. What is more important is to look at the situation of a country, such as the socio-cultural and political factors, before making any decisions such as what kind of environmental technologies are suitable to be used for a particular type of industry, and so on.

Another best example is the theory of EM. It was argued earlier that the approach of EM in developing countries may not be applicable as the origin of the concept was from the developed nations such as Germany and Holland. However, it has been also illustrated in this chapter that the approach may be applicable in some ways such as in the case of pulp and paper manufacturing in SEA even though there are certain areas in EM that those countries cannot fulfilled for example the concept of dematerialisation as other developed countries may achieve.

For EM to be applicable across nations, the theory should be understood as something geographically or culturally specific, rather than the same everywhere. This is because every country may have different socio-cultural and political factors that in some cases, due to its differences, EM cannot be adopted fully. For instance, some developing countries that are still based on the top-down approach in their governments may not be developed sustainably as it was mentioned earlier that one of the key transformations for achieving sustainable development in accordance to EM is the change in the role of nation state i.e. more decentralized and less top-down approach. If this becomes one of the main characteristics in EM to achieve sustainable development, EM may not be achieved globally. So as long as the economic health, social responsibility and environmental protection are being prioritized in industrial development but the nation state is still based on top-down, sustainable development may still be achieved. In a way, EM should be made adaptable to the socio-cultural and political factors in a specific country so as long as the social responsibility, economic health and environmental protection are prioritized.

Another example is on the dematerialisation of production that many developing countries are still using virgin raw materials in their production for example in the case of SEA in pulp and paper manufacturing where virgin raw fibre is still used. It was also mentioned earlier that there is a probability that the success of dematerialisation in the developed countries is as a result of materialization in the developing countries and thus EM cannot be achieved. In this sense, it is important to think that EM is geographically or culturally specific so that it makes sense that it can be used to develop sustainably in industrial operation. Because Brunei is neither a developed nor developing country, it would be interesting to see whether the concepts such as SID and EM can be made relevant to the industrial development of the country or the opposite.

In addition, as it was mentioned few times in this chapter, the concept of resource use conflict in ICM will also be used in this study in order to answer the research question on the possibility of resource use conflict issue that may be present at and around SPARK. After looking at those frameworks, it can be found that approaches of SID or EM can be combined together with ICM i.e. by drawing on ICM's focus on conflict management. SPARK is an industrial development which is located on a coastal area and thus by studying the impact of the development towards the economy, society and environment may add to the literatures on SID or EM that focuses on the industrial development in coastal areas.

For the purpose of this research, the two main theoretical approaches (SID and EM) will be used as the frameworks of this study. This will be presented in Chapter 9 of this thesis.

4.6. Summary and conclusion

This chapter has outlined the theoretical frameworks that will be used in this research. First, it has described and explained the concept of sustainable development as an introductory framework for the two main theories, sustainable industrial development and ecological modernisation. The three components of sustainable development: environment, economy and society are integrated together in order to achieve a development that is sustainable. In the sustainable industrial development framework, it has been explained that the focus is on constant innovation and improvement as well as use of environmental technologies in order to reduce levels of pollution and consumption of resources. There are a number of approaches that can be used in order to achieve sustainable industrial development, namely, 'Green Chemistry' and 'Green Engineering', emission reduction, benign by design, distributed manufacturing, and industrial ecology. Corporate social responsibility was also explained in the section as it is also part of the effort made by businesses and industries to develop sustainably. As with any other theoretical frameworks, the concept of sustainable industrial development may also face some challenges and obstacles that should be considered in order to develop in a sustainable manner.

Secondly, the concept of ecological modernisation has also been explained and discussed in this chapter. This basically carries the meaning of a technology-based and innovation-oriented approach to environmental policy. Because of the 'win-win' opportunities, this has become a driving mechanism for the concept to be used by businesses and industries. There are some key features of the theory that were also explained here, and some successful examples given of industries that have adopted the approach to move towards sustainable development. The applicability of the approach in the developing countries was also discussed, as the study focuses on Brunei which is also a developing nation. Lastly, the strengths and limitations of the concept were also mentioned in this chapter.

Resource use conflict management in ICM was also explained briefly in this chapter. Firstly the definition of ICM was explained briefly and then issues in resource use conflict as well as resource use conflict management were discussed. Barriers to the management of resource use conflict were also brought up and possible solutions to the challenges were proposed, based on previous studies.

After looking at the theories, the main ingredient that have been presented in the theories are on the sustainability of development. There is a similarity between SID and EM in such a way that both of the theories put heavy emphasis on the advancement of environmental technologies in order to achieve sustainability in industrial development. However, for the theories to become relevant across nations, it should be understood that they are more geographically and culturally specific so that the main aim of sustainable development can be achieved. After looking at those theories, there is a possibility of combining the theories such as EM and ICM in terms of drawing issues on conflict management and thus, this adds to the literature of sustainability especially focusing on sustainable industrial development in a coastal area.

CHAPTER 5 - RESEARCH APPROACHES AND METHODOLOGIES

5.0. Introduction

The research approaches and methodologies are derived from the aims and objectives of this research. The key issue for the development of the petrochemical industry in Brunei is sustainability and the main aim of this research is to investigate the extent to which such an industry can be developed sustainably. This chapter firstly outline the relationship between the research questions and the variety of methods used in the research in order to answer the research questions. After that, a variety of methods of data collection as well as data analysis will be described and justification given as to why those methods were chosen. The general data sampling of the research as well as the reliability and validity of research are also discussed in this chapter. Lastly, this chapter will discuss some of the ethical issues that can be found in the research and the problems encountered during the study will also be indicated.

5.1. Linkages between research questions and methods

In order to respond to the research questions, several methods were chosen. Table 3 shows the relationship between the research questions and methods employed as well the constituent elements involved in the methods.

Table 3 Relationship between the research questions and methods

Research Question	Method	Element (Data Needed)
Q1: Will there be likely more socio-economic benefits or drawbacks from SPARK that will eventually determine the sustainability of the industrial development?	Questionnaire interviews; in-depth & semi-structured interviews; country reports; Environmental Impact Statement (EIS); companies' reports; other published books; and unpublished slide presentations	- Open-ended opinion on socio-economic development; - Quantitative economic data; and - Economic development information.
Q2: Will there be an issue of coastal resources' conflicts between the SPARK project and other stakeholders at and around the SPARK area that may affect the priorities and well-being of the stakeholders?	Questionnaire interviews; in-depth & semi-structured interviews; direct observation; and site visits.	- Experience of people living close to the project; - Stakeholders' participation in the project; and - Observation of the way of lives of the communities and others.
Q3: Will there be likely that the impacts created from the project affect the environment and may challenge the effort of Brunei to protect the environment and to develop sustainably?	In-depth & semi-structured interviews; site visits; direct observation; and EIS.	- Scoping checklist on the significance of environmental impacts; - Secondary reference for the likely environmental effects; and - Open-ended opinion on environmental issues, monitoring and management.
Q4: Are the monitoring and enforcement of environmental policies and regulations (if any) at SPARK effective in maintaining the sustainability of the industry?	In-depth & semi-structured interviews; and EIS.	- Impact mitigation and environmental monitoring data.

5.2. Methods of data collection: primary and secondary

A range of methods of data collection were employed during the study by using both primary and secondary data collection. These include an initial exploratory forum and meeting, direct observation of the industrial area and the surrounding areas, site visits to the industrial park, questionnaire interviews with the local communities living near to the development, and formal in-depth and semi-structured interviews with the project proponents of the petrochemical industry, government officials and village heads. In addition, a camera was used in order to take some photographs for visual accounts of evidence of the study area so as to improve explanation of the issues present in the development.

In addition, relevant data were gathered by using secondary resources. These include the Environmental Impact Statement (EIS) of the SPARK project, which was analysed, and SLA's reports, as well as investment incentives booklets for FDI to Brunei. Other secondary sources include other unpublished information about SPARK from internal presentations.

Primary data were collected for six months, i.e. from April to September 2012. Initial exploratory fieldwork, which included attending a forum organised by the BEDB and SLA and informal meetings with officers from the SLA, was carried out in April. The questionnaire interviews with the communities living in the two villages called Kampong Sungai Liang and Kampong Lumut were conducted over three months, from June to August. In-depth and semi-structured interviews with the project proponents, tenants of the industrial park, government officials and village heads were carried out throughout the months of June to August. Lastly, direct observation and site visits to the study area (SPARK) and the surroundings were conducted three times from June to September.

According to Flick, Kardoff and Steinke (2004, p. 178), use of multiple methods or more simply the triangulation of data methods, basically "combines data drawn from different sources and at different times, in different places or from different people". This method aims to reduce the risk of systematic biases or limitations of a specific form of method in our conclusion, and allows us to gain broader and more valid understanding of the issues and becomes a route to additional knowledge (Flick, Kardoff and Steinke, 2004; Maxwell, 2005). For example, triangulation of interviews and desk research of official documents can provide more reliable sources rather than by using either method alone. Therefore, for the purpose of this research, the triangulation of information was employed in order to strengthen the evidence of the research.

5.3. Forum and informal meeting

Prior to the formal meeting with the officials from the SLA and BMC, a forum on the Brunei National Development Plan organised by officials of the BEDB and SLA was attended. The forum was held on the 1st April 2012 and it took about two hours, explaining the projects that have been developed and that will be initiated by BEDB for the purpose of diversifying the economy of Brunei, including the SPARK project. The researcher took this opportunity to ask some questions about the environmental management of the project, which helped to develop research ideas for formal meetings or interviews with the officials from the project proponents and tenants of the project. In addition, the researcher had a chance to speak with the officers from the SLA personally and arranged an informal meeting with them prior to the actual and formal one.

During the informal meeting with the Head Representative and the Assistant Business and Stakeholder Development Officer of SLA, which lasted for one and a half hours, a brief introduction about SPARK was given on a PowerPoint presentation and a discussion on the types of questions and information that needed to be asked during the actual interview was also made. The Head Representative of SLA also suggested additional relevant contacts in order to obtain data about socio-economic and environmental perspectives on SPARK. This helped the researcher to overcome difficulty in finding the right person to be interviewed (Valentine, 2005) and this reduced the amount of time dedicated to finding them. A copy of the presentation slides was given to the researcher as an accurate brief reference about SPARK; some published country and company reports were also provided to add more references to the research.

5.4. Direct observation

Observation can be considered as a major and highly important approach in qualitative method inquiry (Marshall and Rossman, 2011). Observation can be defined as "a purposeful, systematic and selective way of watching and listening to an interaction or phenomenon as it takes place" (Kumar, 2011, p. 140). It seeks to understand practices, interactions, as well as events that occur in a specific setting, from the inside as a participant or as a mere observer from the outside (Flick, 2002). It can be accomplished not only through visual but also via other senses as well such as through sense of touch and smell, in order to provide new and insightful descriptions of a specific setting

(Marshall and Rossman, 2011). For the purpose of this study, direct observation was used to gather much information on the research area.

5.4.1. Formats of the direct observation

Two types of observational methods were used in the research. The first was informal, non-participant observation, for the purpose of looking at the surrounding areas of SPARK. This was carried out before collecting the data through formal interviews, site visits and questionnaire interviews. According to Robson (2002), informal observation is less structured and allows an observer to gather and record data freely by note-taking and asking questions from informants. Meanwhile, non-participant observation is a method where a researcher does not get involved in the activities of the groups who are observed and "remain[s] as a passive observer, watching and listening to its activities [for a number of times] and drawing conclusions from this" (Kumar, 2011, p. 141). During this type of observation, the observation aimed to describe the setting, the people and the series of events that have taken place. This is called descriptive observation (Robson, 2002). Table 4 shows the dimensions of the descriptive observation approach derived from Spradley (1980, as cited in Robson, 2002) that was used as a guideline in the first type of observation method used in this study.

Table 4 Dimensions of descriptive observation

Dimensions	Description of dimensions
Space	Layout of the physical setting; rooms, etc.
Actors	Relevant details of the people involved
Activities	Various activities of the people involved
Objects	Physical elements e.g. camera
Acts	Relevant individual actions
Events	Specific occasions e.g. meetings
Time	Event sequence
Goals	What are the things that actors attempt to accomplish
Feelings	Emotion in particular context

Source: Spradley, 1980, as cited in Robson, 2002.

During this observation, the researcher was basically looking at the main activities or types of land use that can be found at the surrounding of the industrial areas. The researcher also had some conversations with people within the area regarding the industrial development. Only a few people were willing to stop by when asked to give their opinion about SPARK. Most of them were in the middle of something, such as going to get some groceries, going home or in a hurry and therefore, the research could not get as much information as might have been wished.

Observations were recorded as field notes or in a diary, which formed a useful reference before the site visit method was employed and it helped to add additional questions for the main interviews. The notes contained the essentials of the answers and information from respondents. Notes were taken briefly and as quickly as possible but clearly after recognising something interesting. At the end of the day, a full set of field notes was written, which included details such as date and day, location, who was involved, and so on. Some personal reflections about occasions and people were also jotted down as well. From here, the initial analytical thoughts i.e. on what had been observed and heard, were also jotted down and became useful as a facilitator for theoretical explanation of the data

(Bryman, 2012). This is called 'narrative recording' by some researchers (e.g. Kumar, 2011, p. 142).

The second type of observation was by using the structured or focused observation technique. This was carried out three times throughout the research period by using a checklist as a guide during the observation. According to Robson (2002), checklists provide a long series of items that can be recorded. For the purpose of finding out the possible environmental and socio-economic impacts from the development project, a scoping checklist was used in an attempt to identify the likely significant environmental as well as socio-economic impacts from the project. The scoping checklist that was used was based on the scoping checklist prepared by the European Commission (2001) on the Guidance on EIA on scoping. This can be found at the URL, http://ec.europa.eu/environment/eia/eia-guidelines/g-scoping-full-text.pdf or at ***Appendix 1*** of this thesis.

The main elements of the scoping checklist were focused on the impacts of the industrial project towards the environment in the phases of construction, operations and decommissioning. There are 10 major elements of questions that must be filled in the scoping checklist and these elements are the categories used in the research in finding out the impacts from the project. Those elements are as listed below:

- **Physical changes in the local area:** e.g. any changes in topography, land use, water bodies, etc.?
- **The use of natural resources:** will the resources be renewable or non-renewable?

- **Storage, handling and transport of product substances:** will they cause any harmful effects to the human and environment?
- **Solid waste generation:** will it be created during construction, operation and also decommissioning?
- **Generation of air pollutants:** will it be toxic or noxious to the atmosphere?
- **Vibration and noise pollution:** will they affect the community, public and fauna?
- **Generation of pollutants to the land and water:** will they affect the land, sewers, surface and ground water as well as coastal and seawater?
- **Risk of accidents:** will there be any risk of accidents during the construction and operation of the project?
- **Social changes:** will it result in the changes in demography, employment and everyday culture?
- **Cumulative effects:** will there be any possibility of cumulative impacts with other existing activities?

5.4.2. Justification of the method used

There are some important justifications for why the observation method was used in the research, based on the advantages that it can offer. One of the main advantages of using the observation technique in the collection of data is its directness, i.e. the researcher watches what people do and listens to what they say, rather than asking them about their views, feelings, or attitudes (Robson, 2002). In addition, this method also seems to be predominantly an appropriate method for getting at 'real life' in the real world (Robson, 2002). Observation can be used to validate the messages obtained in interviews (Robson, 2002) and it is also helpful in providing accurate information that cannot be produced by questioning, because the respondents are either not co-operative or unaware of the answers (Kumar, 2011).

However, there are also some limitations of the method. The observation method tends to be time-consuming (Robson, 2002). Moreover, it is difficult to synthesize data and also to abstract and organise data (Robson, 2002). In addition, this technique is subject to biases in observation (Robson, 2002). Our interests, experience and expectations all affect an observer when collecting the data and this is called ‘selective attention’ (Robson, 2002). For instance, an observer would be more likely to attend to what an informant tells them if they see each other, rather than to someone with their back to the observer (Robson, 2002). As well as that, there is a possibility of incomplete observation and/or recording (Kumar, 2011). For instance, an observer may watch one event enthusiastically and then jot down the information on paper but while he or she is jotting it down, he or she may miss some important interaction or events (Kumar, 2011). One solution in order to avoid all of these is by making a conscious effort in the distribution of the attention widely and evenly (Robson, 2002) and this is what has been done throughout the observation of the SPARK area and its surroundings.

Another limitation of the method, which is actually a type of bias that is commonly produced, is what is called ‘selective encoding’ (Robson, 2002). This is an unconscious ‘rush to judgement’, where something is labelled on the basis of early and very partial information (Robson, 2002). In order to avoid such bias, it is important that an observation is started with an open mind and it should be kept open all the time (Robson, 2002) and this is what the researcher was trying to do during the research. Apart from that, the longer one waits after an observation event to construct a narrative account, the poorer such an account will be in its accuracy and completeness, and it becomes more in line with pre-existing schemas and expectations (Robson, 2002). For a solution, the researcher quickly wrote up field notes into a narrative account, as advised by Robson (2002). The last type of bias is the 'interpersonal factors', by which an observer may focus on and interact with only a few types of people, for example those who are much more welcoming and friendly rather than those who are not (Robson, 2002). This may affect the quality of the data, as some data may be lost if other groups of people are not considered during the observation. This type of bias can be avoided or reduced by recognising and discounting all biases towards all groups of people (Robson, 2002).

Generally, all types of bias that could occur were avoided during the observation of the industrial park and the surroundings by adopting an open-minded approach and remaining neutral all the time, i.e. making no personal judgement or trying to connect on what was observed with theories or any other preliminary thoughts about the situation observed. During the observation of SPARK and the surrounding area, the people surrounding the area noticed about the presence of the researcher as she was taking down notes but they were just looking at her and did not ask anything about it. Presumably, they were thinking that the researcher was the one from a Government Department who was looking around the area.

5.5. Questionnaire interview with local communities

The use of questionnaire interviews provides useful data on "people's attitudes and opinions about social, political and environmental issues such as neighbourhood quality of life, or environmental problems and risks" (McLafferty, 2010, p. 88). It also helps to gather information about people's lives that cannot be made available from published sources such as employment characteristics and so on especially in developing countries where government data sources are usually poor and out of date. For the purpose of this study, a questionnaire interview was used to gather information from the local communities living close to SPARK regarding their experience living close to the industry, as well as their opinions and attitudes towards the industry.

5.5.1. Format of the questionnaire interview

The number of questionnaire interviews conducted with the communities was not large. Initially, it was intended that 50 interviews would be conducted. The reason for this was that the populations of the two villages were only small, about 3,000 people in each village (SPARK EIS, 2001). Furthermore, the main purpose of the interview was to look into the qualitative answers from the respondents through open-ended questions. They were not intended to be representative of the total population and therefore, the sample did not need to be large in size. The sampling procedure of this method and other interview methods in the research will be further explained in detail in section ***5.10***. Moreover, the research also entails interviews with village heads of the two villages and this will be a key source of data collection as they are the representatives of the whole communities. A further details of the format of interviews with village heads can be referred in section ***5.6.1.***

Despite the effort to recruit 50 interviews, the researcher was only able to interview 20 respondents. The reason for the non-participation is due to the unwillingness of the communities to participate in the research as either they were busy or they did not have any idea what to say. The interviews were conducted in two villages which are very close to the industrial park. The names of the two villages are Kampong Sungai Liang and Kampong Lumut I. The researcher went to homes in both villages and asked residents if they were willing to participate in the interviews.

The questionnaire interview was designed so that the respondents were able to understand and answer the questions easily. A cover letter or brief information to respondents about the research study was given to each participant (see ***Appendix 2***). This included the aim of the study and what was expected from the interview and the importance of the research to the country and society. Respondents were also informed that participation in the study was voluntary and they could refuse to participate in the interview as they wished. Contact details of the researcher as well as supervisors and the ethics officer were also given for reference to the respondents should they have any questions on the research or the ethics of the research. If respondents wished to participate in the interview, they needed to sign the consent form that was also provided during the interview.

There were two major types of questions in the questionnaire interview. The first one was simple fixed-response or factual questions that asked about the sex type, age, level of education, and work type of the respondents and the name of their village. All of these were basically asking about the socio-economic background of the respondents. The second type was the open-ended questions that asked about the respondents' experience and opinions. According to McLafferty (2010), open-ended questions allow respondents to express their own feelings and they are not constrained in answering the questions, compared to when they are asked to answer fixed-response questions.

The interview was designed in order to answer the research question on the socio-economic impacts from SPARK and to investigate whether the industrial project may have caused conflicts between the public or communities and the industry. Some of the essential elements of the questionnaire are shown below:

- **Opinion about the SPARK development:** Have the communities heard anything or do they know about the project? What are their opinions about it?
- **Information about the project:** Is there any organisation that gave an explanation about the project to the communities?
- **Public participation prior and during the development:** Were the communities given a chance to participate in discussions about the project?
- **Opinion about the benefits from SPARK:** Benefits to the environment, social or everyday lives, economy, community or neighbourhood.
- **Opinion about the benefits of the project towards the country's development:** Does the development improve the economy of the country? Does it help to achieve the economic diversification effort by the country?
- **Experience in living close to the project:** How do the communities feel living close to the development? Are the activities carried out at SPARK having impacts on the everyday lives of the communities during the construction and operation of the project?
- **Opinion towards environmental impacts from the project:** Opinions about environmental impacts and risks from the industry.
- **Opinion on further changes in the future:** Do the communities see further changes will happen when the project was fully completed? Will the changes be positive or negative?

Details of the sample of the questionnaire interview can be found in ***Appendix 3*** of this thesis.

5.5.2. Justification of the method used

One of the advantages of using the questionnaire interview is that an interviewer may clarify questions to respondents if respondents are not clear about the questions asked (Robson, 2002). Moreover, the presence of the interviewer may encourage more participation and the interviewer may also judge the extent to which the survey is treated seriously (Robson, 2002). It was noted that during the interview with the respondents, some of them were shy at the beginning but when the researcher began to clarify the questions to them, they began to open up a bit and added more opinions and suggestions in their answers. In addition, the advantage of using open-ended questions is that it provides room for respondents to express themselves freely, resulting in a larger variety of information (Kumar, 2011).

However, one of the drawbacks of using the questionnaire interview is that the data collected from this method are affected by the characteristics of the interviewer such as their personality, motivation of the study, skills and well as their experience (Robson, 2002). This is again similar to the disadvantages in the observation method, which were been explained before in this chapter. There is sometimes a bias where interviewers may unconsciously influence the responses, probably through verbal and non-verbal cues indicating the answers that the interviewers want (Robson, 2002). Furthermore, the interaction of interviewer and respondents may affect the data collected as the difference in class or ethnic background may affect the way of communication between the two parties (Robson, 2002). In addition, respondents may also feel that their answers are not anonymous and so they may be reluctant to be fully open in their answers (Robson, 2002). The limitation of having open-ended questions is that some respondents may have difficulty expressing their answers by themselves (Kumar, 2011). A solution for this was for the researcher tried to try to be open minded while interviewing the communities without any pre-judgement about the answers that were given to her. In addition, the researcher explained in detail that the answers given to her during the interviews would be kept confidentially, so that the respondents would have the trust to open up their opinions about the project. These issues will be explained in more detail in the section on the ethical issues in the research, in section ***5.13***.

5.6. Interviews with officials and village heads

Throughout the fieldwork period, in-depth interviews were the main method of data collection. Robson (2002) and Hopf (2004) describe qualitative interviews as a widely used method in social research. Similarly, in geographical research, interviews especially semi-structured interviews are one of the most commonly used form of qualitative methods (Kitchin and Tate, 2000). According to Kumar (2011), an interview can be defined as “any person-to-person interaction, either face to face or otherwise, between two or more individuals with a specific purpose in mind” (p. 144). A semi-structured interview schedule has a fixed set of open-ended questions, but the order can be changed in accordance with the interviewer’s perception of what seems most appropriate (Robson, 2002; Remler and Van Ryzin, 2011). The questions are usually accompanied by probes that help in the structuring of the discussions (Remler and Van Ryzin, 2011). The power of open-ended probing in semi-structured interviews is what makes the richness of the data, which benefits a researcher in the collection of data. In addition, in semi-structured interviews, each interview covers significantly the same topics, even though it is flexible to modify the questions during the interview (Remler and Van Ryzin, 2011). This is the main reason why semi-structured interviews were used for this research, so as to allow the researcher to ask questions beyond the structure of the original schedule.

5.6.1. Formats of the interviews

Three types of interviews were employed. The first was the semi-structured, in-depth, one-to-one interview. This was used with the government officials from the Department of Environment, Parks and Recreation (DEPR) and the Department of Economic Planning and Development (DEPD). The interview sessions for both departments were audio-recorded and the interviews lasted about 21 minutes and 22 minutes respectively. The audio tape provides a permanent record and allows interviewers to fully concentrate on the interview (Robson, 2002), rather than worrying about missing points while jotting them down on paper and that is why it was used to record the interview. However, the researcher was also ready with a notepad to jot down some major important points in both interviews, just in case the tape recorder was not working properly.

The second type was a semi-structured, in-depth, homogenous group meeting interview and this was employed with the BEDB, the authority that is in charge of the development i.e. SLA, as well as with another group meeting interview with the BMC. The main reason for using the group interview was a suggestion from the SLA that certain questions in the interviews could only be answered by specific officers and it would be better if the interviews were attended by several officers. The interviewees from the SLA who were present during the interviews consisted of the research and development section, stakeholder relations section, planning and technical services section and from the BEDB, from the FDI section. The interviews with the SLA and BEDB were combined together at one time, and took about 41 minutes. The interview took a shorter period of time than originally planned because written answers to the questions had already been prepared by respondents and were given before the interview started. The researcher was given 15 minutes to read the answers and then after that, if she needed to ask for more clarification from the answers given and needed to ask for more questions, those clarifications and questions could be addressed during the interview session. The second group interview, i.e. with the BMC, was carried out on another day and officers from the production management, corporate services staff as well as environment and safety were present during the interview. The interview lasted an hour and a half; it was tape-recorded by the researcher and notes were also taken of the major important points mentioned during that interview.

The last type, i.e. semi-structured, in-depth telephone interviews, was used to interview village heads in the two villages located very close to the industry (i.e. Kampong Sungai Liang and Kampong Lumut I). As it was mentioned earlier that this is the key interview sources of the research as village heads are key representatives of the voices of the whole communities. In Brunei, village heads are elected by local communities in every village. Any concerns and complaints from the villagers regarding the well-being of the neighbourhood are informed to the village heads so that solutions of the problems or concern can be made. In any occasion that the concern are beyond the capabilities of the village heads to handle, the complaints will be put forward to the head of Mukim (subdivision of district) or to the District Officer if the problems persist. Interviews with village heads of the two villages are therefore important to find out if there is any concern of the villagers towards the development of SPARK. This method is very relevant to understand the concern as there was a problem of recruiting more numbers of questionnaire interviews among the local communities.

The reason for conducting the interview over the phone was due to the difficulty of reaching the village headsmen face-to-face because of their heavy workload every day, so that they are often unavailable at the home office. Moreover, during the period of research, the village heads were busy organising events for the birthday celebration of the Sultan (king) of Brunei and during that year, 2012, the Belait District (the district in which both villages are located) was the host district for the event. The Sultan's birthday is on 15th of July but preparations for the event take place a few months before that and the celebration continues until the end of July. After the event ended, there were other cultural events in both of the villages. Therefore, since reaching them by phone was the quickest way to interact with them, a telephone interview was carried out with both of the village heads. The telephone interview with the village head of Kampong Sungai Liang only took about 15 minutes, whereas the one with the village head of Kampong Lumut I was about 45 minutes.

The essential elements in the interview questions for the BEDB, SLA and BMC were as follows:

- **Nature of the SPARK development:** Motivation for the development, location of the area, types of technologies used, waste management practice.

- **Benefits from the Development:** Benefits to the economy, society and environment.
- **Challenges/potential problems of the development:** Challenges to the ecosystem and the environment, competition of petrochemical industry with other countries.
- **Monitoring and mitigation of environmental impacts:** Environmental management plan, environmental audit, environmental contingency plan.
- **Stakeholders' involvement in the project:** Involvement of stakeholders in the project, consultation with the local communities, coastal resources conflicts.
- **Sustainable development and SPARK:** can SPARK achieve its sustainable industrial development?

Please refer to ***Appendix 4*** and ***Appendix 5*** for interview questions for BEDB and SLA, and BMC, respectively.

The essential elements for the interview questions with DEPD were basically about the economic aspects from the project such as benefits, economic diversification, economic challenges and sustainable economic development (see ***Appendix 6***). For the interview with DEPR (see ***Appendix 7***), the essential elements of the questions that were asked were as follows:

- **Involvement in SPARK:** Involvement of DEPR in the Environmental Impact Assessment period, waste management.
- **Impacts/changes from SPARK:** Potential impacts to the environment and ecosystem (i.e. air, water and land).

- **Environmental mitigation plans and environmental policy:** Environmental policy and monitoring of SPARK.
- **SPARK and sustainable development:** Can environment be protected while SPARK is developing economically?

The essential elements for the telephone interview questions with the village heads were similar to the questions asked to the community residents but the questions were asked in terms of the opinions of the village heads towards the overall situation of their own communities.

5.6.2. Justification of the method used

There are many advantages of using interviews in the collection of data and all of these form the justification for that choice. One of the benefits of using the face-to-face interview is that it is a flexible and adaptable method of investigating things and a short cut in seeking answers to research questions when compared to direct observation (Robson, 2002). It is considered to be the most appropriate method for studying complex and sensitive issues as an interviewer gives respondents opportunity to prepare before sensitive questions are asked and can explain complex questions to respondents individually (Kumar, 2011). In semi-structured interviews, the subjectivity of viewpoints from respondents is better expressed rather than in a standardised interview or in questionnaire surveys (Kohli, 1978, as cited in Flick, 2002). Moreover, non-verbal cues from respondents may also give messages which assist in understanding verbal responses (Robson, 2002). Interview questions can also be clarified whenever there is a misunderstanding and unclear in the questions asked to respondents (Kumar, 2011).

However, there are also few disadvantages of interviews that need to be considered and avoided. For example, in-depth interviewing is a time consuming method (Robson, 2002), like the questionnaire interview method. An interview that requires time of more than an hour may make unreasonable demands on busy interviewees, and thus, this could limit the number of people who are willing to participate in the interviews. One solution for this is to limit the period of the interview to one hour maximum and making sure that questions are asked clearly and directly so as to avoid wasting of time in clarifying the questions repeatedly to the participants.

In addition, all interviews usually require careful preparation, which is time-consuming such as in making arrangements to visit and securing necessary permission to interview, as well as confirming arrangements and rescheduling appointments to cover absences and crises (Robson, 2002). Realising this fact, the researcher had made advance arrangements to contact the participants as early as possible in order to secure the visit. Moreover, an official letter from the University and the sponsor of the research i.e. the Government of Brunei, authorising the research, was provided before the researcher went to the research area, so as to avoid any delay in collecting the data.

Apart from those limitations, more time is required for writing up notes on the answers given by respondents and data must also be transcribed if the interviews are recorded by using tapes (Robson, 2002). This, however, was tolerated by the researcher as the time to translate and transcribe the data was managed carefully, by doing the work when the researcher can work best, i.e. during the evening time and translation and transcribing work were limited to five hours a day so that the researcher would not experience any mental fatigue that would demotivate from working on the next day.

In addition, one disadvantage of using the telephone-interviewing method is that there is a lack of visual cues that may cause problems in interpreting data (Robson, 2002). According to Bryman (2012), body language is important because the interview may be able to note down such things as discomfort, puzzlement or confusion. One solution for this was for the researcher to detect cues only from the tone of the voice of the village heads. Even though there were no visual cues that could be detected from this type of interview, this was the best way to interact with the village heads, given that it was very difficult to reach them personally during that research period.

5.7. Industrial Park and Plant Visits

Site visits to SPARK and the methanol plants of BMC were carried out in June and September respectively. A visit to the SPARK area included at looking at the whole scenery of the industrial park from the tower of the SPARK centre (the branch office of SLA at SPARK) and the researcher was given brief information on the area before going around the industrial park area by car. During the tour by car, the researcher was shown around the area and the methanol production area and other facilities and amenities of the area. It took about half an hour to complete the tour and the scoping checklist was used to fill in any information that could be noted from the tour. In addition, some photos were also taken of some interesting features and areas seen around the industrial area. The reason for taking photographs during the site visits was that it allowed detailed recordings of facts and provided a more comprehensive and holistic presentation of lifestyles and conditions (Flick, 2002). In addition, questions were also asked to the officer, who was extremely helpful in answering and showing the researcher around the industrial area.

The visit to the methanol plants was conducted by three officers around the methanol plants and detailed explanations of the production phases were given verbally by the officers. The visit took about one hour walking around the plants. Each of the officers explained the functions of the methanol plants according to their expertise. The tour started from the area where methanol is produced i.e. from where the feedstock [i.e. Liquified Natural Gas (LNG)] is obtained through pipelines that are connected from the Brunei Liquefied Natural Gas (BLNG) which is situated next to the methanol plants. The tour ended at the zone where the product methanol is transported through pipelines. A scoping checklist was again used for evaluating and recording the significance of impacts. This is to evaluate the potential impacts to the environment and the socio-economic of the people near to the area. During the tour around the plant area, the researcher was given a safety industrial suit that included a coverall, safety helmet, boots and ear plugs. After the tour visit, the three officers took the researcher back to the office and asked if she had any further questions about the plants. Further questions especially on the health and safety of the plants, were asked.

Mobile phones, cameras and video recorders were not allowed to be used in the plant zone, for safety reasons. This, however, prevented the researcher from recording important information from the tour. As a solution, the researcher used note-taking and the scoping checklist to record important information from the tour, as which would otherwise have been possible. Moreover, further questions could also be asked by phone and e-mail and this helped the researcher to check the extent of the information that was written down and to clarify any points that were missed out during the tour.

The justification for the use of this method is similar to the ones for the direct observation method that, has been provided earlier in this chapter (i.e. ***section 5.4.2.***)

5.8. Desk research using documents

Another useful and helpful method of data collection was by using written documents, whether books, newspapers, magazines, letters, etc. (Robson, 2002; Remler and Van Ryzin, 2011). A common approach to documentary analysis is called ‘content analysis’, which is a quantitative analysis of what is in the document (Robson, 2002). In content analysis, we are dealing with something that is produced for other purposes, and indirectly, we are gathering information from those sources (Robson, 2002). There are a number of types of secondary data that can be used in order to obtain information. One of them is archival records, such as government or semi-government publications such as ‘census, demographic information, economic reports (Robson, 2002). Other useful examples are organisational records, such as budget or personnel records, as well as maps, charts of the geographical characteristics (Robson, 2002). In addition, earlier research or studies that have been done to provide the required information as well as mass media such as reports published in newspapers, magazines, and internet, are other types of secondary data that helped in the gathering of useful data for the research.

For the purpose of the research, some important documents were collected and analysed in order to collect additional information regarding the socio-economic and environmental effects from the SPARK project.

5.8.1. Formats of the collection of documents

For the purpose of this research, data were also collected from the secondary sources. The EIS of the SPARK project was studied in-depth. Since the copy of the statement could not be taken out of the project office due to reasons of confidentiality, the researcher spent two weeks at the DEPR to study the EIS. The officers at the department were very helpful in guiding what information should be looked for in the EIS for the research. Apart from that, information on investment incentives was also gathered from the Ministry of Industry and Primary Resources (MIPR) through the booklets produced by that department. This information was used to gather information about investment incentives that the Government has provided to the tenants of SPARK. In addition, both published and unpublished reports about SPARK as well as slide presentations from the BEDB and SLA were also gathered during the fieldwork and studied and this eventually added more information to the study.

5.8.2. Justification of the method used

One advantage of using secondary data or performing content analysis is its ‘unobtrusive’ nature (Robson, 2002), i.e. the researcher can ‘observe’ without being observed by others. Moreover, the data are in permanent form and thus can be subject to re-analysis, allowing reliability checks and replication studies (Robson, 2002). Written texts are not human subjects and thus, they do not require informed consents (Franklin, 2012).

However, one limitation content analysis is that the documents available may contain limited or partial information (Robson, 2002) which is not sufficient for the research purpose (Robson, 2002). Moreover, it is less suited for questioning about interpersonal interactions, behaviour, or events (Franklin, 2012). It also requires more time to be carried out; for example the issue of selectivity (i.e. what and when) requires much thought (Franklin, 2012). However, those limitations can be solved by other methods that have been described in this chapter (i.e. interviews and site visits), as data from those other methods can help in filling the gaps of data gathered from the secondary sources.

Another limitation of using a secondary source of data is that commonly some misleading, mystifying or deliberately coded pieces of information are found in some political and cultural texts which were produced for propaganda, and this would eventually call into question the validity of the resources (Franklin, 2012). Moreover, another form of limitation of using secondary sources as a set of data is the question of its validity and reliability (Kumar, 2011). One solution in order to reduce or avoid those limitations is to carefully select the most reliable sources of data in the secondary sources, so that they can be used in the analysis of data.

5.9. Sampling of the Research

As the main purpose of a qualitative research approach is to explore diversity, sample size and sample strategy do not play an important role in the selection of a sample (Kumar, 2011). According to Kumar (2011), if the sample is carefully selected, diversity can be extensively as well as accurately described on the basis of information gathered even from one individual (Kumar, 2011). Unlike in quantitative research, there is no need to have a sample size in mind for the qualitative study (Kumar, 2011). It is important that in qualitative research, the sample is guided by the researcher’s judgement, i.e. as to who is likely to provide the 'best' information (Kumar, 2011). The concept of saturation point is used in the collection of data in qualitative research, which means the inquiry continues to the point where no new information is obtained (Kumar, 2011). The concept is more applicable to situations where the gathering of data is on a one-to-one basis (Kumar, 2011). When no further new information can be obtained, it is assumed that the saturation point has been reached (Kumar, 2011). For that reason, the sample size used in this research does not really take into account the representativeness of the population of study especially in the questionnaire interview, which was discussed earlier in this chapter.

However, it is also important to choose an accurate sample of data and therefore, different types of sampling were used in the research. According to Kumar (2011), in qualitative research, there are different types of sampling methods that can be used, such as "[…] purposive, judgemental, expert, accidental and snowball […]" (p. 212). Purposive sampling refers to choosing people who have a unique perspective or people who occupy significant roles, or selecting people or artefacts to represent theoretical categories or considerations (Patton, 2002, as cited in Remler and Van Ryzin, 2011). This type of sampling is basically selecting of units, which may be people, organisation, documents, and so on (Bryman, 2012). The research questions act as guidelines as to what categories of units are chosen to become a sample in the research (Bryman, 2012). This qualitative method of sampling was used in the selection of the respondents who were involved in the questionnaire interviews as well as the interviews with the officials and village heads. Based on the research questions, interviewees were chosen purposely. For instance, for the research question concerning the socio-economic impacts of the SPARK project, the interview sample should be chosen from those people who live close to the development, whose experience is relevant to the research, rather than interviewing other people who live outside the development, as the people who live close to the area may have experienced the impacts more than anyone else.

In addition, another type of sampling called snowball or chain sampling was used. Snowballing is basically using one contact to help recruit other contacts, who will eventually put the researcher in touch with other contacts (Valentine, 2005). In this sampling method, the researcher will first make initial contact with a small group of people who are applicable to the topic of study and then use these to establish contacts with other participants. The strength of this method is that it overcomes the problem of recruiting interviewees (Valentine, 2005). As mentioned earlier in this chapter, during the informal meeting with the officials from SLA, some possible informants who would be useful for the research was suggested to the researcher. In this case, the officials acted as gatekeepers for the research. Gatekeepers are “those individuals in an organisation that have the power to grant or withhold access to people or situations for the purposes of research (Burgess, 1948, p. 48, as cited in Valentine, 2005). This is a quick and good way of recruiting informants for the research but at the same time, gatekeepers may possibly filter participants according to their own agendas, or after they know what is the agendas of the researcher (Hoggart, Lees and Davies, 2002).

5.10. Data analysis of interviews, field notes and scoping checklist

Data collected during the fieldwork were analysed qualitatively. Both primary (responses from questionnaires, in-depth interviews, field notes, and photographs) and secondary data (contents in documents) were analysed qualitatively in order to identify themes in the study. Primary data from in-depth interviews were mostly recorded by digital tape recorder and by writing. Qualitative data analysis is a method of organising and interpreting raw material data (Remler and Van Ryzin, 2011). It is like entering "a portal through which you pass in order to construct an argument and make it stick as you present your findings and draw conclusions about the inquiry" (Franklin, 2012, p. 213).

5.10.1. Transcribing

There are a number of steps in the procedure of data analysis. First of all, since most of the interviews were audio-recorded, it was necessary to transcribe the audio data into written words. According to Kowal and O'Connell, 2004), the process of transcription can be defined as "the graphic representation of selected aspects of the behaviour of individuals engaged in a conversation (for example, and interview or an everyday chat)" (p. 248). It is a basic aim that the answers from these conversations, i.e. transcripts, are made available on paper for analysis (Kowal and O'Connell, 2004). The transcribing process is very time consuming and requires a lot of effort it took a month to complete the process. The main reason for the time taken in transcribing the interviews is that all of the conversation during the data collection is being transcribed, including the non-linguistic behaviour, i.e. vocal and non-vocal. According to Kowal and O'Connell (2004), it is very important that those non-linguistic behaviours are also included in the transcription because those indicate something; for instance the extent to which an interviewee is sure about his or her answer can be indicated by his or her eye movement while he or she is giving the answers during an interview. Some examples of vocal ones are laughing and throat clearing and some examples of non-vocal ones include eye movements and gestures (Kowal and O'Connell, 2004).

5.10.2. Translating

Since most of the interview scripts were written in the local language (i.e. Bruneian Malay), it was also important that the scripts were translated into English as the thesis is written in English. This process also required a lot of time as a careful translation of words or phrases needed to be made, bearing in mind that some words in Bruneian Malay do not carry the same meanings as their literal English equivalent. It took two weeks for the translation of the interview scripts into English to be completed.

5.10.3. Preparation and organisation of data

After the above steps have been done, the data are then prepared and organised. It is important to spend some time in organising the data (Marshall and Rossman, 2011). This is to make sure that all of the data can be easily retrieved and that any overwhelming and unmanageable kind of data could be cleaned up (Marshall and Rossman, 2011). The types of data were logged according to the dates, places and people involved in the data collection.

5.10.4. Coding

The coding of transcripts were also done as soon as possible, so as to sharpen the understanding of the data and to avoid the feeling of being swamped by the data, which may happen if the analysis is left until the end of the data collection period (Bryman, 2012). Coding is basically a process that can be defined as "tagging the text or other qualitative data using a system of categories, a coding scheme – essentially the creation of variables" (Remler and Van Ryzin, 2011, p. 76). Coding data is considered to be the "formal representation of analytic thinking (Marshall and Rossman, p. 212). Different categories of codes were produced during the analysis of data collected, based from thinking about the topic, theory or past studies and also through reading and interpreting the data. The coding schemes were also developed and changed as they were used, as the data were read more than once in order to develop a better set of categories.

5.10.5. Creation of analytic memos

Transcripts, field notes and documents were read through several times without writing down any interpretation and at the end, an analytic memo was jotted down generally to include what was considered interesting and important from those sets. Analytic memos are basically comments and reflections on the data collected (Robson, 2002).

5.10.6. Generation of themes and categories

The data were read through once again and the codes reviewed and if the codes consisted of two or more words or phrases, these were made as short as possible and if the codes were related to concepts and categories in the existing literature, it was considered worthwhile to use those instead. In addition, the materials were reviewed in order to try to identify similar forms of phrases, patterns and themes, connections, sequences, as well as differences between sub-groups, etc. Taking these forms of patterns and themes, a small set of generalisations can gradually be elaborated that cover the consistencies that have been distinguished in the data. This process is called thematic analysis, which can be defined as the search for themes (Bryman, 2012). Themes are categories identified in the data transcripts or field notes that relate to the research focus and are built up from codes (Bryman, 2012). This eventually provides the researcher with a theoretical understanding of the data and hence could make a theoretical contribution to the research focus literature (Bryman, 2012).

When searching for themes, Ryan and Bernard (2003) recommend looking for repetitions in the data as well as similarities and differences in the answers given. Moreover, it is also useful to look for indigenous typologies which are unfamiliar to the researcher as well as metaphors and analogies that are used by the participants. Linguistic connectors such as ‘because’ or ‘since’ can be used to identify causal connections in the minds of respondents. Lastly, theory related material can also be used as a springboard for theme identification. The category/theme system can then give a current statement of the elements in the theory that will show where the preparation has led and where to travel next (Richards, 2009). In addition, it can also provide a means to locate patterns as well extract new connections between topics and growing theories (Richards, 2009).

5.10.7. Generalisation from the themes

The themes and categories made in the analysis were then used to make some generalisations about the topic. Here, discussions and conclusions were made and all the data that had been analysed were linked to the literature review and theoretical frameworks discussed written in the previous chapters. The results are displayed as texts, histograms, charts and tables.

5.11. Reliability and Validity of the Research

This subsection discusses issues regarding the reliability and validity of the research so that the data collected and results may answer the research questions correctly.

5.11.1. Reliability

Reliability refers to "consistency in its findings when used repeatedly" (Kumar, 2011, p. 184). In other words, it is concerned to the extent that the results of a research are repeatable. Since the research is qualitative in nature, the concept of reliability does not really applicable. However, repeated patterns may be found in the questionnaire interviews and observation. Therefore, the reliability of the research can be assessed from both of those methods.

5.11.2. Validity

According to Kumar (2011), validity refers to "the ability of a research instrument to demonstrate that it is finding out what you designed it to […]" (p. 184). It is the most important criterion of the research world, which is concerned with the integrity of the conclusions that are gathered from a research (Bryman, 2012). There are two types of validity, internal and external. Internal validity is the extent to which there is a congruence between the researcher's observation and the theoretical ideas that is developed, whereas external validity is concerned with the extent to which the results of a research can be generalised beyond the research context (Bryman, 2012). Structural corroboration is a method that uses various types of data to either support or contradict the interpretation

(Eisner, 1991, as cited in Creswell and Creswell, 2007). Confluence of evidence that leads to credibility is what is looked for in structural corroboration; this allows the researcher to feel confident about his or her observation, interpretation, and conclusion. Because this research study has employed a number of methodologies, this helped in validating the research.

Another way to measure the validity of a research is through the trustworthiness of the study, addressed through the indicators of credibility, dependability and confirmability (Bryman, 2012). Firstly, the significance of credibility focuses on multiple accounts of social reality (Bryman, 2012). For credibility, the research findings were submitted to the interviewees for confirmation, which is called respondent validation. After the data had been transcribed, the researcher submitted the answer scripts to the officials and village heads for validation.

Secondly, dependability adopts an ‘auditing’ approach that makes sure that complete records are kept throughout the phases of the research process, i.e. “problem formulation, selection of research participants, fieldwork notes, interview transcripts, data analysis decisions, and so on-in an accessible manner” (Bryman, 2012, p. 392). After the data collection was completed, all records of data were kept so that the researcher could refer back to them. Lastly, with regards to confirmability, it should be apparent that the researcher will not allow her personal values or theoretical inclinations to sway the conduct of the research and thus the findings obtained from it (Bryman, 2012). As explained before, in order to avoid bias and judgement or any personal views about the research topic, the researcher conducted the collection of data with an open and neutral mind.

5.12. Ethical issues in the research

Ethics can be referred to as "the systematic study of or formalization of rules concerning the separation of good conduct from bad" (David and Sutton, 2011). There are two main reasons why a researcher should behave ethically while doing his or her research study. Firstly, ethical behaviour may protect the rights of individuals, communities, as well as environments that are involved in or affected by a research (Hay, 2003). Moreover, it contributes to maintain public trust, so that no suspicion caused or fear will be caused amongst those participants who are involved in a research (Hay, 2003).

5.12.1. Ethical check

Because the research study involved the participation of humans, research participants have the rights to be protected against "deception, dangerous procedures, and invasion of privacy" (Graziano and Raulin, 2007, p. 65). Prior to the data collection process, a proforma for beginning a research project was filled in and it was confirmed and signed by the Ethics Officer at the Department of Geography, Environment and Earth Sciences of the University of Hull (refer to ***Appendix 8***). A Student Risk Assessment Form (refer to ***Appendix 9***) for general overseas fieldtrip and a Travel Policy form were also filled in and confirmed with the principal supervisor and safety officer (refer to ***Appendix 10***). This was to ensure that the researcher would be safe during the data collection period.

5.12.2. Informed consent

Informed consent is a basic element of research ethics (Remler and Van Ryzin, 2011). It is considered unethical to collect data without the knowledge of participants, and their expressed willingness and informed consent (Kumar, 2011). Respondents are made fully aware of the type of information, the reasons why they are being sought, and what purpose it will be put to, how can they participate in the study, and how it will affect them directly and indirectly (Kumar, 2011).

Prior to the data collection, official letters from both the University and the sponsor of the research [The Brunei Government through the Brunei Students Unit (BSU) in London] were sent electronically and by hand (refer to ***Appendix 11*** and ***Appendix 12*** for official letter from the University and BSU respectively). For the interviews with the officials from the government departments from DEPR and DEPD, the researcher had to call them in order to arrange for an interview. In Brunei, in order for a researcher to get a quick arrangement to meet, it is advisable to call directly to the government department. Therefore, instead of giving the official letter first, the interviewees were called to make the arrangement and when they were met with individually, then the letter was given.

In addition, participants were informed in advance about the potential risks, benefits, obligations and so on of the research study, which might affect their decisions to participate. This is called 'informed consent' (Petre and Rugg, 2010). It is important to preserve the privacy right, or to preserve the rights of individuals to determine personal information (Gola and Schomerus, 1997, as cited in Hopf, 2004). As been mentioned earlier, informed consent forms were given during questionnaire interviews as well as in the individual and group in-depth interviews. Furthermore, before the surveys and interviews were carried out, respondents were briefed about the purpose and methods of the research as well as the allocation of time for the study, in an open and honest manner in accordance with professional conduct during the data collection period. Please refer to ***Appendix 13*** and ***Appendix 14*** for the informed consent form for the 1) questionnaire interview and 2) interviews with government departments, companies and village heads respectively.

Apart from these issues, participants were also informed about the potential physical or psychological harm arising during the fieldwork, such as that the interviews may require a long period of time talking about their opinions and experience, which could make them feel tired and their everyday activities were somewhat affected by the amount of time dedicated for the interviews. The researcher tried her best to minimise the amount of time and informed the participants that she may contact them again if they were not available on the first visit. Lastly, all the data collected (responses from the interviews, field notes, photos) were kept in a confidential place and the researcher preserved the confidentiality of participants' identities unless under certain circumstances written consent was given to expose the identity such as the job description of the officers interviewed.

For the telephone interviews with the village heads, the village heads were informed and their consents were obtained in the opening minutes of the interview. Before the interview began, a statement was read that introduced what the research topic was all about and a statement of confidentiality was also provided. If the village heads agreed to participate in the interviews, they were assumed to give a form of tacit consent.

5.12.3. Protecting privacy and confidentiality

Sharing information about a participant with others for purposes other than research is considered as unethical (Kumar, 2011). Therefore, identification or other potentially private information should be kept in privacy and confidentiality, and it is best to only ask for "age, income, level of education, and other personal information in broad categories rather than in detail" (Remler and Van Ryzin, 2011, p. 233). To protect confidentiality, all sets of data collected were kept and stored in a locked filling cabinet both at the office and at the researcher's home. Computer passwords were also created for the data stored on computer so that the data could not be accessed by unauthorised users. Details of the respondents were also not exposed in the written thesis so as to protect the privacy and confidentiality of the participants.

5.12.4. Avoiding bias

It is unethical to introduce bias into a study and this should be avoided with an open mind (Kumar, 2011). As mentioned previously in this chapter, allowing judgment and personal feelings into the research in the collection and analysis of the data will lead to bias in the research. Therefore, the researcher maintained an open mind in conducting the research.

5.12.5. Problems of publication

It is also possible to harm participants by talking about information about individuals and also as groups in publication, in such a way that it may cause harm to them and which may lead to some disadvantages to them (Hopf, 2004). As a solution, anonymity is maintained in the representation of the results, i.e. no individual names and other identifying details are given in the thesis.

5.13. Problems encountered during the research

Some problems were encountered during the research. One of the main problems was finding an appropriate time for in-depth interviews with officials and village heads. The permission letters to participants were sent in March but it was only in late May that the interviews could be carried out. This was due to the busy commitment of the officers and the village heads, especially with regard to the group meeting, where every each person had to come at one particular time. This problem is common in many research projects, so it is often harder to get people to agree to be interviewed especially if it involves people in government, businesses or NGOs (Franklin, 2012). As a solution, the researcher had to interview the village heads by telephone and while waiting for the officers to become available, the researcher looked at other possible interviews that could be carried out and looked at secondary sources for data collection during that time. This is because, as Franklin (2012) noted, if consecutive silences happen, a researcher should move on to other interviews (Franklin, 2012).

Secondly, not many residents in the two villages participated in the questionnaire interviews when they were approached individually. One way to increase the number of respondents was to advertise the research on Facebook and family members and friends were told about the interviews so that they could inform their families or friends who live in either of the two villages and invite them to participate in the interview. Brunei is a small country and has a small population and almost everyone has relations with other members in the society. Therefore, this was the quickest way to recruit interviewees.

Thirdly, there is a difficulty of gaining a range of different perspectives in this research context as only 20 interviewees were recruited in the questionnaire interviews with local communities at the two villages. However, as it was mentioned few times earlier, the method of interviewing village heads of the two villages become the main sources of any concerns of the local communities towards the SPARK project as they are the representatives of the whole communities. Therefore, different perspectives in the research context may be achieved.

Another problem was that during the group meeting interview, the conversation between the researcher and the participants was not allowed to be tape recorded. This increased the potential for missing important points during the interview. This is a typical problem in an interviews with elite people as according to Valentine (2005), “they (elite people) control access to knowledge, information and informants and want to have influence on the research process, refuse to allow interviews to be tape-recorded or demand the right to vet interview transcripts and influence the way that research findings are presented” (p. 115). However, since the researcher was informed in advance that no recording of audio and video would be allowed, she was ready with a notebook to jot down the answers from the interviewees. Moreover, the participants were willing to respond back to any points that were missed during the interview through email. Therefore, the problem could be solved.

In addition, as mentioned before, during the group interview, answers to the questions were written and given before the interview session started, as the interviewees requested advance notice of the questions. As a result, the answers was not given spontaneously and the 15 minutes allowed for reading the answers given were not sufficient. However, the researcher tried her best to understand the answers given and tried to highlight which of the answers need to be elaborated more and what further questions need to be asked during the interview session. Lastly, some documents such as the Emergency Response Plan and other important documents were not made available publicly and this has caused some limitations for the researcher in looking for some important findings. However, since the most important data could still be collected, this did not affect the overall findings from the research.

5.14. Summary and Conclusion

This chapter has outlined and discussed the various methods of data collection and analysis that were carried out in the research. The methods of data collection were 1) attending a forum and informal meeting; 2) three times direct observations; 3) questionnaire interviews with 20 local communities who live close to SPARK; 4) interviews with 11 relevant officials and two village heads; 5) two site visits to SPARK and the surrounding areas; and 6) desk research on documents. The analysis of the data involved the 1) transcribing and translating of data scripts; 2) coding of the answer scripts and generation of analytic memos; 3) generation of themes and categories; and finally 4) generalisation of the themes to form a finding.

The most important element in the collection and analysis of data is the ability to use various methods in order to make the research to be valid and reliable. Several key issues on ethics and problems encountered during the study were also discussed. Even though several problems and issues were encountered, these were solved by various methods so that the data collection and analysis processes could be carried out without having to change them.

CHAPTER 6 - SOCIO-ECONOMIC ISSUES AT SPARK

6.1. Introduction

This chapter interprets empirical results on the socio-economic issues resulting from the development of the petrochemical industry at SPARK based upon questionnaire interviews with members of local communities who live at Sungai Liang and Lumut I villages, group face-to-face interviews with BEDB and SLA, individual face-to-face interviews with BMC, DEPR and DEPD, as well as telephone interviews with village heads of Sungai Liang and Lumut I. In addition, this chapter interprets results from direct observation of the study area as well as from desk research using published and non-published documents.

There are five parts in this chapter. This chapter firstly discusses the awareness and opinion of local communities towards the development of SPARK and secondly it studies the issue of public participation at SPARK. After that, an explanation is given of the current and potential benefits that can be gained from the development of SPARK. In addition, both the current and potential challenges towards the socio-economic situation of the local communities and the country are discussed. The final part of this chapter presents an overall discussion on the socio-economic issues that are present as a result of the SPARK development.

6.2. Local communities' awareness and opinion about SPARK

This section interprets results from the questionnaire interviews with local communities who live at the Sungai Liang and Lumut I villages as well as telephone interviews with village heads at the same villages about the opinion and awareness of local communities towards the development of petrochemical production at SPARK.

6.2.1. Awareness about the SPARK project

When the respondents were asked about the communities' awareness about the SPARK project, i.e. whether they had heard about the project, the majority of the respondents, 65 per cent, were aware about the project, i.e. they had at least heard about the industrial development. Only a few of them (i.e. 10 per cent) were not aware of the project and another 10 per cent were not sure about the project. Figure 14 shows the communities' awareness percentage about the SPARK project. From the figure, it can be seen that 65 per cent of the respondents were aware of the project. Of those respondents, more than half described the SPARK development as solely dedicated for methanol production and 15 per cent of them acknowledged that the methanol production is for export. In addition, 15 per cent of the respondents mentioned that the industrial activity at SPARK is for crystal production and another 15 per cent recognised the presence of facilities that are present at SPARK such as a multi-purpose hall, sports centre, and place to eat i.e. Kentucky Fried Chicken (KFC) restaurant. Only a few of the interviewees (15 per cent) were clear about the function of the project, that it is an industrial project that is dedicated to the diversification of the economy.

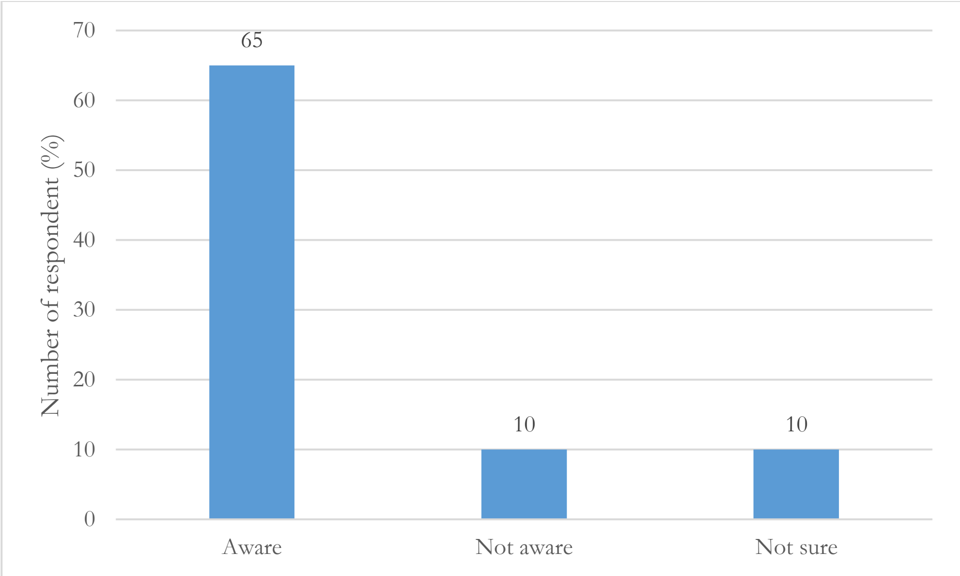

Figure 14 Communities' Awareness of SPARK

When the village heads at both villages of Sungai Liang and Lumut I were interviewed about their knowledge of SPARK, one of the village heads (from Sungai Liang) explained that SPARK was providing land for petrochemical companies to set up production. Meanwhile, according to the village head of Lumut I, currently biochemical industry is carried out by BMC. Apart from that, he also mentioned that there are utilities such as the fire department which are located at SPARK and there will be spin-off businesses which have not started operating yet.

6.2.2. Opinion on SPARK

When the local respondents were asked about their opinions on SPARK, the majority of the respondents were positive about the development. A majority of these respondents, 75 per cent of them, said that the development project would eventually add to the country's economic resources and revenues and consequently lead to the diversification of the economy. Another 20 per cent of the respondents commented that the project generates employment opportunities for the population. Another seven per cent of the respondents however, thought that the SPARK development is a good project only if the environment is managed properly. Only five per cent of the respondents interviewed gave a negative response that the project is still based within the oil and gas industry and thus it is not fully diversifying the country’s economy. In addition, 20 per cent of the respondents were not sure about their opinion on such development. Figure 15 shows the communities’ response towards the SPARK development.

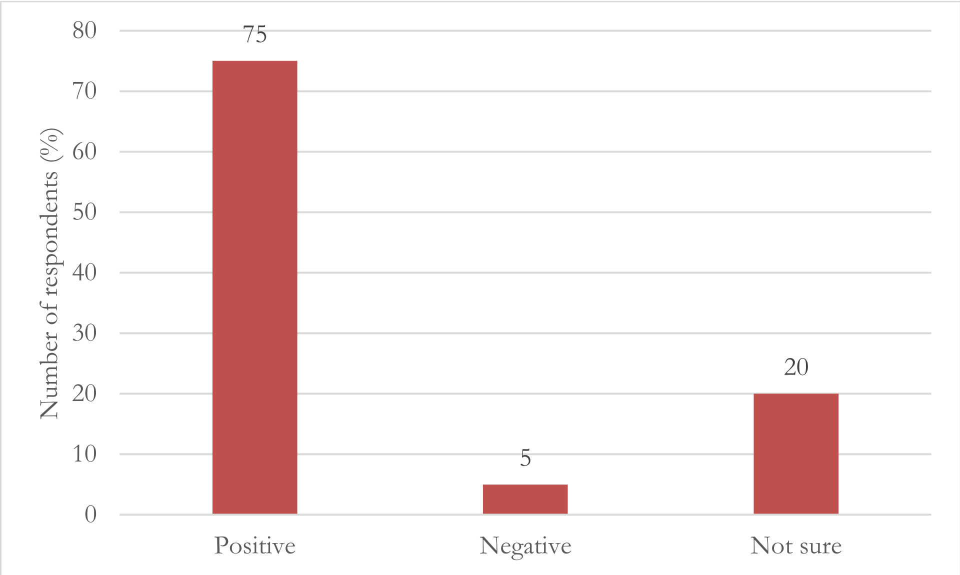

Figure 15 Communities opinion about SPARK

Village heads were also asked about their opinions on the project. The village head of Sungai Liang gave the same answers as about his knowledge on SPARK that it is an industrial authority that provides land for petrochemical industry. Meanwhile, the village head of Lumut I commented that the development of SPARK is good as it generates income to the economy of Brunei. However, he expressed concern on the environment and worried about the communities’ safety, as the development project is very close to residential areas.

6.3. Public participation in the SPARK project

It was noted from an interview with the SLA that there are four main stakeholders who are involved in the development of SPARK. Table 5 shows the main stakeholders that have priorities at SPARK. As can be seen from the table, one of these important stakeholders who is involved in the development of SPARK and who will be affected the most is the people of the Mukim Liang area. This section discusses issues on the involvement of local communities who live close to the industrial area, which are located within the Mukim Liang area, i.e. Sungai Liang and Lumut villages. It examines the participation of local communities before the SPARK project commences and during the operation of the project with the SLA, as well as BMC as the only tenant at SPARK.

Table 5 Main stakeholders at SPARK

Main stakeholders	Stakeholders
1) Relevant government departments	Public Works Department; Department of Water Services; Land Department; Survey Department; Department of Drainage and Sewerage; Department of Roads; DEPR; Department of Electrical Services; Department of Town and Country Planning; Belait District Office; Brunei Fire and Rescue Department; Royal Brunei Police Force (Belait branch)
2) Mukim Liang community	Mukim head of Liang; community leaders in Mukim Liang (village heads of Sungai Liang, Lumut I and II); consultative council members of Mukim Liang, Sungai Liang, Lumut I and II; school principals of schools in Mukim Liang; Sungai Liang Police Station; Sungai Liang Health Centre; Royal Brunei Armed Forces Third Battalion Lumut
3) Corporate stakeholders	BEDB; BMC; BLNG; BSP; TOTAL; contractors (e.g. Arkitek Idris, United Engineers, Swee Sendirian Berhad)

6.3.1. Participation in meetings and discussions

Figure 16 shows the percentage of respondents who have participated in the development of the project before the SPARK project commenced. The meaning of ‘participation’ in this context is whether the respondent attended any meetings or discussions prior to the development of the project. As can be seen from the figure, a majority of the respondents (85 per cent of the respondents) had not participated in any meetings or discussions before the project commenced. Only five per cent of the interviewees had been involved in the participatory meeting with the SLA before the project commenced. Ten per cent of the respondents were not sure whether there was any participatory meeting or discussion for the communities that was organised by the relevant authority (in this case the SLA) prior to the commencement of the SPARK project.

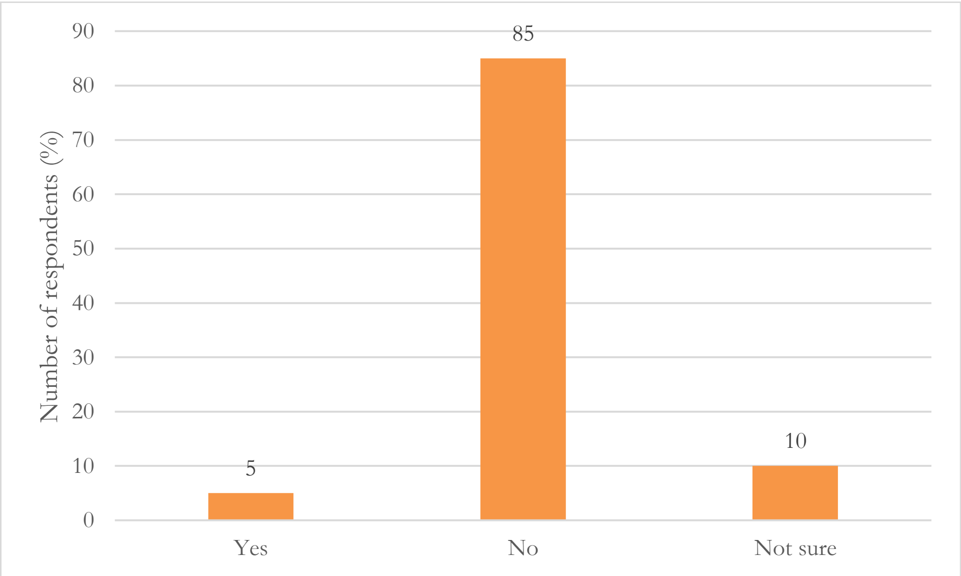

Figure 16 Public participation in the SPARK project

However, it was noted from an interview with the Stakeholder Officer at SLA that a possible reason for the low participation from the local communities interviewed is that most people who came to the dialogue meeting were 1) community leaders of Mukim Liang-Lumut (Liang-Lumut sub-district); 2) consultative council members of that sub-district (especially those north of SPARK); as well as 3) government officers such as the principal or teachers of the nearby schools, representatives from the Belait District Office, Sungai Liang Fire Station, Sungai Liang Police Station, Sungai Liang Health Centre and Lumut army third battalion. Furthermore, according to the officer, consultation or communities meetings are commonly those from the 35-60 years age group and are men.

Similarly, dialogue meetings between the local communities and BMC also involved community members, village leaders, village council members and also during the national stages of the project, relevant government stakeholders such as the Land Department were also invited. The local community members who usually attended the meetings were aged late 30’s to late 60’s.

6.3.2. Information given to local communities about SPARK

Figure 17 shows whether or not the local communities were briefed regarding the SPARK project. When the respondents were asked about whether they were given any briefing regarding the development of SPARK, 65 per cent of them said that they were not given any briefings about the project. A few of those respondents (i.e. 15 per cent) said that they became aware about SPARK from the public, i.e. through social media such as newspapers. Only 15 per cent of the respondents said that they were briefed about the project and that most of the information that they were given concerned the safety of the people living surrounding the industrial areas, i.e. Lumut I and Sungai Liang. 20 per cent of the respondents were not sure about the information given about SPARK.

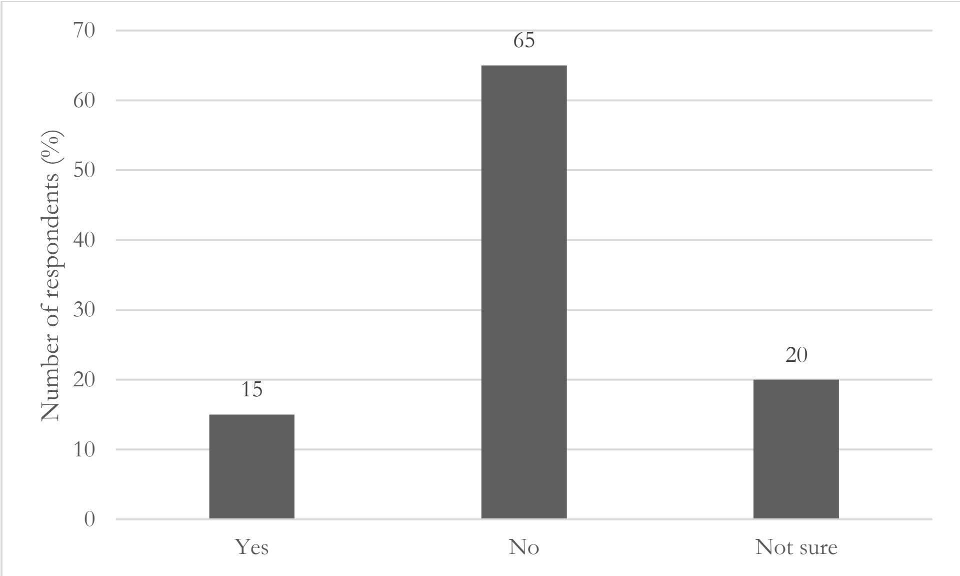

Figure 17 Briefing regarding SPARK

When the village heads of Sungai Liang and Lumut I were interviewed regarding information given to local communities about SPARK, one of the village heads, from Sungai Liang stated that the they were given information regarding companies that wanted to invest at SPARK, and about the safety of the villages and local communities. Meanwhile, the village head from Lumut I said that the information that were given to his villagers are how the industries at SPARK operate and also about the environment.

However, according to the Stakeholder Officer of SLA, the SLA holds a community dialogue at least once a year where members of the panel include representatives from SLA, BMC and BEDB. Representatives from each company deliver progress updates followed by a question and answer session. The Stakeholder Officer also stated that information provided to communities and other stakeholders included brief summaries on SLA and SPARK, completed projects, the status of projects are in progress, upcoming projects, company and community activities, as well as facilities available in SPARK for public use. In addition, information about employment opportunities within SPARK, opportunity for local SMEs to be involved with SPARK projects and emergency response (if any major emergency arises) was also given in the meeting with the local communities as well.

Meanwhile, the BMC usually holds a stakeholder meeting in every quarter of the year. From an interview with the officers at BMC, during the initial stages of the methanol production project, local communities were given information regarding the structure of the methanol production project, employment opportunities, explanation about methanol and its downstream uses, the methanol production process, and environmental impacts from the project. In addition, during the construction of SPARK, BMC has updated the local communities with regards to the construction phases.

6.3.3. Concerns and issues

When the respondents were asked whether their opinions, concerns and needs are considered by the relevant authorities, only five per cent said ‘yes’ but the remaining respondents were either not sure about the matter or it was not applicable to them as they had never attended any meetings or discussions. One interesting opinion from a few respondents is that they believed in the wisdom of SLA to manage the project and therefore, they felt they did not need their opinions and suggestions to be considered by the SLA. They believe that SLA is capable of managing the development so that the communities would not be affected negatively, for example in health and safety terms. However, it was mentioned by officers from SLA and BMC that communities are welcome to give feedback regarding the project.

According to the village head of Lumut I, one of the concerns that the local communities had during the dialogue meeting was about the waste management of the industrial effluents, i.e. some of them wondered where the effluent waste was disposed of. According to the village head, the worry is not about the effect of the effluent waste on the people but on the marine life if the waste is disposed into the coastal water. The village head also added that even though some members of the local communities do not have a high level of education and knowledge, they have lived in their village for a long period of time and thus they has seen what have happened in their everyday lives.

An interview with the Stakeholder Officer at the SLA indicates that the main concern that the local communities usually have during meetings is environmental concern. Meanwhile, according to one of the officers at BMC, during the initial stage of the project, there were unnecessary requests made from the community. For example, before the construction of a temporary jetty for landing heavy machineries via sea route, local communities were informed about that matter. One member of the local community asked the officers from BMC to stop doing the construction work at 12pm so he could take his cows across to the other side where the grass is greener. One of the officers interviewed at BMC said,

"Their main concerns […] I wouldn't call it intelligent feedbacks. Why I said that. I just give you one example. There was this one instance when the company decided to have a temporary jetty in which is about few hundred meters forward […] because we had to land our heavy machineries. So, we couldn't go through the land route. We have to use the sea route. So, one of the community members when we informed about this project, they actually made a request to say, 'Can you actually stop construction at 12 pm?' We asked why. 'Because I want to bring my cows across to the other side where the grass are

more green'. So for things like that…for for a project, it's… I would be.. I wouldn't go at first classifying as unimportant but it's not necessary for us".

In addition, an interview with officers at BMC revealed that local communities became more concerned about the development of SPARK and less resistant to the project after the dialogue sessions with BMC. Some members of the local communities even asked for assistance to improve facilities at SPARK and the surroundings. Before the dialogue session was conducted, most members of the local communities were ignorant. According to one of the officers at BMC, "[…] the first reaction of the … 'Not in My Back Yard'. But lately, when we have our stakeholder dialogue … when we […err…] when we are normal operation, then they are more accepting […]". One of the officers interviewed at BMC added that the communities are becoming receptive of the project after being given information about the project and after paying a visit to the methanol plants. The officer mentioned that in the beginning of the year 2011, BMC invited the village heads of the nearest villages as well as heads of village councils and a member of the Brunei Legislative Council for a plant tour. During the dialogue meeting, they had raised some concerns regarding the safety of the local communities from the project and by taking them on a plant tour, BMC was trying to prove that their concerns were unfounded. According to the officer, they finally understood the situation. However, the officer expressed his concern that while the most important people within the community now understood the situation, the main challenge that they were facing at that time was to make the general public, i.e. local communities, accept the situation in the same way as the village leaders accepted.

6.4. Socio-economic benefits of SPARK

This section interprets some benefits to the socio-economy of the local communities and the country that have resulted from the development of SPARK. This includes interpretation of the benefits from 1) economic diversification from petrochemical production; 2) attracting FDI; 3) GDP growth; 4) spin-off/spin-over effects; 5) local employment opportunities; 6) CSR efforts; and 7) infrastructural development.

6.4.1. Economic diversification through petrochemical production

One of the main benefits from the development of petrochemical industry is that it helps in the diversification of the economy of Brunei, which is still dependent on the production of oil and gas. It was noted from an interview with the Economic Officer at the Department of Economic Planning and Development (DEPD) in Brunei that almost 100 per cent of the Brunei's crude oil and natural gas are exported to other countries, so this is the main economic source of the country's economy. With the introduction of petrochemical production, Brunei is moving into downstream industries. In other words, it can be said that the petrochemical production at SPARK helps in extending the value chain of the oil and gas industry that has existed in Brunei since the year 1929. According to the officer, even though diversification through the production of petrochemicals is occurring, Brunei is still adding more value on oil and gas and thus contributes to the diversification of the economy.

Moreover, the research also indicates that even though the only production of petrochemicals to date at SPARK is the production of methanol, there will be other downstream industries that will produce more petrochemicals (i.e. gas based petrochemicals, ammonia, urea, ammonia-urea based downstream sectors e.g. fertilisers, plastics, textile industries etc.). As mentioned by an officer at the BMC, there will be up to 40 different types of chemical products that can be produced if there is a process combination between the products methanol and ammonia. As a result, more petrochemical production will consequently improve the diversification of the economy and hence will also improve the productivity of the country. The officer added that in the future, there will be more linear production of petrochemicals which will maximise raw materials. There is also a plan to build another methanol plant and expand the size and its capacity.

Similarly, some members of local communities who were interviewed at Sungai Liang and Lumut I villages also agreed that SPARK has contributed to the diversification of the Brunei economy. When the respondents were asked about their opinions on the communities' socio-economic benefits, some of the respondents (20 per cent) said that the development has diversified the Brunei economy and consequently has raised the country's revenues, which can be used to improve education and healthcare for the population and provide more employment opportunities. A few of the respondents also mentioned that petrochemical production at SPARK has enabled Brunei to develop economically and thus the country may not be solely dependent on the production of oil and gas.

6.4.2. Attracting FDI

It was also noted from an interview with the Economic at DEPD that another important contribution of SPARK is that there will be an increase in the FDI flowing to Brunei and for this reason there will be a significant amount of capital investment by foreign companies into the country. Apart from that, in the long term, Brunei will also benefit from the transfer of knowledge and technology (technical know-how) which are new to the country. This is supported by research conducted by Jefri (2009) and BEDB (2012) which shows that the methanol production in Brunei has brought in expertise, management skills and a work ethic relevant to run a highly-complex operation, which in return will improve the efficiency and effectiveness of the work of the local people in Brunei.

According to the officers at SPARK, the aim of the industrial park is to become an internationally competitive petrochemical hub. The key aim of SPARK is to provide potential investors with a ready prepared industrial site for new investments into Brunei. SPARK will provide a ‘plug and play’ concept where investors can locate with ready infrastructure and utilities, with close proximity and access to natural resources such as oil and gas. This attracts potential investors in a variety of downstream fields, such as the BMC allowing Brunei to have its first methanol exports as well as the upcoming project by the Japanese consortium, Mitsui to produce ammonia, urea and related derivatives.

Similarly, the local community members interviewed also agreed that the SPARK development has attracted the flow of FDI coming into the country. When the respondents were asked about their opinions on the contribution of SPARK towards the socio-economic development of Brunei, some of the respondents said that SPARK may also gain economic benefit through the flow of FDI from the investment from foreign petrochemical companies into the country.

6.4.3. GDP growth

Petrochemical production may also contribute to the growth in Brunei's GDP. This can be achieved through export trade and tax revenues flows to the country. From an interview with officers from BMC, the methanol product is exported to several countries such as to the SEA regions i.e. Singapore, Vietnam, the Philippines, Thailand and Indonesia as well as to North Asia such as Taiwan, China, Korea and Japan. In addition, the export of methanol is also extended to as far as the west coast of the United States of America (USA) i.e. Seattle. BMC's methanol plant has a capacity of production of 850,000 metric tonnes per year and this could actually contribute to the slight increase in the GDP. Unfortunately, there are no data to show the percentage contribution of methanol production to GDP. It was noted from the interview with the Economic Officer at the DEPD that the data for the percentage contribution of methanol to the GDP is included in the oil and gas data *(refer to Figure 5)*. Therefore, it is difficult to see the exact figure for the contribution of methanol production to the GDP. However, according to the forecast revenue, which is based on the 2009 price, it is estimated that the yearly production of BMC would result in an increase of around one per cent to the national GDP. Moreover, according to the estimation data by Jefri (2009), the annual sales of methanol could amount to USD333, 200, 000 if the methanol price per tonne is assumed to be USD392.

It was mentioned in an interview with BMC that receipts from exports of methanol are kept as profit and distributed as dividends among the shareholders. Because PB holds 25 per cent of the share and it is a semi-government company, the profit will go to the Government in return as well. In addition, according to one of the officers at SPARK, local employees at BMC as well as other petrochemical companies at SPARK may also spend the salaries that are earned within the country and therefore, contribute to the economy of the country.

The view that SPARK is adding to the GDP of the country is also agreed by some members of the local communities who were interviewed during the research. When the respondents were asked about their opinion on the socio-economic benefits towards Brunei from the development of SPARK, some of them recognised that the benefit would add to the economic resources of Brunei, which would eventually benefit the country economically and the next generation. Similarly, village heads of both Sungai Liang and Lumut I expressed the same opinion that the development may benefit the communities and the country through the income gained from the petrochemical industry at SPARK.

The income gained through the inflow of taxes into Brunei would in turn benefit the country. An interview with the officers at the SLA revealed that petrochemical projects usually have a lifespan of 20 to 35 years. During that period, the amount of tax revenues generated from the foreign companies helps in increasing the GDP of the country. Moreover, the Government in effect will also obtain some benefit from the raw material payment i.e. from crude oil and natural gas feedstock. This is because the payment is made to the Brunei Shell Petroleum (BSP) Company as well as BLNG which are semi-government companies.

Apart from that, the Government may also receive some revenues from the supplies of water, electricity, and natural gas as well as lease of the land. In order to produce each tonne of methanol, 3.3 tonnes of water is needed (Jefri, 2009). Therefore, based on estimated data obtained from Jefri (2009), annually, the revenue from the water supply received during the construction of the methanol plant alone is USD363, 000 and it is estimated that the revenue from the operational phase is USD 1, 089, 000. In terms of the electricity supply, 64 kilowatt-hours of electricity is used to produce each tonne of methanol and it is estimated that the amount of revenue is USD802, 000 during the construction phase; in the operational phase the estimation could reach USD1, 603, 000 (Jefri, 2009). In addition, it is also estimated that the annual revenue from natural gas feedstock would be USD21, 675, 000 (Jefri, 2009). This amount is based on the assumption that the price of natural gas is USD5 per Million British Thermal Unit (MBTU). Lastly, the annual revenue from the land lease at SPARK would amount to USD 36, 329, 000. In total, for each year, the revenue obtained from the supplies of the amenities would be approximately USD 61.5 million. However, it should be noted that there is also an 85 per cent subsidy on the water and electricity as well as feedstock costs provided by the Government. Therefore, the revenues generated from those basic amenities are much lower in amount i.e. USD 6.3 million. Overall, the total revenues from those basic utilities and land lease would be about USD 42.6 million. It should be noted also that the revenues mentioned above are for the methanol production only. The revenues earned by the Government from the provision of the above resources would increase when other downstream industries begin their construction and operational phases.

6.4.4. Spin-off/spin-over effects

Apart from the above mentioned direct economic benefits from SPARK, there are also some indirect economic effects from the industrial project. The indirect impact to the economy is through spin-off or spin-over effects, i.e. through activities such as construction, maintenance work, logistic, and non-technical services such as accounting and catering. The research discovered, based upon the interviews with the DEPD's Economic Officer and a number of officers and managers at BEDB and SLA, that those indirect impacts will consequently benefit the locals for their involvement in those types of activities. However, the research has revealed that services like construction and maintenance work are not being conducted by local companies in Brunei, as some of them cannot be obtained locally. According to one of the officers at the BEDB, local services are being prioritized, but if the services cannot be found in Brunei, there is a need to import services from outside the country. Local SMEs participation may only be able to benefit from smaller sub-contractual work from the project (Jeffreys, 2009).

6.4.5. Local employment opportunities

Another major benefit that can be gained from the development of SPARK is that it has created, and will be creating, a significant amount of quality employment opportunities for the local people which are also new in Brunei, rather than supplementing already existing employment, apart from the knowledge, technologies and skills that are brought in by FDI through the SPARK project. SPARK is providing an alternative place of work to the current oil and gas industry in the country. An interview with SLA and BEDB reveals that often, in new industries, there is opportunity for local equity participation by a Bruneian entity, which opens up avenues for expansion of businesses, experience and exposure for local companies or entities. Findings indicated that currently, there are about 200 jobs for local people at BMC, making 98 per cent of the employment held by the locals. The majority of the jobs are of the technical type, such as working at the production, maintenance, HSSE and procurement of the plant. Others are administrative jobs working at the sections of Human Resource (HR), corporate services, finance and marketing, information technology, legal and accounting services.

The research also discovered that there will be the creation of other future employment opportunities e.g. through the Mitsui Consortium Company that will begin its ammonia and urea production by the middle of 2016 that will generate about 470 operational jobs. It is hoped that the employment opportunities will be filled by Bruneians, which will eventually reduce the level of unemployment in Brunei i.e. 2.7 per cent of the Brunei labour force as of the year 2013 (Economic Watch, 2014). On top of that, there will also be a large volume of indirect employment generated, two to three times larger than the number of direct jobs. The interview with one of the officers at the BEDB revealed that there will be about 6,000 potential employment opportunities at SPARK in the future which will include high quality employment in management and technical areas. It is predicted that this figure would eventually reduce the unemployment rate in Brunei by 20 per cent. The officers at SLA and BEDB also added that there will be opportunities for local employees at SPARK to undergo skill training both in-house by experts of the industries and also overseas at the company's international facilities.

However, according to the view of the Economic Officer from the DEPD, the petrochemical industry is a capital intensive industry and therefore, it is not going to generate more jobs than the development of labour-intensive industry does. Brunei needs to engage in more labour-intensive industries such as business services, finance, tourism, etc. The support services, for instance, legal business sectors, insurance, etc. are still not currently from local companies. For example, it is only recently that the crude oil and natural gas companies have been insured by local companies; before that, they were insured by foreign companies. In his view, it is important to develop local capacity, or otherwise, the work will be sub-contracted to the foreign affiliated companies from abroad. But then again, Brunei has a small population (about 410, 000 people) and has a large educated young labour force and given the fact that the type and quality of job opportunities provided by the project demand a high level of expertise and experience, it seems appropriate for Brunei to engage in this type of industry. This view is supported by one of the officers at the BEDB, who said that even though the petrochemical industry is not a labour intensive industry, the job opportunities offered at SPARK are significant and suitable for Bruneians. This is because the majority of Bruneians are not willing to work in the labour intensive industries such as in the textile industry because of these are perceived to be lower-class jobs.

6.4.6. CSR efforts

Since the establishment of SPARK, the SLA in collaboration with the Brunei Methanol Company and Mitsubishi Gas Chemical Company Inc. (MGC) have participated in philanthropic activities through donations for national events as well as helping local communities who are in need. For example, donations were given during the celebration of the birthday of His Majesty the Sultan (king) of Brunei in 2012, held the Belait District, as well as during the Eid celebration that is organised annually. During the Eid celebration, fatherless children of the Mukim Liang-Lumut (Liang-Lumut sub-district) were invited and given cash donations. In Brunei, it is the culture that during the Eid celebration, special delicacies are cooked and new clothes are bought. Therefore, the cash donations would burden on single mothers of trying to provide everything for their children.

In addition, as part of the CSR effort, a project to revitalise the Sungai Liang Beach Recreational Park with renovated and refurbished facilities was funded by the BMC, SLA and MHI (SLA, 2010). The project was basically for refurbishing “the sheltered stalls area, mini stage, new picket fences, new bridge crossings to replace the old instalments, additional picnic huts, repairs on all public facilities including toilets, the conversion of the old basketball court into a futsal court and a spacious parking lot” (SLA, 2010a, p. 17). Moreover, SLA is also supporting the Ministry of Development’s ‘No Plastic Weekend’ campaign, in order to conserve the environment by reducing the usage of plastic bags and making reusable bags to carry groceries and other items purchased at stores. In 2011, over a period of two days, the SLA distributed a total of 2000 pieces of reusable bags to the public in some major retail outlets in Brunei. This was a good opportunity to encourage Bruneians to be more aware of environmental appreciation, which is in line with one of the core values of SLA, i.e. to improve the safety and well-being of the people as well as to the environment. It was noted from an interview with the village headman of Lumut I that SLA and BMC have so far made some good efforts in helping the communities, as reflected in the philanthropic activities carried out by both SLA and BMC.

When looking at the efforts of CSR by the petrochemical companies at SPARK i.e. MGC, ITOCHU Corporation, and MITSUI & CO., Ltd. Worldwide, the Japanese petrochemical industries at SPARK are also developing initiatives towards CSR activities. ITOCHU Corporation is aware of its role as a good corporate citizen, i.e. the need for harmony between their industrial activities and with both local as well international communities (ITOCHU Corporation, 2014g). ITOCHU Corporation is focusing on five areas: 1) global humanitarian issues; 2) environmental conservation; 3) local community contribution; 4) growth of future generation (youth development); and 5) support for volunteer work by the employees (ITOCHU Corporation, 2014g).

Similarly, MITSUI also recognises that the sustainable growth of a private corporation cannot be achieved without improvement in the society as whole (MITSUI, 2014d). MITSUI believes that the aim of its CSR is to continuously contribute both directly and indirectly to the growth of the domestic and foreign communities for a better standard of living (MITSUI, 2014d). The culture of 'Yoi-Shigoto' expresses the sense of value that good quality of work should be shared with every employee (MITSUI, 2014d). Those values are 1) beneficial to society; 2) useful to create added value for the customers as well as business partners; and 3) employees' worthwhile challenge (MITSUI, 2014d).

In its CSR activities, the company is focusing on four areas, namely, 1) human rights; 2) the environment; 3) consumer issues; and 4) community involvement and development (MITSUI, 2014a). Some examples of the CSR activities that MITSUI has engaged in are 1) expanding the eucalyptus afforestation and woodchip production in Australia for sustainable forest resources (MITSUI, 2014h); 2) creating local employment and protecting the local culture of Vale communities in Brazil (MITSUI, 2014f); and 3) exercising due diligence through impact assessment of the MITSUI's project on the indigenous population of aborigines (MITSUI, 2014e).

6.4.7. Infrastructural development

In terms of the development in infrastructure, since the establishment of SPARK, the road system has been improved. The main road, the coastal road, was previously a single carriageway and caused traffic problems for workers, especially commuters from the Brunei-Muara and Tutong districts travelling to work at the BSP and BLNG (SPARK EIS, 2001). However, since the development of SPARK, the road has been transformed to a dual carriageway to the southwest past the BLNG plant. As revealed in the interview with the SLA, the Road Department is currently in the process of completing the realigning of the coastal road to the south of the Lumut Hills and downgrading the existing road. This will further reduce the traffic problem along the road and will benefit both the residents living near the areas and the commuters as well.

Some of the local people interviewed also expressed their satisfaction with the improvement in the road system, noting the easier road access due to the dual carriageway of the road system. Moreover, as mentioned in Chapter 4, the Zone Village at SPARK also comprises a multi-purpose hall (for weddings and other function), sports hall, etc. and according to some local respondents interviewed, the provision of those facilities has raised the standard of living of the local communities.

In addition, observational findings also indicated that the drainage system in the vicinity of the industrial area especially at the Sungai Liang Kechil Road has also been improved since the area is low-lying and is prone to flooding. It was also acknowledged by the village head of Sungai Liang that the drainage system installed by SLA is modern and would prevent the area flooding. Figure 18 shows the drainage system, which is being expanded in size in order to prevent flooding at the low lying areas along the Sungai Liang Kechil Road.

Figure 18 Drainage system improvement at the Sungai Liang Kechil Road
Source: Fieldwork, 2012

In order to prevent any possibilities of fire and explosion incidents, a fire station with fire fighting vehicles fully equipped in fighting both Hazmat and industrial fire at SPARK was built. The specialised fire fighting vehicles are designed to operate and provide fire-fighting and rescue services in a petrochemical environment (SLA, 2010a). The Hazmat Tender can handle hazardous material incidents in industrial plants and chemical spillages. The Foam Tender carries foam-making equipment and produces high expansion foam for fighting fires that involve inflammable liquids. Figure 19 shows the Fire Department that is located at SPARK.

Figure 19 Fire Department at SPARK
Source: Fieldwork, 2012

6.5. Socio-economic challenges

This section discusses the socio-economic challenges that are faced and will possibly be experienced by the local communities and Brunei. This includes volatility of petrochemical prices, health and safety issues, as well as psychological effects from the project.

6.5.1. Volatility of petrochemical prices

There are also some challenges that may arise from the development project. One of the issues is that methanol production is a potentially high-risk project that requires huge capital spending and feedstock costs, and prices are volatile (Jefri, 2009). Furthermore, even though there is a contribution to the country's GDP from the petrochemical industry, there is a concern that the return on investment may take a long time to be achieved. It was suggested by the Economic Officer at the DEPD that it will not be feasible to get back revenues from the production of methanol, given that the BMC's production is not very big and its contribution to the GDP is just minor. However, this statement was contradicted by one of the officers from BEDB, who argued that prior to any investment with SPARK, due diligence is carried out on the proposal. A detailed feasibility study must then be done in terms of the economic feasibility of any project. This includes studying historical pricing data as well forecasted data to ensure that the project will be sustainable throughout its lifespan.

In addition, from the interview with the Economic Officer at the DEPD, that the tax revenues from this industry will also take a long time to be earned due to the tax holiday (eight years for a pioneer industry like methanol) (MIPR, 2011). Also, the local share from the methanol production is just 25 per cent, when compared to the 75 per cent of the Japanese companies' shares of the project. Therefore, the contribution does not really seem significant when compared to the production of oil and gas in the country.

Moreover, it was also noted in an interview with the DEPD's Economic Officer that methanol and other petrochemical products are dependent on oil and gas prices. If the oil price is high, it will be beneficial for the country but if the opposite situation happens, then the profit margin will be lower. Apart from that, petrochemical production also depends on the foreign demand effect. Unlike the price of oil, which is set and stabilised by the Organisation of Petroleum Exporting Countries (OPEC), the methanol price is largely determined by market conditions. This issue was discussed with the Economic Officer at the DEPD and he added that if the trade agreement on petrochemical products between BMC and importing countries is a long-term one, then the trade is more secure and Brunei will consequently have an advantage from the agreement. However, if the agreement is more like a spot basis agreement, the return investment will be affected by external factors, e.g. foreign demand factor and credit crunch. However, according to one of the officers at BMC, one of the shareholders of BMC, the Mitsubishi Gas Chemical (MGC) is not only a shareholder but also a product taker. BMC has signed an agreement with the MGC and MGC is responsible to buy and market the methanol product and is committed to take 100 per cent of the production. Therefore, this could secure the export trade in the product and thus secure the profit income to Brunei as well.

In addition, the DEPD's Economic Officer mentioned that another economic challenge that SPARK may experience would be in terms of competition between Brunei and other established petrochemical industries outside the country, such as those in Singapore, Korea and Malaysia. The petrochemical industry in Brunei is small when compared to those renowned foreign petrochemical industries and this would create some barriers for Brunei in competing with them. However, Brunei has its own supply of feedstock for the petrochemical industry, i.e. oil and gas. According to the Economic Officer at the DEPD, Brunei is a small country that has a GDP of less than USD15 billion and for Brunei to capture even a small part of the international market for the petrochemical industry will still be significant. Moreover, Brunei has a cost-competitive factor, since it has no transportation cost for feedstock, an attractive cost of utilities and investment incentives in terms of a tax holiday or tax exemption period. For a pioneer industry such as the petrochemical industry that has a fixed capital expenditure of BND2.5 million or over, the tax exemption period is eight years from the first day of production (MIPR, 2011). Not only is it exempted from income tax but also from the corporate tax. There is also an exemption from taxes on imported duties on machinery, equipment, component parts, accessories and building structures. Income tax is also waived for a company that is engaged in "international trade in qualifying manufactured goods or Brunei Darussalam domestic product and export sales of those goods or produce separately or in combination exceed or are expected to exceed BND3 million per annum" (MIPR, 2011, p. 11). Other types of taxes, such as payroll, sales and manufacturing taxes, are also exempted. The exemption of taxes may also extend to not more than 11 years in total.

Furthermore, the prosperity of Brunei, which offers excellent infrastructure and also its strategic location within the 10 ASEAN members will attract more foreign investors to come to Brunei to engage in more petrochemical industrial projects. In addition, the costs of utilities that Brunei is providing are among the lowest in the region, there are no big natural hazards, a low pollution rate, no political instability and the crime rate is also very low, which makes Brunei a good place to stay and more secure than any other countries in the region. Lastly, there is also no major challenge to hiring both local and foreign manpower and resources and foreign participation regulations are also equitable and flexible.

6.5.2. Health and safety issues

Apart from the economic challenges, there are also some potential challenges that may affected the health and safety of the people living very close to the development. When the respondents in the questionnaire interviews were asked about their experience of living and doing their everyday activities close to the industrial area, 30 per cent of the respondents interviewed said they felt uneasiness about living close to the industrial area. One third of them feel that it is not safe to live close to SPARK, in terms of both the health of the local communities and the environment. A few of the respondents also felt worried about the development, for example the possibility that the methanol plants will blow up, so they are not sure what may happen in the future.

One of the male respondents of aged 47 years old said,

"Perasaanku macam takut bah. Mana tani tau apa kan terjadi. Melatup kah ia apa kah SPARK ani. Bagi ku inda jua selamat rasanya dari segi kesihatan sama environment tani".

[Translation in English]

"I feel scared. We don't know the possibility what will happen. The plants at SPARK have the possibility to be blew out. For me, I don't feel safe in terms of the health [of the communities] and also our environment".

Similarly, in an interview with the village head of Lumut I, the leader expressed some worries about the safety of the communities living close to the industry. According to him, those people who live along the Sungai Liang Kechil Road (the street located next to the industrial area) will be strongly affected by the development as they are very close to the development. Because of this, he has suggested that the people should be relocated away from that area. In fact, he has proposed this suggestion to the higher authority and also to the local people. In his view, the industrial area should be located away from residential areas. The public should not have access to pass by the industrial area because it is dangerous and the area is not fully secured with safety measures and no security provisions are found at the mooring pipes which are located very close to the residential area at the Sungai Liang Kechil Road. There will be a possibility of industrial accidents such as leaking of pipes. The local people are willing to be moved out from the village, as long as they are provided with a proper new housing settlement.

Some of the interesting opinions from the village head regarding the safety of the local communities are quoted below,

"Pipe atu yang that kampong Sungai Liang Kechil yang really affected tu. Jalan Sungai Liang yang di pantai atu. […] Even I talked to Dato' Ali, Timbalan Menteri Jabatan Perdana Menteri. Okay, and then I said to him, cubatah Dato' long term.. I'm asking about long term. Pindah tia orang-orang yang ada di sekeliling sana atu. Jadi, concentrate industry atu saja, you know. […] It's good for the country… for the income… I don't deny. Inda pulang kitani kan membantah apa ani. But at the same time, we must consider people… who residing apa ni, very close to the plant atu bah".

[Translation in English]

"The [mooring] pipe that will affect the Sungai Liang Kechil village. The one which is located on the coastal area. I even have talked to Dato Ali, the Deputy Minister at the Prime Minister Office regarding this. I said to him, please, Dato'… for the long term, I'm asking about the long term. Relocate all the village surrounding the project. So, just concentrate on developing the project only [without worrying about the health and safety of the local communities]. [The project] is good for the country... for the income… I don't deny [that]. We are not actually against it. But at the same time, we must consider [the] people… who are residing very close to the [industrial] plants".

In addition, the communities are also affected by the smoke generated from the methanol plants. According to the village headman of Lumut I, even though the local people were told that there is no need to worry about the smoke, as it is harmless, they do not fully trust these assurances as no research has been done. They thought that the explanation was only for the benefit of the company itself and the people were not happy with it. Even the wife of a former government minister went to BMC and made a complaint about the smoke coming directly to her house from the plants.

The village head of Lumut I said in his interview,

*"Tapi public ani [*laugh*] still doubtful bah ah…kabur… Banar kah cakap durang ani nya atau durang memang lah nya… kan menjaga durang punya image lah nya. Tapi I hope BLNG, BMC, SPARK, whoever they are… be honest. Tell the truth. Be honest kan. Jangan ada 'udang di sebalik batu' bah. […] Sebelum perkara atu berlaku, so iatah bejaga-jagalah. Precaution lah ah".*

[Translation in English]
*"But the public [*laugh*] are still having a doubt [on the assurance from SPARK regarding the health and environmental impacts from SPARK]… not clear… Are they talking the truth or is it just for the company's clean image? But I hope BLNG, BMC, SPARK to be honest. Tell the trust. Be honest. Before any bad thing happen, we have to be cautious. Take any precautionary measures".*

When the respondents in the questionnaire interviews were asked about the matter, few of them are also concerned about the smoke. According to one of the female respondents of aged 54 years old who was interviewed in the study, she has experienced that sometimes she smells kerosene during the morning. There seems to be a relation between the smoke coming from the petrochemical plants and the smell of kerosene as according to her she has not smelled any kerosene before the development of petrochemical industry at SPARK.

According to her,

"Sometimes we woke up with kerosene smell which is very irritating… I think it is coming from SPARK because before this […] have not experienced to smell something bad. Maybe from the smoke from the industry"

However, according to the village headman of Sungai Liang, there is no smoke coming from the methanol plant and therefore there is no health effects that can be caused from it. Moreover, he believed that any big industrial developments like SPARK have their own environmental standards such as ISO that should be followed and thus it is less likely that there will be negative environmental impacts from the development.

Up until now, there has been no serious illness reported that may be caused by the industrial activities either during the construction and operation of the project. According to the village headman of Lumut I, some residents have experienced more health problems, for instance coughing, etc. and based upon the questionnaire interviews with the local communities, a few respondents also said that there have been more flu incidents recently. Thirty per cent of the respondents mentioned that the development has affected their health or the health of family members. Some of them reported an increasing number of flu cases. One of the female respondents of aged 20, who owns two houses at Lumut and Muara (which is in another district of Brunei-Muara) mentioned that she experienced frequent asthma attacks when she stayed at Lumut, but she did not experience this when she stayed in her other house in another district. During her medical check-up with her doctor when she developed asthma, the doctor mentioned that there had been an increasing number of asthma attacks recently and the doctor assumed that was caused by the development of SPARK along with effects from the oil and gas industry, which has been present in that area since a long time ago.

According to that female interviewee,

"Kalau ku tinggal di Muara, okay wah ku tapi kalau ku di Lumut, start tah ku ampus. Ku ada rasa macam bejerebu bah jua. Selalu lah aku batuk-batuk and ampus. Kata doctor nya banyak orang ke clinic pasal ampus".

[Translation in English]

"I feel okay if I stay in Muara, but when I come to stay in Lumut, I start to get asthma attack. I think [the air] is also hazy. I coughed many time and got asthma too. The doctor [that I went to] said that there have been increasing number of patients going to the clinic because of asthma attack".

In addition, another male respondent of aged 28 years old also said that her nieces and nephews get more fever than ever before, but she was not sure whether that was related to the development.

In the interview with the respondent, he said,

"My nieces and nephews have been easily getting fevers than it was before. Maybe there is some relation [with SPARK] or maybe it was just my assumption".

Similarly, the village headman of Lumut I took the view that even though there have been increasing cases of illness occurring among the local communities, there is no proof that the leading cause is from the petrochemical industry, i.e. from methanol plants. According to him, there is no third party research on the environmental impacts from the project, suggesting that it may lead to the deterioration of the health condition of the people. However, it should be noted that in the questionnaire interviews, more than half of the respondents interviewed said that they had never experienced any health impact caused by the development.

The health issues mentioned above were also mentioned in the SPARK's EIS. According to the health and safety study of the SPARK EIA, the two top causes of illness from 2000 to 2004 in Sungai Liang were respiratory infections such as asthma and skin infections. These could possibly be caused partly by long-term exposure to low levels of airborne particulate and gaseous emissions particularly from the oil and gas industry. The presence of more petrochemical industries around the area may have the potential to exacerbate the health condition of the communities unless extra careful precautions are taken. Alternatively, the high number of those illness cases recorded is probably due to improved reporting of such illnesses in recent years, due to better access to health care.

Apart from the potential problems for the health and safety of the residents, there are also some possible health and safety issues in the workplace and this was mentioned in the SPARK's EIS. Exposure to methanol could lead to acute toxic syndrome which is associated with the irritation of eyes, skin, noise and throat. When the ammonia/urea plants are operated in the future, there will also be some potential risk from the release of the gas, such as toxic cloud and flash fire, causing injury or even fatality. The housing areas to the north of the ammonia plant lie within the hazard contour and it is assumed that people should be evacuated from these properties. In addition, exposure to ammonia in the workplace could lead to asphyxiation, suffocation and if the symptoms are left up to 48 hours, pulmonary oedema may result in fatality. Irritation to eyes, skin, nose and throat could also occur due to the exposure.

When the officers at BMC were interviewed regarding the health and safety risk from SPARK, one of the officers mentioned that methanol production is quite safe in terms of affecting the community as a chlorine base (sodium hypochlorite) is used in the production instead of chlorine gas. According to him, if chlorine gas was used, it would be very toxic to the environment, as when there is a leak, chlorine settles on the ground as it is heavier than air. On the other hand, sodium hypochlorite is in the liquid form and it does not disperse into the environment. In addition, the officer argued that methanol itself is not a carcinogenic chemical and it is unlikely that it will lead to any cancer risk, unlike effluent from a nuclear power plant. Effluents from the methanol plant could contain some carcinogens, but carcinogens are mainly found from the products of any combustion, including carbon monoxide, carbon dioxide or organic compounds.

6.5.3. Psychological effects

In addition, there are also some psychological effects that are experienced by the local communities. When the respondents were asked about their experience living close to the industrial area, a few of them said that the project development is affecting the well-being of the local communities. A few of them also complained that there have been loud noises from the operation of the project and erosion problems have occurred recently, since the project was developed.

The noise problem was also mentioned by the village head of Lumut I. According to the village head, the noise is usually heard during the night time and sometimes during the day. The company did inform the village headmen about the noise, but the noise is still there. Similarly, during the construction of the project, noises could be heard from huge and heavy machinery that transported construction materials but this problem occurred only for a very short period. However, based on a telephone interview with the village head of Sungai Liang, the noise coming from the development does not occur all day long but only at some times in a day, therefore, it does not affect the everyday activities of the villagers. The village headman describes the noise as the noise of an aeroplane on take-off and landing, as well as the noise of cars passing by a village.

During the observation of the industrial park in June and September 2012, no loud noises were heard coming from the area. This is probably due to the fact that, according to the village head of Sungai Liang, the noise only occurs at some times of a day or it may occur during the night, as the village head of Lumut I has said.

It is stated in the EIS of the SPARK project (2001) that during the operational phase at the methanol and ammonia/urea plants, there should not be any noise produced that is audible to residents. During the construction phase, activities such as site clearing, loading as well as unloading, excavating, building, hoisting, grading or pneumatic hammering may disrupt the comfort of the local residents. However, according to the village headmen of Lumut I and Sungai Liang and also a majority of the questionnaire interview respondents, the noise generated during the construction of the SPARK area was just temporary. The main nuisance at the time of the research was said to be industrial operation, i.e. methanol production. Moreover, it is also stated in the SPARK EIS (2001) that noise from the methanol plant may only become a slight problem to the residents living along the Sungai Liang Kechil Road to the north and not to those living to the south. However, according to the village head of Lumut I, the noise can be heard at his house, which is located at the Lumut I village.

In addition, there has also been an increase in the traffic congestion around the SPARK development. This was mentioned in the questionnaire interviews with members of local communities, according to some of them, there has been an increase in such incidents, especially in the morning, even though the road system has been widened into a dual carriageway. However, they acknowledged that the congestion is also caused by people coming to work at the Third Battalion army area. Lastly, some respondents also experienced odour annoyance; according to a few of them, they experienced an unpleasant smell of kerosene, especially during the morning.

6.6. Discussion

Taking into account the findings above, there are some important conclusions that can be drawn. The first one is in terms of the awareness of local communities of SPARK. Even though the respondents were aware of the SPARK project, they had minimal understanding of what the development is. Thus, their opinions regarding SPARK were necessarily limited and this was shown in the answers that were given during the questionnaire interviews. The majority of them believed in the benefits of SPARK for the socio-economy of Brunei, but quite a high number of them were not sure if the development of petrochemical production would eventually benefit the local communities.

This situation is similar to a study undertaken by Tosun (2000) regarding public participation in the tourism industry in many developing countries, which revealed a low level of awareness among local communities regarding socio-cultural, economic and political issues associated with tourist developments. The reasons for this were said to be due to apathy, limited concern and lack of interest in the issues. These reasons could also be some of the reasons why the local communities around SPARK have minimal understanding and few opinions about SPARK. As a result, this is one of the challenges Brunei faces in achieving sustainability, due to the very limited understanding of the local communities towards the project. This is because if they are not aware about the project and if there is any danger from the industry in the future, e.g. explosion and fire, the communities might not be able to prepare any mitigation measures in order to save themselves from such incidents.

In terms of the awareness of both village heads that were interviewed in the research, it can be said that they were aware about the project, as they understood the functions of SPARK, i.e. to provide space for petrochemical companies to set their production in the area and they were also aware about the facilities that can be found at the industrial area.

However, what can be found in the research is that there were differences of opinions between the two village heads regarding the development of SPARK. It is true that both of them agreed that SPARK has generated income to the economy of the country but it seems that the village head of Lumut I had more negative views about the development. While the village head of Sungai Liang was positive about the development and did not find any drawbacks from the project, the village head at Lumut I was more concerned about the health and safety of the villagers as well as the environment, because of the project development. The village head believed that the local people who live close to the industry should be relocated away from SPARK so as to protect them from any possibilities of industrial accidents that would seriously affect the health and safety of the communities and the environment. It is surprising to see there are differences of opinions between the village heads knowing the fact that the Sungai Liang village is near to the development than the Lumut I village yet the village head is more positive on the development of SPARK. This is because it was assumed that the negative impacts from SPARK may be felt in Sungai Liang as it is nearer to the project and that the head of that village may become negative than the village head of Lumut I. However, the opposite scenario occurred.

One interesting issue that can be found in the answers of the respondents is that there seems to be change of perspectives during the questionnaire interviews with the local communities. For example, when the respondents were asked about their opinion on SPARK, 75 per cent of the respondents were positive about the development but as the interviews going on, some of them began to comment about their uneasiness towards the project for example some of them viewed SPARK as a development that may affect their health. It seems that in the beginning, they are reluctant to discuss about the issues but later on, they began to open up their concern and expressed their anxieties towards the project.

In terms of the public participation in the development of SPARK, especially before the commencement of the project, there also seems to have been little involvement by local communities in the development of SPARK. This is due to the fact that most of those who were involved in dialogue meetings and discussions were only those who had official positions in the communities. Moreover, more than a half of the local communities interviewed were not briefed with any information regarding SPARK. This is probably because the majority of them were not informed about the project and were not present during the dialogue meetings, because according to officers interviewed at SLA, dialogue meetings are conducted at least once a year and for BMC, the meeting is carried out four times annually. Local people may not have been interested to get involved in any dialogue meetings or perhaps they trusted in the capabilities of both SLA and BMC to manage the development very well.

Another reason for low participation is probably due to the time constraint, meaning that the local community members have no time to attend briefings and dialogue meetings. This is because the meetings were carried out during the morning and on weekdays, when the working population and students at the villages are out of home for work or study. Housewives and mothers would not have time to attend dialogue meetings as they have to take care of the house and children at home. As a result, the majority of those who attended the meetings were men and in the age range of late 30's to 60's, who had retired from work. It should be noted that the age range of those who attend meetings was given by SLA and BMC and includes those village leaders and community councils. Should the meetings were carried out in an appropriate time for example during weekend, local communities may willing to come as they may want to learn more about the development and its possible impacts.

According to Rosener (1982, cited in Tosun, 2000), the public or communities only tend to participate when they are strongly motivated to do so, but most of the time, they are not motivated. This is because they believe that their ideas will not be considered by higher authorities and thus this does not motivate them to express an interest or views. This situation is present at SPARK - as mentioned earlier, most of the local people at Sungai Liang and Lumut I were not involved in the project because of reasons such as time constraints and lack of interest in participating. Due to these reasons, they were not motivated to participate in any discussions or meetings regarding SPARK. Some local community members have also put their trust in the relevant authorities to manage SPARK and their limited involvement in the SPARK project is due to their belief their opinions may not be taken seriously by the relevant authorities.

In addition, according to Tosun (2000), based upon his study of community participation in the tourism industry in many developing countries, there are three types of limitations that hinder community participation. Those three limitations are 1) operational; 2) structural; and 3) cultural. An operational limitation to community participation is a lack of co-ordination between relevant parties who are involved in community participation and there is also little information made available to the local communities about the tourist destination. In a different sectoral context, this is a common problem in Brunei, especially the problem of a lack of co-ordination among the government agencies, as they often operate in isolation.

Regarding the structural limitations, many developing countries fail to respond to the need for tourism planning by the adoption of appropriate educational and research programmes, as it seems to be difficult to acquire expertise as well as financial resources. This is also the case in Brunei, as the information given to the local communities about SPARK would appear not to be sufficient as shown from the lack of understanding of most of the local community members about the industrial project. Lastly, the study by Tosun (2000) also explains about cultural limitations. Some cultural factors such as the limited capacity of poor communities to manage tourism development effectively, as well as apathy and a low level of awareness in the local community, become obstacles in the operationalization of a participatory tourism development approach. This last type of limitation is also common at SPARK, especially due to apathy and the low level of awareness.

However, the findings revealed that the local communities became more aware about SPARK after they attended the dialogue meetings. It was mentioned earlier that when the local respondents were asked about the matter in the questionnaire interview, the majority of them were aware about the project. This is probably through village heads and councils who spread the information, or through conversation amongst the communities. However, it should be noted that even though the majority of the local community members interviewed were aware of the existence of the project, only a few of them understood what the project is all about. This leaves a challenge for the authorities to communicate with local communities effectively regarding the development. It was also noted by one of the officers at BMC that the major challenge is to make local communities understand how their operation works.

Another interesting thing that can be concluded regarding the public participation at SPARK is that there seems to be more of the 'top-down' process between the developers and local communities. This can be seen from the way the consultation process at SPARK was carried out i.e. more of the information briefings about the development and employment opportunities were given rather than discussing about their concerns. As it was mentioned earlier, some requests priorities of the local communities were ignored and regarded as unnecessary for example as in the case of a local community who asked the construction of a temporary jetty at SPARK to be stopped because he wanted to bring in his cows to graze near to the construction at a certain time of time.

Another conclusion that can be reached is about stakeholders' priorities for the industrial area and the surrounding. It was noted in an interview with the SLA that there had been no conflict or any such possibility. According to the officer at SLA, prior to the development of SPARK, all relevant stakeholders were informed of the future development to gain their feedback to ensure that such conflicts would be avoided. However, from the interview with the officers from BMC regarding the request from a local community member to stop construction of the temporary jetty, it seems that there is a slight conflict their priorities regarding the space surrounding the industrial area. In addition, there also seems to be a conflict in the use of the main road going to the industrial area, as the development has contributed to traffic congestion in the area, especially during peak hours (i.e. in the morning when people go to work and school, lunch time and when people go back home from work and school). In addition, from the observation of the Sungai Liang area, there are some conflicts of stakeholders' priorities that can be found in the area. For examples, the interest of the Forestry Department of Brunei is to save some parts of Sungai Liang as forest reserves while others use the area for residence, schools, a clinic and recreational area. On the other hand, Sungai Liang is also used as a petrochemical industrial area. Therefore, there is a conflict of the use of the area. There is a possibility that the petrochemical industry may affect the residents in terms of their health and safety as well as the environment of the air and the forest reserve, etc. Furthermore, in the near future, when the project is complete, with more petrochemical production, traffic congestion in that area will be worse due to the influx of people coming to work to SPARK and more workers would stay close to the area, if no mitigation method to reduce the congestion is put in place.

These conflicts that can be found at SPARK are common in other countries in similar coastal locations. According to Cicin-Sain and Knecht (1998), there are two major types of coastal and marine conflicts. The first one is conflict among users and the second one is conflict between government agencies that manage marine or coastal programmes. Both types of conflicts are usually interrelated, and both of them may pit particular users, as well as agencies, against other users and agencies. In the case of the conflicts found at SPARK, it seems that both types of conflicts that have been mentioned by Cicin-Sain and Knecht (1998) are occurring at SPARK because there are conflicts among the users of the coastal road, i.e. villagers, workers and others who use the road and also among government agencies that have different priorities for that area.

Another study by Majanen (2007) on the analysis of resource use conflicts in areas near the Marine Protected Areas (MPAs) in Mabini–Tingloy, in the Philippines also indicates a similar situation with the conflicts at SPARK. The author found large differences of perceived benefits and costs towards conservation and tourism between stakeholder groups and these inequalities have eventually led to conflicts between the groups. According to the study, due to unequal power relations, subsistence fishers are the weakest stakeholders of the area, as they have the lowest level of knowledge of conservation activities and they also have the lowest rate of participation in such activities. In reference to the conflicts over resource use at SPARK, it seems that the local communities are the ones who are the weakest as they have the least power in the local society and therefore, they have less power to put forward their views on the development. It was mentioned earlier that the villagers are willing to be moved out from their current residences at Sungai Liang due to the disruption caused by the discomfort and noise coming from SPARK. However, because they cannot afford to move out unless the

Government provides them with new housing, they are left with no choice but to stay at their current residences and therefore, this disadvantages them.

The main reason for the occurrence of conflicts is competition for space and this is supported by Cicin-Sain and Knecht (1998) who argue that the major reason for conflict is such competition. In addition, according to Brody, et al. (2004), the major reason why conflicts arise in coastal areas is due to the increase in population growth, as well as urban development in coastal areas, which eventually creates scarcity in the natural resources of the coast. When the available coastal resources become scarcer and there is more concentration of human activities in the area, various stakeholders are brought into conflict over issues such as conservation and development. As mentioned above, in the situation of SPARK, there is a conflict in the management of SPARK in that one department (the Forestry Department) seeks to reserve the forest for conservation but close to the forest reserves, there is a petrochemical industry which has the potential to harm the environment.

In addition, there are some important issues that need to be looked into in identifying the major benefits and challenges from the project. Firstly, when looking at the benefits of SPARK, the increase in the employment opportunities generated from the development for the local population can be considered to be the major positive impact upon the socio-economy of the country. This is due to the fact that almost all of the jobs are occupied by the local population and thus helps the country to reduce the rising unemployment rate in Brunei. Even though the petrochemical industry is not a labour intensive industry, the amount of employment that it will generate is considered high. Moreover, the type and quality of jobs offered at SPARK will attract the rising number of young and educated

Bruneians to fill the posts, compared to the employment opportunities in the labour intensive industries. This is because, recently, there is an increasing number of unemployed bachelor and master degree holders in Brunei. With the availability of quality employment opportunities at SPARK, this would eventually help those unemployed to work at SPARK.

In addition, another major benefit is in terms of the infrastructural development from the development of SPARK. The dual carriageway road system and the widening and deepening of drainage systems in the vicinity of the area can be considered to be another major benefit especially to the local communities and commuters going to work at SPARK, as well as to BSP and BLNG. There will be fewer or no flooding incidents, due to the improvement in the drainage system. Moreover, workers going to the work places at SPARK, BSP and BLNG, who are mostly commuters from other districts, would not have difficulty in arriving at work on time due to the major road traffic that they experienced before.

However, there is one major issue that SPARK may experience, which is that due to the period of tax exemption or holiday, there will be no tax revenues gained by the Government for eight years or 11 years if the tax exemption period is extended. Because the Government through PB only have 25 per cent of the share in the methanol production, the revenues from the taxes will be the most important source of income for the Government. In addition to that, there is also an issue whether it is economically appropriate to provide a huge percentage of subsidies to the foreign companies, i.e. 85 per cent subsidies for feedstock, water, and electricity. Assuming the tax exemption period is shortened and the level of subsidy is reduced, the Government could gain more income, but then again, this would make investors less attracted to set up their business in Brunei. Even if consideration is given to the income generated from the spin-off or spin-over effects, the benefits are still very small because most of the construction and maintenance work is being sub-contracted to foreign companies, due to the unavailability of local services for such work. Moreover, the methanol and other petrochemical prices are dependent on market conditions, which may negatively affect the business.

In addition, in terms of the health and safety of the local communities, there is a high possibility that the people who live especially at the Sungai Liang Kechil Road may be affected if there are any unfortunate events such as fire and explosion in the industrial area. Hence, the residential area along the road is considered as a hazardous zone and this is even stated in the SPARK EIS. Furthermore, if all the projects at SPARK are completed, more negative impacts will result, for example, more noise disturbance as well as traffic congestion may occur and this would further affect the local communities. In addition, it also seems that vulnerable groups of people, such as people who have asthma and elderly people, are more affected in terms of their health as a result of the development of SPARK, together with the effects from the oil and gas industry. Therefore, it is reasonable that the local communities should be relocated away from the industry and that there is no more residential areas, schools, etc. will be located close to SPARK.

According to Lee, et al. (2007), it is found that there is a risk of acquired dyschromatopsia (dysfunction of the nervous system) which is validated by using the loss of colour-vision as an early marker of neurotoxic damage. Moreover, workers at petrochemical plants are also exposed to risks of industrial accidents (fires, explosions and substance release) and this may affect the health and safety of the employees. Similarly, Vijayalakshmi, Agamuthu, and Hashim (2013) also note that petrochemical facilities are considered as major hazardous installations that have facilities that store and process huge amounts of flammable and/or toxic materials which could potentially cause adverse impacts to the surrounding population and property, as well as the environment. Furthermore, the industry is also known to be a high risk work environment because the employees are exposed to the chemical pollutants in the air and physical hazards at the workplace (Lai, 2010).

However, Nivolianitou, Konstandinidou and Michalis (2006) argue in their study that the main causes of industrial fires and explosions are human error and equipment malfunctions. There is a lack of safety culture knowledge and the communication system to diffuse the knowledge is also not structured. Similarly, a study by Konstandinidou, et al. (2011) also argues that in Greece from the year 1997 to 2003, the analysis of accidental incidence recorded revealed that human errors and equipment malfunctions are the main causes of industrial accidents, rather than other causal factors. In Korea, Kim, et al. (2002) also agreed that human error is the major cause of industrial accidents. All of these studies seem to suggest that with good safety management of petrochemical industry, any major industrial accidents can be reduced or avoided. However, there is still a risk that petrochemical plants may cause danger to the plant workers because of the risky nature of the industry.

There is an issue that lies here as to why the Japanese multinational companies at SPARK did not make any investment towards the relocation of the local communities away from the industrial area. As it was mentioned earlier that there are some philanthropic activities that have been carried out by the MGC in collaboration with SLA and BMC. However, with the project's potential impacts towards the health and safety of local communities who live close to the industry, the companies should engage in the relocation of the residents as the communities are willing to be relocated. This question the CSR of the companies in developing their industries in a sustainable way.

Apart from the physical health problems that may challenge the sustainability of the petrochemical industry in Brunei, some local communities near SPARK also experienced uneasiness due to the operation of the project, such as from the noise and fumes emitted from the industrial area. Similar situations are reported in other studies, such as a study by Luginaah, et al. (2002) which showed that some residents were not satisfied with the presence of oil refineries in the municipalities. In particular, parents whose children had symptoms or chronic health problems were more likely to experience perceived stress and odour annoyance by living close to petrochemical sources. Residents continued to feel anxious even though most odour reduction measures had been implemented. Their anxiety was reinforced by some occasional odour incidents and visual cues such as smoke emitted from the refinery stacks. This is also happening at SPARK and some community members continue to believe that fumes coming from the methanol plant's chimney are dangerous, even though it is just water vapour.

Regarding the issues related to smoke from the industry and the health problems that some local communities have experienced, it is interesting to know that there are differences in the views about the impact of the smoke to the health of the local communities. The SPARK developers and village head of Sungai Liang who were interviewed mentioned that the smoke is harmless, while the village head of Lumut I and some residents in both villages commented the opposite. As it was mentioned earlier, the SPARK developers have communicated about the absence of risk from the smoke to the local communities and the village heads but there are still a number of the communities who were not reassured about it. This is maybe because of the health impacts that some of them have experienced that have the possibilities to have a relation with the SPARK project.

According to a research by the EPA on the Shell Norco plant in Houston, US in 2010, more than 480,000 pounds of toxic pollutants were released into the air and among them is polycyclic aromatic compounds which is responsible for asthma (as cited in Sturgis, 2012). There could be a possibility that the smoke coming from the methanol plants is a pollutant that may become responsible for the increased number of asthma at the villages. Moreover, as it was mentioned before that one of the respondents smelled kerosene sometimes in the morning that may indicate it may be coming from the smoke.

6.7. Summary

The majority of the local community members interviewed were aware of the existence of SPARK, but only a few of them understood what the project is all about. For that reason, a majority of them had limited opinions about the development. However, it seems that the village heads of Sungai Liang and Lumut I were aware of the project as they both understood the functions of SPARK. However, it seems that the information on the functions of SPARK was either not communicated very well to the communities or the villagers were not interested to listen about the matter. In terms of the opinions about SPARK, the two village heads have differences in the opinions; one of them had a positive view of SPARK but the other one was more concerned about the health and safety of the local communities and environment of the village because of the project.

There was also little involvement from local communities in the development of SPARK because most of the people who were involved in the dialogue meetings with both SLA and BMC were those who had positions in the communities. Other reasons behind the lack of participation of communities were probably because of being poorly informed, not interested or not having time to get involved in any meetings and they have put their trust in both SLA and BMC to manage SPARK very well. Lastly, there has been a little issue on conflict on space resources between SPARK and some local people especially during the construction of the development.

This chapter has also discussed some of the benefits and challenges of the SPARK project for the society (particularly the local communities) and the economy of Brunei. Based upon the results, there are two major benefits that can be achieved from the project i.e. local employment opportunities and improvement in the infrastructural development surrounding the project area.

In addition, there are also some major drawbacks or weaknesses from the project. One of the weaknesses of the project is that it will be a long time before the revenue is returned to the Government, due to the inappropriate period of tax holiday. As well as that, the subsidies given to investors can be said not to be economically viable, as more income could be generated if the level of subsidy is reduced. Moreover, there is also little benefit from spin-off activities that the Government could gain, due to the unavailability of local services, such as in construction and major maintenance of the project. Lastly, the project may also affect the health and safety of local communities, especially those who live along the Sungai Liang Kechil Road and vulnerable groups that have health problems. When more petrochemical productions takes place at SPARK in the future, those negative effects from the development may affect the local communities if no mitigation methods are put in place in order to reduce or avoid the negative impacts to the socio-economy on the local communities as well as the country.

CHAPTER 7 - ENVIRONMENTAL ISSUES AT SPARK

7.0. Introduction

This chapter interprets the results from interviews, observation and analysis from the SPARK's EIS and discusses the likely benefits as well as drawbacks to the environment and ecology as a consequence from the development of SPARK. Firstly, this chapter discusses the current and potential environmental benefits that can be created from the SPARK project. Following these discussions, this chapter also outlines the current threat to the environment as well as the potential environmental risks through pollutant emissions from the industry to the surrounding air, water and land, which will eventually affect the environment and ecology surrounding the industrial area. Lastly, this chapter also examines environmental management and monitoring at SPARK.

7.1. Environmental benefits

With regard to the environmental benefits that can be derived from the production of petrochemicals at SPARK, it is unlikely that there will be any environmental benefits from the initial development of the project. From an interview with one of the environmental officers at the DEPR, it is noted that there is no possible environmental benefit that can be gained from the development. In fact, according to the officer, the natural environment will be affected. This is through the removal of the natural surface that is covered by trees, for the building of concrete surfaces for the industry. Moreover, when the local community respondents were asked in the questionnaire interviews about the potential benefits the environment from the project, a majority of them (80 per cent) said that there were no observed or potential benefit to the environment as a result of the project. Five per cent of the respondents were not sure about it and another 35 per cent of them had no comment about the benefit (see Figure 20). None of the respondents believed that there is any potential benefit to the environment as a result of the development. In fact, some of them said that it is dangerous to have that development near to the residential area. This issue will be explained in further details in ***section 7.2.*** of this chapter. Figure 20 shows the response from local communities interviewed on the potential benefit that can be derived from SPARK.

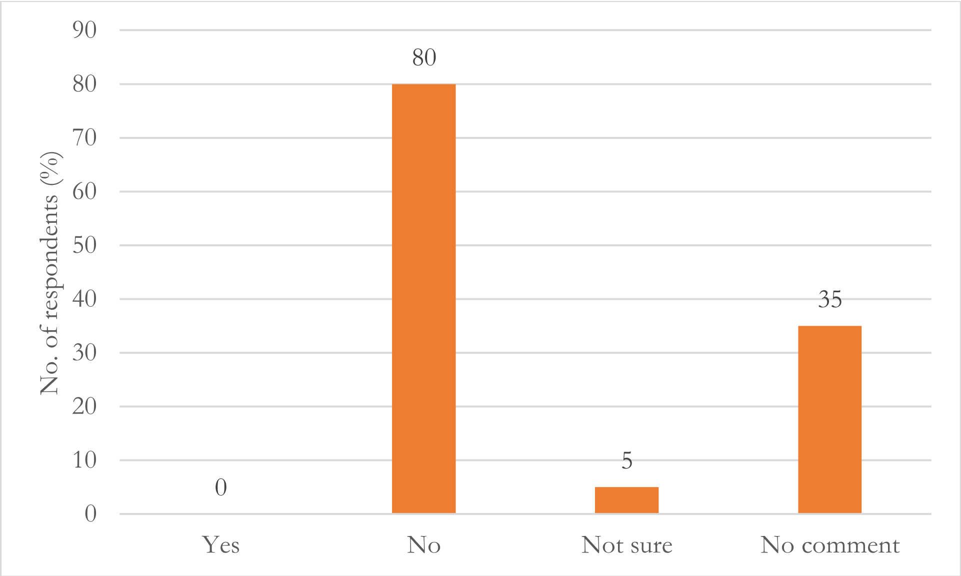

Figure 20 Local communities' opinion on potential environmental benefits from SPARK

Having said that, there are however, some possible environmental benefits that could be gained from the project, which can be inferred by looking at the entire process of the development of the petrochemical industry. As it is stated in the SPARK EIS (2001), one of the environmental benefits that could be gained from SPARK is during the operational phase of the SPARK development, when the beach along the Sungai Liang area will become inaccessible to the public. This will eventually benefit the turtle population, as

Brunei is a coastal state characterized by sandy beaches, which are suitable for turtle nesting. Olive Ridley, Hawksbill and Green turtles are the three most common species of turtles that nest in Brunei that must be protected and with the closure of the beach area, these turtles can safely lay their eggs and their population will increase and consequently their species will be protected (Turtle Management and Conservation). Moreover, it was also noted in an interview with BMC that environmental awareness activities in schools, including a turtle awareness campaign, have been sponsored by the company, in conjunction with the turtle management and conservation programme in Brunei Darussalam and as part of the Corporate Social Responsibility (CSR) programme. The aim was to raise awareness, especially amongst young children, about endangered species like turtles. Therefore, the SPARK development has contributed some benefits to the environment and ecology surrounding the industrial area.

In addition, another benefit to the environment that can be achieved from the SPARK development is through environmental technologies that are put in place in the operation of petrochemical production. In order to meet standard environmental requirements and guidelines, methanol production at SPARK is currently using environmental technologies that help in reducing the likely negative impacts to the environment and thus this will protect the environment from being negatively affected. The methanol production at SPARK is using the Mitsubishi processing technology. As noted in the interview with the BMC, this technology has several heat integrated systems. Waste heat is recycled and the excess steam is re-used in a steam turbine generator and converted it into electricity, instead of being vented out into the atmosphere. The temperature of a steam reformer is about 900^{o}c and after an endothermic reaction has occurred, the heat is no longer needed in the process. Instead of cooling it down and wasting the heat, the company recycles the heat and it uses it again in other parts of the plant. Moreover, according to the officer at BMC, the type of the NO_x and CO_2 burners that are used emit low amounts of NO_x and CO_2 to the atmosphere. Therefore, less of these gases is emitted and hence, this will reduce the greenhouse effect upon the environment. In addition, the officer from BMC also mentioned that the methanol production at SPARK is also quite safe in terms of affecting the community. For example, a chlorine (sodium hypochlorite) is used, instead of chlorine gas, which is dangerous because chlorine gas is very toxic and if there is a leak, it will sit on the ground as it is heavier than air. Sodium hypochlorite is in liquid form and it does not disperse into the environment.

7.2. Environmental challenges: pollutant emissions and risks

In an interview with the Environmental Officer at DEPR, it was argued there has been no significant negative impact on the environment from the start of the project and that the environmental effects are under control. In addition, according to the SLA, there will be no project on the coastal area that really affects the ecosystem. Effluents from the industry are also being treated internally and will be released to the channel within safe limits. Thus, the development's effects on the environment may be avoided or reduced.

However, when the respondents were asked in the questionnaire interview whether the SPARK project may lead to negative environmental impacts, 45 per cent of the respondents agreed that the project may affect the environment negatively. There is a mismatch between the views of the project proponents and industrial tenant and the local population, who seem unconvinced by these views. Some of the respondents believed that the development may eventually lead to air pollution and release of other pollutants as well as acid rain and loss of diversity of living species as a result of the project. Twenty per cent of the respondents that said that the project does not affect the environment negatively, while 20 per cent of the respondents were not sure about the matter and another 15 per cent had no comment on that. Figure 21 shows the opinions from the local communities regarding environmental impacts from SPARK.

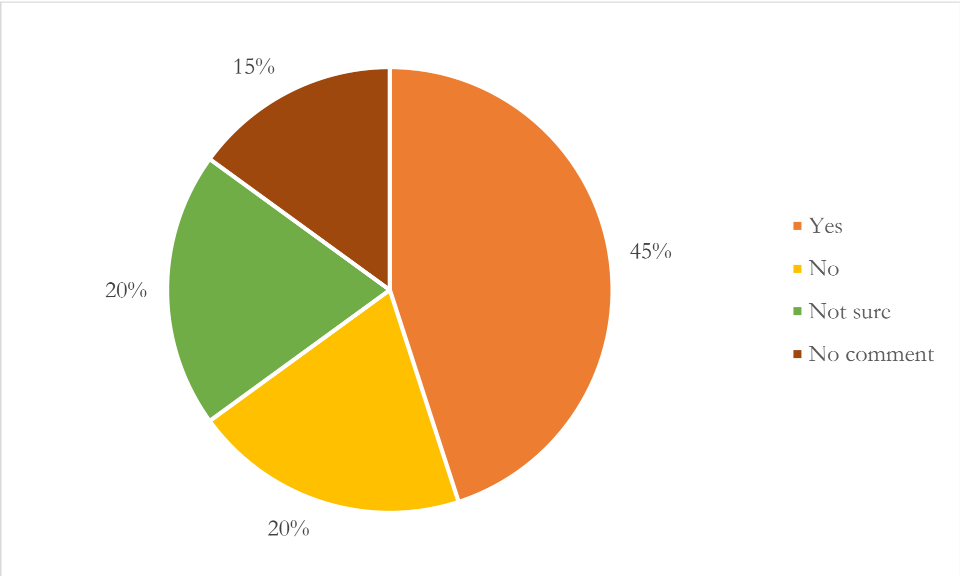

Figure 21 Local communities' opinion whether the SPARK project may affect the environment

Based on the environmental scoping checklist prepared during the industrial and the surrounding visits to SPARK, as well as examination of the SPARK EIS (2001) and other relevant documents about SPARK, this chapter analyses some possible challenges that the petrochemical industry at SPARK may face. These could occur through the effects of pollutant emissions from the operation of the development. The following section discusses the impacts upon air quality; hydrology; surface water; coastal natural resources and processes; and lastly ecology from the petrochemical industry at SPARK.

7.2.1. Impacts on the air quality

As stated in the SPARK EIS (2001), the methanol plant will generate a maximum level emission of 246µg/m^3 NO_x whereas the ammonia/urea and power plant may emit 150 µg/m^3 and the combination of the two will be 391 µg/m^3. The emissions for both of the two plants satisfy US guidelines but exceed the Malaysian guidelines (SPARK EIS, 2001). However, the generally high wind speeds are likely to disperse these emissions and thus the pollutants may not settle in the air at a particular place and time. In addition, air emissions from the methanol plant stacks will also include NO_x maximum level emission of 246µg/m^3 (EIS, 2010). This is well within the one-hour guideline in Malaysia (320 µg/m^3) as well as the Philippines (260 µg/m^3) and the US (500 µg/m^3) but exceeds the levels permitted in New Zealand (200 µg/m^3) and Australian (240 µg/m^3) levels (SPARK EIS, 2001). The CO, SO_x and PM_{10} emissions are all negligible and satisfy guideline values set by other countries in Asia and Australasia (SPARK EIS, 2001).

In a telephone interview with the village headman of Lumut I village, it was reported that the communities have experienced some health problems, for example coughing, but have no proof that the problems experienced were as a result of any air pollutant emitted from the development. It was mentioned in the previous chapter that when the respondents were asked whether they had experienced any health change as a result of the construction works and operation of the project, some of the respondents said that they had experienced some unpleasant changes, including health problems such as asthma and flu. Those health problems may have been caused by the air pollutant from the development, as according to one of the respondents quoted in the previous chapter, she experienced asthma when she stayed at her house in Lumut, but not when she was at her house in another district.

If this is true, this indicates that the air quality around the industrial area is affected by the development. However, this is just based on hearsay and therefore, it cannot be counted as reliable evidence.

7.2.2. Impacts on hydrology

It was noted from the SPARK EIS (2001) that the development of the industrial park will also cause some modification of the existing watercourses during the initial phase of the development and also the infilling of the Sungai Liang Kechil area if the development is extended towards the shoreline. Moreover, it was also noted from the EIS that the industrial park site will be paved with concrete, such that any existing surface ponds, especially at the existing sawmill, will be infilled. This transformation was seen during the visits and observation of the industrial area. This transformation of land cover, from forest and scrubland to concrete, will eventually increase surface run-off.

According to the village headman of Lumut I, there were cases of flooding during the start of the SPARK project. This was due to the covering of the area with concrete and due to the fact that the roads were cut off. The water from the development project was flowing out to the lowland area (i.e. the village, especially along Sungai Liang Kechil) which caused the roads to crack and finally become impassible. The village headman also added that the local villagers believed that the methanol production at BMC may have the potential to cause flooding, because before the project took place, there were no flooding incidents around that area. The people who are impacted by flooding are those local communities who live at the Sungai Liang Kechil area.

In the interview with the village head, he said,

"Au banjir. […] Orang inda sekulah pun paham bah tu. Durang tinggal di sana. Iatah pengalaman durang atu dapat diguna pakai. Tapi when we had dialogue hari atu nya, inda… kira kan defend lah… tapi suara ramai atu. Banar tu nyangku… arah sekitar kita bersih, tapi air atu memang lari arah lowland level. Tekana tia ke kampong… lari tia ke kampong air atu… Mana inda pacah Jalan. Sibuk tu kami… anu Jalan Sungai Liang atu olehnya.

[Translation in English]

"Yes, flooding. […] Even those people who don't go to school would know [that the flooding is caused by the project]. Because they live in the area. It is their experience who have been living in the area has made them aware about it. But when we had a dialogue [with the project developer] on that day, the developer seemed to defend themselves [that the flooding is not caused by them]. But [I said] it is from the voice of the public. There is no flooding in your area [at SPARK] but the water is flowing to the lowland area. That's the reason the route way gets damaged. There was a chaos during that time at Jalan Sungai Liang because of that".

7.2.3. Impacts on the surface water quality

The surface water nearby the industrial area may be affected through construction and operation of the project. During the construction of SPARK, it was noted in the SPARK EIS (2001) that the clearance of vegetation and earthmoving activities may increase the sediment load and dust at the industrial park site. Given the fact that there are naturally high concentrations of suspended solids in the waterways, particularly after rainfall, the siltation process will be worsened during the construction period of the development (SPARK EIS, 2001). Eventually, this may lead to siltation in the nearby waterways. It was also noted in the SPARK EIS (2001) that if the disposal of spoils from the clearing operations is not controlled, they may reach the drainage channel, the estuarine areas and even the sea. When this happens, the water quality of the sea may be affected. In addition, during the construction of the SPARK's jetty, siltation will also be likely to occur due to the movement of bottom sediments attributed to piling (SPARK EIS, 2001).

Changes in water quality may also result from the operations of SPARK if all, or any, of the constituent plants discharge their untreated effluent directly into estuarine waters or the sea. There are a number of ways in which the water bodies may be affected through the pollutants and contaminants in wastewater that are generated from the sources in the industrial park. It is stated in the SPARK EIS (2001) that one of the ways is through the process condensate and effluents generated from ammonia/urea and methanol production, as they are contaminated with ammonia and urea. Ammonia and urea are nutrients that promote the growth of protista and plants in water (SPARK EIS, 2001).

In addition, it was mentioned in the SPARK EIS (2001) that the discharge of the heated effluent of water from both steam generator/boiler for process steam production and power generation as well as from the cooling water circuit may also affect the water bodies and will eventually affect the biological community of coastal water if they are discharged directly into the water. Even though the discharge of water from the steam generator/boiler does not contain any toxic components and has a low organic content, it is discharged at a temperature of about 50^{o}c, which is higher than the temperature of the ambient water (SPARK EIS, 2001). Direct discharge of this water will be likely to cause a change in the fish species that can exist in the receiving water body. Furthermore, it may also lower the Dissolved Oxygen (DO) level in the water and thus will affect the fish communities in the water. In addition, the blow-down water from the cooling water circuits normally has a relatively high level of Suspended Solids (SS) and dissolved solids (TDS) and it is discharged at a temperature slightly higher than the ambient water. The situation is exacerbated during the southwest monsoon, when dilution is weakest due to weaker circulation and mixing in the water column and thus will affect the fish population even further.

Furthermore, as stated in the SPARK EIS (2001), wastewater from the demineralization plant for steam generator/boiler feedwater conditioning may also have a high mineral content [Sodium (Na), Calcium (Ca), Magnesium (Mg), Sulphate (SO_4), Chlorine (Cl) and Silicon dioxide (SiO_2)]. Domestic wastewater from kitchens, bathrooms, showers and wash areas may also to affect the water bodies as they may exhibit high Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD), as well as possibly containing coliform (SPARK EIS, 2001). Thus, this will affect the quality of water and eventually the biological community in the coastal water.

As stated in the SPARK EIS (2001), the SPARK development may become a source of pollution to aquaculture farms in the Tutong and Kuala Belait districts. Assuming the degree of wastewater and thermal pollution emanating from the development area is minimal, the other consideration is to know the movement of tides in order to determine whether or not the said pollutants will be dissipated by the time they reach the aquaculture zone (SPARK EIS, 2001). During the southwest monsoon, the direction of the current is towards the northeast, which implies that some damage is possible during this season (SPARK EIS, 2001). However, damage will only occur if there are spills or discharges that are not mitigated or controlled.

7.2.4. Impacts on coastal natural resources and processes

In terms of its impacts towards the coastal natural resources, it is less likely that these will be affected by the development. This is because it was stated in the SPARK EIS (2001) that coastal resources such as coral offshore from Sungai Liang is patchy and local mangroves also have less significance compared with other parts of the Belait District in terms of their abundance.

Even though the biological community such as fish may be affected by the discharge of heated effluents and other pollutants, there is no serious consequence that can be seen in terms of fishing operations due to the relative ease and incur minimal cost to move nearby fishing grounds (SPARK EIS, 2001). Moreover, no fishing activity will be allowed in the Sungai Liang area due to the government regulations that prohibit such activity in order to protect the offshore oil and gas industry pipelines (SPARK EIS, 2001). The only possible threat to the fish resources is if the pollution level from effluent discharge is high and on a large scale, which may kill fish in the area and the nearby water. This may threaten the entire Belait fisheries if large-scale fish destruction or market avoidance occur, if fish is found to be contained by chemicals or oil from acute or chronic oil spill. The value of Belait fisheries is estimated at B$ 2.1 to 3.2 million per year, so the economic consequences could be considerable, as would the impact on local livelihoods (SPARK EIS, 2001).

7.2.5. Impacts on ecology

It was stated in the SPARK EIS (2001) that during the construction of the project, the site was cleared and preparation works have resulted in the physical removal of all existing flora, and these will also scare away the majority of animals, except along the coast, in the estuary of the Sungai Liang Kechil and in parts of the buffer zone where vegetation cover will be retained. Both noise and dust during the construction phase could cause temporary nuisance to remaining fauna. In addition, it was also mentioned in the SPARK EIS (2001) that during the 'earth-moving' operations, soil and sand are dumped into the area to raise the level of the project site very much higher than level it used to be. This will cause enormous dust generation in the area during the dry season. The community and the forest around the project site will be the recipients of dust settling from the air. Dust will also affect visibility, not only for people, but also among wildlife species. Settled dust on the upper surfaces of leaves will affect their photosynthetic activity during the dry season.

Moreover, it was also mentioned in the SPARK EIS (2001) that dust generation during the dry season is another important negative environmental impact in the project site. Dust, as it settles among leaves, fruits, and flowers especially in the surrounding area, disturbs the foraging activity of fruit-eaters. Insects are also deterred from flying with so much dust in the atmosphere. With low insect activity, insectivorous birds are deprived of their source of food. In addition, bulldozers, graders, backhoes, dump trucks and chain saws produce a cacophony of noise that will disturb wildlife in the area. Loss of nesting sites such as nesting trees for the Crested Serpent Eagle, and the sandy nesting grounds of bee-eaters will result from this, as will the loss of foraging areas of certain wildlife species, such as the long tail Macaque.

However, according to the SPARK EIS (2001), it is unlikely that there will be major negative impacts on the ecology since the site is not considered to be an important wildlife supporting area, nor a permanent territory of endemic resident birds of Brunei. Furthermore, the shoreline area along the beach and around the estuaries was generally low in diversity at the time of the survey in March 2005 (SPARK EIS, 2001). Therefore, it is argued that development does not really have a major impact upon the ecological life of the area.

However, the only concern is that the beach is known to be a nesting site for the three species of turtle but, as mentioned earlier, the closure of the beach may benefit the turtle population. Conversely, the presence of lighting in the new industrial site may confuse the hatched turtles, and they might head towards the top of the beach instead of the sea. In addition, the remnant 'alan-bunga' forest lies right next to the proposed methanol production facility and its storage tanks (SPARK EIS, 2001). If there is any fire coming from the remnant forest, this will put the methanol production facility in imminent danger. Tall trees are also lightning hazards and will attract lightning strikes. Whether during the dry or rainy seasons, the remnant forest inside the project site is a real hazard to the whole industrial complex.

During the operation of the planned two facilities, namely, the Ammonia/Urea and Methanol plants, together with the Electric Power Plant, several possible air pollutants may be produced by the industrial complex, most probably ammonia gas (SPARK EIS, 2001). Ammonia in the air will react with rainwater to produce a strong base, Ammonium hydroxide (NH_4OH). Ammonium hydroxide in rainwater affects plant soft tissues, such as buds, flowers, and shoots (SPARK EIS, 2001). It stunts the growth of trees and prevents formation of twigs and blooming of flowers during the rainy season. Mature leaves are not affected as the upper surface is coated with waxy substances. Ammonium hydroxide, however, will be neutralized into ammonium salts as it reaches the soil and becomes good fertilizer. Methanol leaks are a fire hazard. Methanol in water will kill plants as this compound is a very strong preservative. In addition, with the exhaust of the electric power plant, carbon particulates and other gases from burning of fossil fuels will result in air pollution. Flora are not so much affected, but soot and carbon particulates will blacken the tree trunks and 'soil' the scenery.

Apart from that, it was also noted in the SPARK EIS (2001) that a potential secondary impact area will be the Mixed Dipterocarp Evergreen Forest around the Department of Forestry Compound which is within a 2 km radius from the project site. This forest may get a minimal amount of dust during the northeast monsoon when the wind direction comes from the sea towards inland. However, during the rainy months of the southwest monsoon, the forests will not be affected by ammonium hydroxide precipitate, if there is ammonia leakage. The wind direction during the southwest monsoon is from the southwest going north.

7.3. Environmental management and monitoring

In terms of the environmental management and monitoring of SPARK, the DEPR, the main authority in environmental management of the country, has little involvement in it.

Basically, DEPR was involved prior to the development of the project only, i.e. on the EIA, according to an interview with an Environmental Officer at the DEPR. The process was that the project proponent (BEDB) submitted the terms of reference of the EIA to the DEPR and then when both agencies (BEDB and DEPR) had agreed on some amendments, the DEPR then endorsed it. The project proponent started the draft of the EIA and submitted it to the DEPR. If there were any changes or amendments to it, DEPR required the proponent to make corrections and the process went back and forth until there were no further changes to make. According to the Environmental Officer at the DEPR, basically the department analysed sections on the impacts from the development in the EIA. If any potential major impacts were identified, the project proponent was required to set up sufficient control measures to prevent or reduce the adverse impacts that the development may cause.

Furthermore, the DEPR is not responsible for the management of waste (neither solid waste nor hazardous waste from effluents or emission from the industry). According to the DEPR, BEDB is the agency that handles waste management. Waste from the development is managed according to requirements stated in the EIA, such as adhering to the Brunei Pollution Guidelines (BPG) and those of the World Bank. The major reason that the monitoring of the hazardous waste emissions at SPARK is not carried out by DEPR is due to the fact that it is a new governmental department that was established since 2002 and there is a lack of proper competent personnel and equipment for monitoring. It was mentioned during an interview with the Environmental Officer at SPARK that because of these lack of monitoring mechanisms, environmental monitoring of SPARK is only done by the SLA itself and environmental reports on that will be given to the DEPR.

In addition, it was noted with an interview in the SLA and BEDB that SPARK is also actively linked with the National Disaster Management Centre (NDMC) to effectively tackle the biggest scale disasters. NDMC is a national body in Brunei that will ensure and prioritise the risk reduction of disaster risk with a strong institutional basis for implementation (Prevention Web, 2011). In addition, it was mentioned in an interview with the SLA and BEDB that SPARK has its own master plan integrated with the EIA. The EIA is a reference point for every project and any environmental concerns will be considered and actions will be taken to eliminate or reduce any negative impacts on the environment. According to the interview with the SLA and BEDB this indicated that every tenant has its own EMP and SPARK also has its own Environmental Management Plan (EMP). SLA has advised its current and potential investors to work towards the international standard ISO: 14000. In this way, the SLA believes a sustainable environment can be achieved. SPARK tenants are required to provide DEPR with a quarterly environmental report which includes details on the impacts to the environment. From the report, DEPR will analyse if the impacts may have any significance to affect the environment and the society.

In addition, according to one of the officers of the SLA, any industry located within SPARK is also required to have an EIA. Basically, tenants will initiate and conduct the Emergency Response Plan (ERP) exercise. SLA's role is to assist and help the tenants for successful execution. SLA is working on its own ERP. It also has EIA in the master plan report. All aspects of protecting the environment and the local communities have been taken into consideration in the EIA. It is compulsory for tenants to provide an EIA report and risk assessment analysis prior to their development. Independent body monitoring is also based on the EIA and monitoring is done by the own tenant of SPARK (SLA). SLA advises tenants to aim for the HSE international standard i.e. ISO 9001 (Health and Safety) and ISO 14001 (Environment).

In addition, based upon an interview with the BMC, BMC has also its own ERP and the fire department is equipped with Hazmat equipment and BMC also has its own fire-fighting team. The company is following the Brunei Pollution Control Guidelines as well as the World Bank Guidelines. BMC will be comparing both sets of Guidelines, side by side, and will implement whichever is more stringent. All effluents from the industry are treated within the plant. These include solid waste which consists of sludge cakes (98 per cent of which consist of water), scrap metals, plastic bottles and domestic waste. A government approved local contractor (Mashhor Company) will dispose of it for BMC. Scrap metals are recycled and go to the company; they will be compacted and sent overseas. According to BMC, monitoring is also based on the requirements set out in the SPARK EIA and based on the Brunei Pollution Control Guidelines. Third party monitoring is done annually by the Singapore Testing Services. However, as far as could be determined from interviews with the village headmen, there is currently no third party research on the environmental impacts.

When looking at the HSSE of the petrochemical companies that have invested and will be investing at SPARK, the companies are carrying out the HSSE procedures. Because there are limited resources about PB due to lack of published data, this section only gives a very brief account of PB and its HSSE and CSR activities in managing its operation towards sustainable development. In terms of the HSSE, PB strongly emphasises the protection of the people, the environment as well as assets and reputation (MITSUI, 2014b). PB has successfully achieved and maintained a record of zero Loss Time

Incidents (LTI) since its operation in 2006 (MITSUI, 2014b). In addition, with respect to the CSR, PB is also committed to good CSR especially in the areas of encouraging education, environmental protection as well as research and development (MITSUI, 2014a).

Besides PB as the national investor, there are two international petrochemical companies that have invested at SPARK, in methanol production. They are Mitsubishi Gas Chemical Company Inc. (MGC), which holds a share of 50 per cent and ITOCHU Corporation, which has a shareholding of 25 per cent. Another petrochemical company which will invest in the ammonia and urea production is MITSUI & CO., Ltd.

These petrochemical companies are also committed to the HSSE initiative. MGC recognises the importance of sustainable development, therefore it has been promoting the RC initiative by participating in the Japan Responsible Care Council (JRCC) and setting up an Integrated Safety Management System (ISMS) (MGC, 2014c). MGC aims to harmonise business activities with preservation of the environment by ensuring the health, safety and environment in the lifecycle of the chemical product, i.e. from the development, manufacturing, distribution, use and disposal of the product (MGC, 2014c). MGC is committed to focus on 1) occupational health and safety; 2) process safety and disaster prevention; 3) environmental protection; chemical and product safety; 4) distribution safety; 5) community dialogue; and 6) the spectrum of RC (MGC, 2014d). Moreover, MGC has also adopted environmental accounting, developed environmentally-friendly products, conducted green procurement and has made progress in zero emission of waste products (MGC, 2014a).

ITOCHU Corporation is also committed to increasing the environmental awareness of the members of the company (ITOCHU Corporation, 2014b). The company has offered various educational programmes such as seminars on how to improve awareness and compliance with the requirements of environmental law and regulations, as well as holding internal seminars on global environmental issues (ITOCHU Corporation, 2014b). For instance, in January 2013, the company organised a seminar on the Global Environment-oriented Business Management in Tokyo, which was attended by about 180 employees of the company and its affiliates (ITOCHU Corporation, 2014b).

MITSUI is also responding to the REACH regulation where the company has worked in cooperation with its European offices in order to complete a database on the chemical substances and to develop systems to comply with REACH (MITSUI, 2014b).

With respect to the resource and energy efficiency, petrochemical companies at SPARK are also using resources and energy efficiently. For example, ITOCHU Corporation is using bioethanol by which the ethanol is derived from sugarcane (CO_2 is reduced by 60 per cent in comparison with gasoline) (ITOCHU Corporation, 2014f). However, this bioethanol is not used at SPARK, as the feedstock can be derived easily from the Brunei Liquefied Natural Gas (BLNG). Similarly, MITSUI is also commercialising bioethanol and other environmental businesses such as hydrogen and new energy (MITSUI, 2014h). In fact, since the early 1990s, the company has shifted away from fossil fuel to biomass resources in order to reduce negative impacts upon the environment (MITSUI, 2014g). MITSUI has been actively promoting the use of palm oil, and sugar from sugarcane (MITSUI, 2014g). Furthermore, the company is also taking steps to increase the supply chain for both fats and oils, for instance by strengthening its relationship with one of the largest oil palm companies in Malaysia for the manufacturing of chemicals from palm oil (MITSUI, 2014g). Therefore, the company is promoting green chemical business operations that provide raw materials that are environmentally-friendly, including bio-plastics, fatty acids for detergents, as well as cosmetics, glycerine, alcohols, lubricants, rubber, and tyres (MITSUI, 2014g).

In terms of energy efficiency, ITOCHU Corporation has also set up energy-saving measures including the selection of the transportation modes, and actions to improve the efficiency of transportation and coordination between freight carriers and recipients (ITOCHU Corporation, 2014g). Modes of transportation are examined and analysed, and consideration given to the potential to change to rail and domestic vessel modes of transportation away from the long-haul truck type of road vehicle, which will comparatively reduce the impact to the environment (ITOCHU Corporation, 2014g). Consideration of appropriate vehicle type and route selection for transportation are also important and the company is also trying to improve efficiency in loading and minimising specific energy consumption (ITOCHU Corporation, 2014g). ITOCHU Corporation plans to build cooperative frameworks together with distribution companies, partner suppliers and other parties (ITOCHU Corporation, 2014g).

MITSUI is also promoting economical driving practices as well as other fuel saving methods and using larger transport vehicles, introducing cargo consolidation arrangements and reviewing transport routes in order to raise efficiency (MITSUI, 2014b). Furthermore, energy saving measures such as modal shifts by use of rail and ship are also implemented (MITSUI, 2014b).

7.4. Environmental Control and Impact Mitigation

In order to reduce and avoid negative environmental impacts as a consequence of the development of petrochemical production at SPARK, several measures have been and will be put into practice. The measures are in terms of environmental control and impact mitigation on the air, hydrology, and water surface that are mostly stated in the SPARK EIS (2001) as guidelines to mitigate harmful impacts.

7.4.1. Air impact mitigation

There are several measures stated in the SPARK EIS (2001) that are used as guidelines to mitigate impacts to the atmosphere as a result of the development. One of the mitigation methods is to reduce the amount of NO_x that is emitted from industry. It was stated in the EIS that the reduction of ambient NO_x can be achieved through water/steam injection, which is the most prevalent means of NO_x control for combined cycle gas turbines. Water or steam can be injected with fuel and air into the turbine combustion chamber to lower the peak combustion temperature. This decreases the production of thermal NO_x. It was also mentioned during the interview with the BMC that for methanol production, low NO_x and CO_2 burners are used so as their emission into the air is minimised. The use and maintenance of wet scrubbers could lower further the production of particulate matter (PM_{10}) and urea dust. The standard 50m buffer zone for natural waterways (e.g. BLNG floodway and Sungai Liang) and a 10m easement zone for all constructed canals will be implemented. It is proposed in the SPARK EIS (2001) that these buffer zones be established during the initial part of the construction phase to limit disturbance of natural waterways.

7.4.2. Hydrological impact mitigation

Floods from sudden and strong downpours are a potential hazard for the industrial park development. It was stated in the SPARK EIS (2001) that an appropriate and adequate drainage system should be built sufficient to accommodate expected large volumes of rainwater in order to mitigate measure against mass movements and/or differential settlement and liquefaction in the event of an earthquake in the area. Through the field observation in the industrial area and the surrounding area, it was noted that the drainage system at the villages close to the development, especially along the Sungai Liang Kechil area, was improved i.e. the drainage system has been widened.

7.4.3. Water surface impact mitigation

It was stated in the SPARK EIS (2001) that one of the ways to mitigate wastewater is waste minimisation through process modification. It was also stated in the EIS that in the future production of ammonia/urea, a new technology in ammonia/urea production will have an integrated wastewater treatment in the manufacturing process. This technology involves the recovery of ammonia from wastewater using disrobers and recovery of urea using a hydrolyser. The resulting treated wastewater is pure enough to be used effectively as boiler feed water make-up or cooling tower make-up. These processes effectively eliminate wastewater discharge. From an interview with the BMC, it was noted that wastewater is treated first and then it will not be discharged without checking the wastewater readings. According to the BMC, the treatment plant can tackle all the capacity of the plant and therefore, there is no possibility that the effluents discharged from the methanol production are not treated properly before they are released into the seawater.

Another mitigation method that is stated in the EIS is that regular water monitoring should be conducted to detect the presence of harmful chemicals and oil that may threaten fish health. Monitoring activities should also cover the wastewater treatment facility to ensure strict compliance with water quality standards recommended for fisheries and aquaculture operations. Any deviation should automatically trigger the “quick response” system, which shall also include emergency procedures in case of breach of water quality standards.

It was stated in the EIS that an ERP with a regular practice drill must be practised by each proponent within their facility, should there be any chemical spillage from the industry. Some of the products and chemicals are volatile, e.g. ammonia, methanol, ethanol, formaldehyde. The facilities must be well prepared to deal with emergencies arising from accidental spills and emissions. The ERP must include the availability of equipment to handle toxic and hazardous spills and gaseous emissions. Interviews with the SLA and BEDB as well as BMC revealed that ERP has been put in place so that any chemical spillage will be avoided as a mitigating method to avoid any pollution to the surrounding water. In addition, it was also stated in the SPARK EIS (2001) that oil spill in the offshore area coming from the ships loading and unloading cargoes can be reduced by putting an oil and water separator in the jetty. The ships using the jetty will not be allowed to discharge their bilge and ballast water into the coastal water but will connect into the oil and water separator. All ships must also have environmental insurance or their insurance coverage must include an environmental guarantee in case of acute oil spill into Brunei territory.

7.5. Environmental standards, regulations and laws

As far as it was evident from an interview with the Environmental Officer at the DEPR in June 2012, there is no law on environmental issues in Brunei. However, according to the same Environmental Officer, the environmental law in Brunei has been revised and is in a final draft format. The law will cover all environmental issues including law on hazardous waste. At the moment, industries in Brunei should follow the Brunei Pollution Control Guidelines that are produced by the department while waiting for the complete legislation on environmental matters/issues to be enacted by 2013. However, up until now, there is still no environmental law that is ready in Brunei. Therefore, the Brunei Pollution Control Guidelines is used. In addition, from the interviews with SLA and BEDB as well as BMC, guidelines from the World Bank as well as Malaysian, the Philippines, Australian, and New Zealand are also followed in order to achieve environmental standards that will not pollute the air, land and water of Brunei.

However, Japanese petrochemical companies at SPARK are committed to adhere to environmental policies, regulations and compliance. MGC makes an effort to gain trust from the society by contributing to the community and to protect the environment, as well as thinking about how to manage business activities in harmony with the protection of the global environment under sustainable development (MGC, 2014b). Some of the fundamental policies that MGC are following will involve 1) ensuring health standards, as well as safety in operations; 2) securing management of facilities and increasing selfmaintenance technologies and also skills; 3) reducing environmental loads in their operation; 4) developing environmentally friendly and safe products and technologies; and 5) ensuring safety in the logistics of obtaining raw materials, storage and delivering of the products (MGC, 2014b). In addition, MGC is also committed to fully complying with any applicable national laws as well as international rules and will also cooperate with any related international organisations, both national and international administrative organs as well as NGOs, when needed (MGC, 2014b).

Similarly, ITOCHU Corporation has also established the ITOCHU Group Environmental policy, which includes 1) the prevention of environmental pollution – conservation of ecosystems and biodiversity, local and global environment, prevention of any environmental pollution occurrence; 2) observance of laws and regulations –both national and international laws and regulations on environmental conservation; 3) promotion of environmental conservation activities – promoting energy and resources conservation, reduction and recycling of waste and other environment conservation activities; 4) harmonious co-existence with society – supporting local communities for environmental education and assisting in basic research to conserve the global environment; and 5) promotion of educational activities – educating employees and Group companies for their awareness of environmental conservation and improvement of the quality and effectiveness of associated activities (ITOCHU Corporation, 2014a).

In addition, the ITOCHU Corporation has established an Environmental Management System (EMS) regulation since 1997 and became the first trading company to do so based on the ISO 14001 (ITOCHU Corporation, 2014c). The system aims to comply with environmental laws and regulations and take precautionary approaches towards environmental risk, as well as promote environmental conservation (ITOCHU Corporation, 2014c). In addressing environmental risk, the company is using the LCA approach and if the evaluation of the impacts on the environment exceeds the predetermined benchmarks, manuals and solid procedures to manage the transaction of the products will be created (ITOCHU Corporation, 2014e).

MITSUI also adheres to corporate governance compliance, including roles on environment-related business which include measures to mitigate environmental impacts and safety assurance, as well as compliance with laws, regulations and guidelines of the environment (MITSUI, 2014i). MGC has conducted diverse training and research to ensure the employees have full awareness of, and compliance with, both national and international environmental related laws and regulations (MITSUI, 2014b). The company is also conducting research on environmental laws and regulations (MITSUI, 2014b). Moreover, MITSUI also carries out annual training on environmental laws and regulations in order to improve employees' awareness at the company and its domestic subsidiaries and affiliates (MITSUI, 2014b). As of the fiscal year 2013, the company has begun to host the training with other companies not only in Tokyo but also in Osaka, with 160 employees participating from the company (MITSUI, 2014b). In addition, MITSUI also complies with the Waste Disposal and Public Cleaning Law (MITSUI, 2014b). The handling and disposal of waste is managed by the Logistics Management Division of the company (MITSUI, 2014b).

7.6. Discussion

In terms of the environmental benefits from SPARK, none of the respondents from the local community to the questionnaire interviews believed that the development may generate any immediate benefits to the environment. However, there are some benefits to the environment that can be derived if the entire process of development is looked into. These include sea turtle conservation from the closure of the beach area as the industrial area is located on the coastal area. Moreover, with the introduction of new environmental technologies brought in from foreign companies, this will avoid and reduce the impacts from the development to the environment while at the same time the country could still develop economically.

However, there are also some challenges to the environment that SPARK may experience. One of the challenges is its impact on the air quality around the industrial area. It was stated in the SPARK EIS (2001) that there is a slight increase in the NO_x amount around the industrial area but it is under control and other pollutants such as CO, SO_x and PM_{10} are negligible. However, from the questionnaire interviews with local communities as well as a telephone interview with a village headman, it seems that the air quality is deteriorating as a result of the development. This can be seen from the number of flu and asthma cases, which have increased since the start of methanol production at SPARK. It also seems that those people who have been affected by the development are those who have health problems, such as asthma, and some children.

According to a research carried out by Coronas, et al. (2008), exposure to airborne particulate matter has negative impacts on human health as well as the ecosystem.

According to their study, which involved an evaluation of an area close to a petrochemical plant in the town of Triunfo in Brazil, mutagenic activity of airborne particulate organic matter was found in three time periods from Total Suspended Particles (TSP) as well as particles less than 10 m (PM10). This suggests that air pollutants from petrochemical industry may have caused the negative effects to the health of people who live close to the petrochemical industrial park.

Similarly, according to Adiningsih, Lestari, Rahutami, and Wijaya (2009), it is found that even though pollution is still within tolerable limits, the concern about living close to petrochemical industry is related to the scale of environmental contamination and pollution. According to the study, air quality has declined drastically since the chemical factories in Banten, Indonesia were developed. Air pollution which is caused by smoke and fumes, as well as pungent odour emitted by factory chimneys, often cause severe irritation and uneasiness. Some people who are sensitive to strong odour also suffer from headaches. However, the local community in the present study perceived such effects as within tolerable limits, and did not see them as a major cause of serious physical health problems. This study, thus, demonstrates that the petrochemical industry may be the source of low level health problems for communities living close to SPARK.

In addition, as noted earlier in Chapter 2, according to Nadal, Schumacher and Domingo (2011), other potentially polluting stationary sources, including other chemical companies such as oil refineries and mobile sources such as heavy traffic may also become sources of air pollution. Because SPARK is located next to the oil and gas industry of Brunei, the combinations of these industries may contribute to some health problems that the local communities have experienced. Nevertheless, according to

Axelsson, et al. (2010), there is no causal association with living near to the petrochemical industry and risk of liver cancer because the exposure level of vinyl chloride was low and when the addresses of people with liver cancer were examined, it was found that the majority of them had been living in the municipality for less than eight years. Even though the level of liver cancer in this area was higher between the years 1994 and 2005, only two cases out of seven with this type of cancer had lived more than 10 years in the municipality. This suggests that health problems are not necessarily from the industry itself, but may actually reflect the standard of management.

In terms of its impact upon the hydrology of the area, there was an increase of surface water run-off since the project development was started and this led to flooding especially around the Sungai Liang Kechil Road because it is a low-lying area. However, the flooding was solved by the improvement of the drainage system at the area, which has been widened. There has been no serious report on the quality of surface water near the industrial area. The seawater may be affected by siltation during the construction of the project, but no serious impact has been reported from the construction. Another potential surface water impact can be from untreated effluent discharge from the industry, but this will be rare since SPARK has its own effluent treatment plant - for example now BMC has its treatment plant that has full capacity to treat its waste. One of the few possible causes that may affect the quality of surface water is through the discharge of heated effluent which may reduce the level of DO in the water and eventually affect the biological community in the water as may discharge of feedwater that is high in mineral content.

There is no serious negative impact that may result upon coastal resources such as fishery, since no fishing activity will be allowed in the Sungai Liang area due to the government regulations that prohibit the activity in order to protect the offshore oil and gas industry pipelines. In terms of the impacts on the ecology of the area as a result of the development, the impacts from construction through the generation of noise and dust may scare away birds and other fauna but this impact will be temporary. The major concern is the sea turtles. Even though the closure of the beach may benefit the turtle population, the presence of lighting in the new industrial site may confuse the hatched turtles, and they might head towards the top of the beach instead of the sea. In addition, several possible air pollutants may be produced by the industrial complex, most probably ammonia gas and when ammonia in the air reacts with rainwater, it will produce a strong base, i.e. NH_4OH. Ammonium hydroxide in rainwater may affect plant soft tissues, such as buds, flowers and shoots stunt the growth of trees and prevent formation of twigs and blooming of flowers during the rainy season.

There is a mismatch between the views of the project proponent and industrial tenant and the local population, as well as the description in the EIS on the environmental impacts from the SPARK project. For example, the interviewees said that there had been limited or no environmental impacts, whereas the EIS suggests that there might or could be and the local respondents who were interviewed have also experienced some environmental impacts from the project and gave their opinions that the development may lead to some environmental impacts such as air pollution etc. There seems to be some disputes between the project developers and the local communities through different views that they have on mind regarding the impacts from the project. The main reasons for this are maybe because the risk from the development may not be communicated effectively or maybe because the negative experiences from the project for instance flooding, health problems that has made some of the local communities to have negative opinions towards the development.

In terms of the environmental management and monitoring of SPARK, despite the DEPR being the main authority in environmental management of the country, it has little involvement in it. The department was only involved in the EIA of the project and it has no responsibility towards waste management from the project as well as monitoring of the development, as there is a lack of competent personnel and equipment for monitoring. The management and monitoring of the environment are carried out by the SLA through guidelines in the SPARK EIS (2001), ERP and SPARK master plan. In order to reduce and avoid negative environmental impacts as a consequence of the development of petrochemical production at SPARK, several measures have been and will be put into practice. The measures are in terms of environmental control and impact mitigation on the air, hydrology, and water surface, and are mostly stated in the SPARK EIS (2001) as guidelines to mitigate adverse impacts.

There seems to be some issues in the management and monitoring of SPARK. The process of self-policing and self-reporting may not be sustainable as there is a chance of biasness in such processes. There is also a question that to what extent those mitigation measures are being implemented due to the fact that the monitoring is done by SLA and the tenant at SPARK themselves. It is very important for any industrial development to be monitored by a third party in order to avoid such biasness. Furthermore, due to the fact that the master plan, ERP, and EMP of SPARK are not made accessible to the researcher, it is hard to determine whether mitigation methods have been implemented and to know their effectiveness.

In addition, there is also an issue on the commitment of SLA and the tenants at SPARK towards their HSSE policies and how they can know that such policies are effective enough in the absence of monitoring and reporting. When looking at the HSSE's profiles of the Japanese companies that are investing at SPARK, there is also an issue regarding their effort in resource efficiency. It was mentioned before that ITOCHU and MITSUI have been using bioethanol which is derived from sugarcane as feedstock but at SPARK, natural gas is used. This raised a question about the effort of the developed nations such as Japan in dematerialisation of raw materials which doesn't happen in their operation in other countries such as in Brunei. This also raised a question of whether the companies are putting much effort to develop sustainably in Brunei or the opposite. When compared to the effective management of industrial process in Sweden as it was mentioned earlier in Chapter 2, the situation is different in Brunei as the commitment towards the sustainability is not prioritized as the industrial process is not managed through effective HSSE which eventually reduce and prevent any adverse impacts on the environment and people.

Moreover, the situation is exacerbated with the absence of environmental law in Brunei. There is currently no law on environmental issues in Brunei but an environmental law in Brunei has been revised to the final draft and it will cover all environmental issues including a law on hazardous waste. At the moment, industries in Brunei should follow the Brunei Pollution Control Guidelines that are produced by the DEPR while waiting for the complete legislation on environmental matters/issues to be enacted, but no environmental law has been put in place up to now. In addition, guidelines from the World Bank as well as Malaysia, the Philippines, Australia and New Zealand are also followed in order to achieve environmental standards that will not pollute the air, land and water of Brunei. There is an issue over this matter about the commitment of the Japanese companies in developing their industries in a sustainable manner knowing that there is still an absence of environmental law in this country which is giving them a license to potentially pollute the environment.

This is supported by evidence in Muhammad, Samia and Talat (2011) who show that foreign companies may shift their operations to some developing countries in order to take advantage of the absence of environmental laws. This would lead to environmental pollution and degradation of the host countries. In addition, Herman, Chisholm and Leavell (2004) argues that the reason attention has been devoted to the impact of FDI on the environments of developing countries is due to the fact that these countries currently lack the same standards of policies and regulations that can be found in the more developed countries, which might protect the environment. The study adds that while developed countries also experience pollution, these same developed countries have laws and regulations which are meant to slow the effects of continual resource use and thus reduce the environmental degradation of their countries. If an environmental law in Brunei is introduced, risk of environmental pollution could be reduced, as the presence of the law would result in stringent environmental management of the foreign companies for their production.

When looking at the international petrochemical companies as mentioned in Chapter 3, they are also well advanced in adhering to environmental policy, regulatory compliance and environmental certification. For instance, as explained before Sinopec signed responsibility documents for the major target of pollutant reduction, tightened environmental performance assessment and EIA is also carried out. Braskem is following the ISO 9001 for quality management and ISO 14001/RCMS for environmental management and Shell is also complying with product regulatory legislations such as REACH. In addition, there are also petrochemical associations in the developed countries, as mentioned before in Chapter 3, that encourage members to follow international environmental requirements and legislation. For example, AFPM is committed to clean air, water and waste reduction, as well as having an outstanding record of compliance with EPA. Similarly, APPE is also following IED, minimizing pollutant emissions from various industrial sources throughout the EU.

7.7. Conclusion

In conclusion, there are few immediate environmental benefits that can be gained from the development of petrochemical industry at the SPARK site. Moreover, there are some potential negative impacts on the environment and ecology of the surrounding area of the development i.e. to the air quality, hydrology, surface water quality, coastal natural resources, and ecology from the petrochemical industry. However, in order to prevent and reduce the negative impacts upon the environment and ecology, some mitigation impacts are being proposed in the EIS and as long as safety precautions are taken and the environment is monitored and managed, it is believed those negative environmental impacts can be avoided or reduced.

However, the environmental law in Brunei still needs to be put in place so that the industrial actors are more aware of the issues involved in managing the environment from the pollutants that they are emitting from their petrochemical production. There is also an issue of the independence of the monitoring process, which will be carried out by the SLA itself – it could be suggested that this will be biased. In addition, there is the issue of a lack of coordination of information between local leaders and communities with the SPARK authority (SLA) and the current tenant of SPARK (BMC) in terms of third-party monitoring information. Lastly, there is also a mismatch between the views of the project proponent and industrial tenant and the local population, as well as description on the EIS on the environmental impacts from the SPARK project.

CHAPTER 8 – KEY ISSUES AT SPARK

8.0. Introduction

This chapter discusses the important findings from chapters 6 and 7. There are three issues that are covered in this chapter. The first issue is about local benefits and challenges to sustainability from the SPARK development i.e. a discussion on how SPARK impacts upon local communities. Another issue that arises is in relation to SPARK and regional sustainability, i.e. to look at some of the tensions around conservation and the infrastructural impact of SPARK. The last issue is about the national context of sustainability, which considers how sustainability is framed by the international context, i.e. attracting FDI, etc.

8.1. Local benefits and challenges to sustainability

There are some ways that SPARK has impacted on local communities that may affect the sustainability of the industrial development of SPARK. The local benefits from SPARK could act as a catalyst to achieve sustainable industrial development, but the challenges posed to the local communities from the development may hinder or pose some problems in moving towards sustainability in petrochemical development in Brunei.

Based from the findings of this research, the two main benefits to local communities as a result from the development of SPARK are, 1) improvement in the infrastructural development surrounding the project area; and 2) CSR activities through cash donations for national events and helping local communities who are in need, refurbishment of the Sungai Liang Beach Recreational Park, etc. When looking at these main benefits, they could become a good catalyst to achieve sustainable industrial development. However, these benefits seem to be smaller in scale knowing the fact that the CSR activities that the global petrochemical companies mentioned in Chapter 3 were large in scale, such as disaster relief, poverty alleviation and a tree planting campaign by Sinopec and also ecological recovery of Atlantic forest by Braskem.

Apart from those benefits, there are however, some local challenges from SPARK that may hinder the sustainability of petrochemical industry in Brunei. One of the key issues that may challenge the sustainability of SPARK is there is a minimal level of understanding amongst the local communities about the petrochemical industry at SPARK. There is as well little involvement of the communities in the public participation in the SPARK project as there is still a 'top-down' approach between the developers and local communities where requests and concerns from the communities were still ignored and regarded as unnecessary. The combinations of these factors may continuously make the communities to become ignorant about the project and when there is a low level of public participation in the development project, the needs of the communities that could be ascertained through their participation cannot not be known and any information about their safety from the project would not be delivered to them. Thus, these factors challenge the sustainability of petrochemical development at SPARK.

Another important challenge to the sustainability of SPARK that has impacted the local communities is its possible impacts upon the health of the local communities i.e. the increased case of some health problems such as flu and asthma, which the communities believed to be caused by air pollutants coming from SPARK. There is also a high risk to the safety of local communities living close to SPARK as there would be possibilities of industrial accidents which also affect the industrial workers at SPARK. This would eventually be a challenge to achieving the sustainability of the petrochemical industry in Brunei. To date, there have been no accidents occurring at SPARK, but the risk is still high due to the nature of the industry, which involves working with high flammable chemicals.

Lastly, the occurrence of some conflict over resources present at SPARK may also lead to the challenge of SPARK to develop sustainably which are exacerbated by the lack of concern of the developers towards the needs of the local communities. There are also some conflicts in the opinions and views between the developers and local communities, even between the village heads towards the impacts from SPARK. While the developers believe that there is no serious negative impacts towards the health and safety of the locals, the locals are not assured by the statements from the developers. It seems that either the actual risk is not communicated effectively to the locals or the communities are still in doubt about it as they have experienced health problems that they believed to be caused from the development.

8.2. SPARK and regional sustainability

Apart from the local impacts from SPARK, there are also some issues between the development and regional sustainability. There are some tensions around environmental conservation and the infrastructural impacts of SPARK. While the Forestry Department of Brunei considers Sungai Liang as a forest reserve area, and Sungai Liang Recreational area as well as residential areas, schools, clinics, etc. are also located surrounding the industrial park, Sungai Liang area is also dedicated to industrial development of the petrochemical industry. There is therefore some conflict of interest in the area between government objectives for conservation and development and thus, sustainability of SPARK is very difficult to be achieved.

In addition, with the possible negative impact on the air quality of the area surrounding the industrial park that can be seen through the increased incidence of flu and asthma since the petrochemical development has started, there is also a concern about the environmental conservation and infrastructural impacts of SPARK. This is exacerbated by the fact that there is a limited amount of environmental management and monitoring of SPARK. The process of self-policing and self-reporting of environmental management may not be sustainable and there is also a question that those mitigation methods are being implemented or not. Moreover, with the absence of environmental law in Brunei, there is a question that the environment can be managed and conserved effectively while at the same time, a high risk industry such as petrochemical development is developed. Therefore, there is a tension between conservation of the environment and the impacts from infrastructure of SPARK.

8.3. National context of sustainability

The concept of sustainability at SPARK is also framed by the international context such as through FDI into Brunei in acquiring knowledge and expertise, as well as technological innovations from multinational companies. A study by Bwalya (2006) concludes that FDI improves managerial knowledge and skills, as well as increasing efficiency and productivity. According to the study, transnational corporations have assets that the host country may not have, which includes managerial skills and technology as well as export contacts and company reputation. Similarly, a study by Acharyya (2009) also reveals that the positive benefits of FDI to the host country may include the transfer of capital, skill and technology, market access and export promotion. In addition, Muhammad, Samia and Talat (2011) found out that FDI, apart from providing employment opportunities, also helps in the development of managerial and specialized technological skills as well as innovations in the production techniques, by means of training programmes and also the learning process in the host country. As was mentioned earlier in Chapter 6, employees of BMC are required to undergo skills training both locally and internationally, sustainability at SPARK is also shaped by the international context of FDI. SPARK through FDI has improved the ability of local Bruneians to acquire managerial and technological skills.

Moreover, Brunei is also benefiting from the introduction of environmental technologies that are coming from the transnational companies that are investing at SPARK. Such positive impact is reflected in other studies - for instance, according to Guoming, et al. (1999), large transnational companies have made outstanding contributions to China's environmental protection both via direct investment in environmental protection and through the improvement in products and production processes in some industries. Furthermore, multinational companies also have a demonstration effect on domestic firms, encouraging acceptance of higher environmental standards. Similarly, a study by Herman, Chisholm, and Leavell (2004), also reveals that FDI inflows provide economic benefits such as technological spillovers and innovations, apart from the increased employment opportunities that it has also created.

In addition, there is also a similar benefit that Brunei is gaining from the introduction of environmental technologies from SPARK's transnational companies, according to de Almeida and Rocha (2008), the host country will receive positive environmental effects. Via the transfer of technologies that are environmentally friendly, as well as advanced environmental management systems, pushing the host country towards higher environmental standards as well as being ahead of national firms' environmental performance. According to the study, although technological knowledge does not guarantee a high level of environmental performance, it can be said to be a necessary condition. For example, in the case studies that were used in the research, it was found that there is a strong relationship between the existence of quality management systems, and technological innovations, as well as environmental management systems. Therefore, the environmental technologies and standards that the Japanese companies brought into Brunei have benefited Brunei in terms of environmental protection and management.

However, despite those positive sides coming from the FDI into the country, FDI may also become an economic challenge to the sustainability of petrochemical industry in Brunei. This is because the development of petrochemical industry at SPARK may require a long period to receive a return on revenue due to the small contribution to GDP from the industrial project, the lengthy tax holiday, and high level of government subsidies. According to a study of three cases were examined by Hanson (2001) (Ford and GM in Brazil, Intel in Costa Rica), there is weak evidence that FDI may generate positive spillovers for host countries' economies in terms of raising national welfare. The study suggests that subsidies given by Brazil to foreign automobile manufacturers may have actually decreased the national welfare of Brazil. In addition, according to the study, Costa Rica appears to have been sensible in not offering subsidies to foreign companies, as in the case of Intel. The reason for this is that some countries are sceptical about the belief that promoting FDI may raise national welfare, especially in presuming that subsidizing FDI is necessary. It is suggested that unless there is clear evidence that there are social returns to FDI that exceed the private returns, then subsidies to FDI are not warranted. In addition, host countries also appear to offer positive rates of tax to foreign companies as higher taxes would deter foreign investment (Hanson, 2001). The study by Hanson (2001) also reveals that the reason why host governments still continue to offer special treatment to multinational companies is that governments feel obliged to offer such concessions because multinationals decide their location in part due to bidding by potential host-governments.

In addition to the above drawbacks, those are indications that spin-off activities that are usually created from FDI have not occurred successfully at SPARK which is partly due to the nature of the sector, i.e. it is difficult to have small companies spinning off in that type of capital-intensive industry and because the only petrochemical production that has started operation is methanol production, a smaller industry than the future ammonia industry. This contrasts with other studies which indicate that FDI investment into host countries has benefited them through the generation of spin-off activities. For example, according to Adiningsih, et al. (2009), most respondents in their research were satisfied with the establishment of industry in their area because it encouraged many people to live within the locality of industrial factories, such as in-migrants employed at the factory. The increasing numbers of in-migrants as factory employees, who were mostly non-locals, had become a source of economic welfare for the local communities by providing parking services, washing, as well as houses for rent. Similarly, Muhammad, Samia and Talat (2011) also add that the inflows of FDI also encourage local enterprises to increase their investment in development projects and provide employment opportunities for the population, both skilled as well as unskilled labour, in the host country.

Lastly, with the absence of the commitment of the Japanese companies at SPARK to relocate the local communities at SPARK and the issue of the commitment of SLA and the Japanese companies towards the HSSE policies in the absence of independent monitoring and reporting, FDI process at SPARK may not be able in some ways to encourage sustainability at SPARK. Moreover, the dematerialisation of raw material is not practiced at SPARK and therefore, there is a question whether the FDI process at SPARK may or may not successfully develop the project into a sustainable way.

8.4. Summary

This chapter has discussed three important issues that can be found from the findings in both chapters 7 and 8 of this thesis. The three issues are; 1) benefits and challenges to socio-economic sustainability; 2) SPARK and environmental sustainability; and 3) the national context of sustainability.

One benefit that is believed to become the catalyst to achieve the socio-economic sustainability is the improvement in the infrastructural development surrounding the project area and the CSR activities from the developers of SPARK. However, there are also some challenges that may hinder the sustainability of the petrochemical industry in Brunei. Some of the challenges are 1) minimal awareness and understanding about SPARK; 2) low level of public participation in the development project; 3) possible impacts upon the health and safety of the local communities and industrial workers; and 4) conflict over coastal resources or priorities at SPARK and the surrounding area.

There are also some tensions around environmental conservation and the infrastructural impact of SPARK which affect the sustainability of the environment of Brunei. Some of the issues facing SPARK in relation to environmental sustainability are 1) possible occurrence of environmental pollution; 2) limited involvement in the environmental management and monitoring of SPARK by the Government environmental agency; and 3) the absence of an environmental law in Brunei.

Lastly, the national context of sustainability the petrochemical industry at SPARK is also framed by the international context, for example, by attracting FDI into Brunei, new knowledge and skills as well technologies are brought in the country in order to develop the industry into a sustainable way. However, the process of FDI at SPARK may not be able to encourage the sustainability at SPARK because the project 1) requires a long period to return the revenues; 2) limited benefits from the spin-off activities; 3) the lack of commitment of the multinational companies at SPARK towards relocating local communities for their safety; 4) the absence of independent monitoring of SPARK; and 5) materialization of raw material is still practiced at the industry.

CHAPTER 9 - SUSTAINABLE INDUSTRIAL DEVELOPMENT OF SPARK

9.0. Introduction

The aim of this chapter is to provide an overall discussion on whether the petrochemical industry at SPARK can be developed in a sustainable way or otherwise. This chapter relates the findings and discussions back to the theoretical frameworks in Chapter 4, i.e. it discusses issues that are happening and will be happening at SPARK with relation to the three theoretical frameworks (SID, EM, and resource use conflict in ICM), together with the overarching theory about sustainable development.

9.1. SPARK and Sustainable Development

One of the issues which is taken into consideration in order to answer the research questions, aim and objectives is the relationship between SPARK and sustainable development. In this subsection, the analysis focuses on how the three interdependent pillars of SD are linked with the development of the petrochemical industry at SPARK. The three interdependent pillars are economic health, environmental protection and social responsibility.

9.1.1. Economic health and SPARK

Revisiting back to Chapter 4, one of the important features in achieving sustainable development is that there should be some economic development from an industry. It was stated earlier that the health of the economy can be achieved by forecasting and understanding the needs of the market as well as knowing the available resources, investing capital responsibly managing overall employment and growth. At the same time, it is also important for a company to operate profitably, while being environmentally benign and helping to maintain the social fabric of society.

With reference to the development of SPARK in Brunei, as it was mentioned earlier that the major positive impact upon the economy of the country from the development of the petrochemical industry at SPARK is the increase in the employment opportunities that it has generated and will be generating in the future for the local population. Furthermore, with the addition of value to the crude oil and gas from the petrochemical industry, this shows that the available resources are made use of effectively. It is no doubt that the diversification of the economy by extending the value chain of the oil and gas industry through petrochemical production is one of the ways to raise the GDP growth of the country, as well as attracting more FDI to Brunei and thus benefitting the country in terms of the transfer of knowledge, skills, and technologies.

Having said that, there are some important issues arising from the development of SPARK which may affect the economic health of the country. The development of petrochemical industry in Brunei may require a long period to return revenues back to the country. Moreover, there is also little benefit that can be generated from the spin-off activities of the project, contrary to the findings of other studies that suggest FDI investment into host countries may benefit the economy through an increase in spin-off activities. Finally, the petrochemical industry in Brunei may have considerable competition from other major petrochemical players nearby in the ASEAN region. While it is true that the transnational companies that have invested at SPARK may have a good reputation and good export contacts, and that Brunei has the advantage of having its own natural feedstock, other ASEAN members such as Malaysia, Singapore and Thailand may also have the above advantages. From here, it can be seen that there are more challenges that the SPARK project have towards the economic health of the country. It seems that the benefits from SPARK towards the economy is smaller than its drawbacks, therefore, this also challenges the sustainability of the project.

9.1.2. Social responsibility and SPARK

Apart from the economic health, social responsibility is another pillar to achieve sustainability in development that considers the importance of the impacts created from an organisation or industry to society either directly or indirectly (Fava et al., 1998). It is also important that businesses and industries adopt CSR or CC. CSR suggests that the business sector is beginning to reorganise its connection with both the environment and multiple stakeholders (Utting, 2000) and it should also have positive duties towards the prevention of harm to the ecology and environment (Desjardins, 2007). Such duties are fulfilled by undertaking philanthropic activities in order to address social problems (Miller, 1998, as cited in Rondinelli and Berry, 2000).

It was mentioned earlier in the previous chapter that the CSR activities from the SPARK developers are small in scale and the issue of unwillingness of the developers towards the relocation of the local communities away from the industry, it seems that the developers are not fully committed towards the prevention of harm to the local communities because if they do, they would make sure the communities are relocated before the development starts so as to minimise the risk of the development towards the people. Moreover, as it is known that the forest reserves is also located near to the project, it is inappropriate to locate the industry close to that area. It seems that this factor is not taken into consideration as it may harm the ecology and the environment because in CSR, the prevention of harm towards the ecology and environment is highly prioritized.

9.1.3. Environmental protection and SPARK

In order to achieve sustainable development, protection of the environment from industrial activities must be carried out through the approach of the 'cradle to grave' principle, which means consideration of the environment should start from raw material acquisition and continue to the process and to final deposition (Fava et al., 1998). All resource materials and energy that a company uses should also be from a renewable resource (Gibson, 2000; Glavič and Lukman, 2007) and the usage of resources should also be minimised in terms of the raw materials, water, energy and other natural resources. Furthermore, the '3R' concept of recycling, reuse and repair is also important in order to protect the environment and eventually to develop sustainably.

With reference to the development of SPARK, it was discussed much earlier that the dematerialisation of the resource materials or feedstock does not happen at SPARK even though the Japanese companies at SPARK are doing it in their country. A non-renewable resource i.e. natural gas is still used and therefore, it can be considered as unsustainable. The deterioration of air quality which can be seen through the increased number of flu and asthma cases in the area surrounding the industrial plant and flooding cases may also add to the challenges to the protection of the environment. The absence of the third party monitoring of SPARK that question the ability of SPARK to implement the mitigation methods and the absence of the environmental law in Brunei may also exacerbate the situation. To have an environmental law in Brunei is necessary in Brunei as more and more industrial projects, such as the petrochemical industry at SPARK, are taking place in Brunei. An environmental law would prevent or reduce the potential for multinational companies to take advantage of the host countries by polluting the environment. Therefore, in order for Brunei to develop sustainably, it is important to have an environmental law put in place in Brunei in the near future.

9.2. SID and SPARK

Looking back to Chapter 4, SID may be defined as the constant innovation and improvement as well as the use of environmental technologies in order to reduce levels of pollution and consumption of resources (Jenck, Agterberg and Droescher, 2004). It is basically a means of employing technologies and technical know-how to use less material and energy, as well as maximising renewable resources as inputs, reducing pollutants or harmful waste generation during the manufacture and use of product, and producing biodegradable and recyclable products (Jenck, Agterberg and Droescher, 2004). This section looks into elements in SID and industrial operation at SPARK.

9.2.1. ‘Green Chemistry’ and ‘Green Engineering’

It was mentioned earlier in Chapter 4 that ‘Green chemistry’ relies on efforts to minimise waste, the use of renewable resources, eco-efficiency, reducing degradation, as well as improving health and safety. Meanwhile, ‘Green engineering’ can be defined as the design, construction, operation and use of techniques that are practicable and economical while minimising the generation of pollutants at source as well as risk to human health and the environment (Glavič and Lukman, 2007).

With reference to the production of petrochemical at SPARK, natural gas is still used as feedstock in the methanol production, which is not sustainable. However, there is a concept of recycling that is practiced in the production of methanol such as the recycle of waste heat and scrap metals. Furthermore, in methanol production, sodium hypochlorite is used, which is much safer and thus reduce the adverse impact to the environment.

Due to some confidentiality issues, the researcher was not be able to find out the details of the technologies used and the operation details at SPARK. Therefore, it is difficult to find out whether petrochemical production at SPARK is practising the concept of 'Green chemistry' and 'Green engineering' in any detail.

9.2.2. Emission reduction

In order to achieve sustainability in industrial development, pollutant emission reduction must also be achieved. In achieving that target, methanol production at SPARK uses low emitting NO_x and CO_2 burners which reduces the emission of these gases into the atmosphere and reduces the greenhouse impact upon the environment.

9.2.3. Benign by design

Due to the confidentiality issue, it is hard to determine whether the petrochemical production is using the concept of benign by design in details.

9.2.4. Distributed manufacturing

Distributed manufacturing is a concept in the SID where smaller volumes of manufacturing are produced at a variety of remote sites, which avoids the transportation of toxic, flammable materials as well as storage with high safety risks, and distributes the possible environmental effects. When looking at the development of SPARK, there is no need for a feedstock for petrochemical production to be transported from a long distance because the location of the feedstock is very close to SPARK. The natural gas is just transported through the pipeline system. Therefore, it is safer in a sense that it does not lead the high risk of accidents that exists when the feedstock is transported from a long distance.

9.2.5. Industrial ecology

It was mentioned earlier that in industrial ecology, there are some principles that need to be followed in order to achieve sustainability in industrial development. One of them is to use waste from one industry to become a feedstock of another industry in the same industrial area or park. With reference to petrochemical production at SPARK, this does not seem to happen yet but as it was mentioned earlier, there will be a collaboration among petrochemical producers at SPARK that may produce a combination of petrochemicals in the industrial park. Furthermore, there is also an improvement in industrial processes such as by using the low burners of NO_x and CO_2. In addition, there is a development of renewable energy for industrial production, such as by reusing waste heat for the use of other parts of the methanol plants. However, SPARK is not following the concept of industrial ecology in terms of its safe boundary with nature. This is because SPARK is located near to the forest reserves in Sungai Liang and situated very close to the residential areas, recreational park, beach, schools, shops, etc.

9.3. EM and SPARK

Chapter 4 noted that EM can be referred to as a technology-based and innovation-oriented approach to environmental policy (Janicke, 2008). It basically carries a positive message that ecological sustainability can be achieved by some transformations in society and institutions without leaving the modernisation path (Mol and Spaargaren, 1993; Pataki, 2009). It works through promoting the application of environmental policy to positively influence economic efficiency and technological innovation while still being able to harness the forces of business for environmental gain.

When looking at the petrochemical production at SPARK in Brunei, there is no environmental policy yet in Brunei and therefore, it cannot be used to influence economic efficiency and technological innovation. However, SPARK is using technological innovation and it is an industrial project intended to diversify the economy of Brunei, which is based on the oil and gas industry.

It was mentioned earlier in Chapter 4 that one of the most important transformations made under EM is the changing role of science and technology. Rather than being seen solely as the causes of environmental problems, science and technology are used to cure and prevent them through the use of new and cleaner, environmental technologies. In the case of SPARK, environmental technologies are used to reduce its industrial impacts to the environment, for example the low NO_x and CO_2 burners and the recycling of the waste heat. In addition, a changing discursive practices and new ideologies have emerged, such that nowadays, in Brunei the emphasis is not solely upon economic development alone, but it is also on environmental interests in order to achieve a sustainable way of development. However, there is still no change in terms of the role of the nation state because there is still a top-down approach in the government for example as in the case of public participation at SPARK and no environmental regulation has been put in place in the country.

9.3.1. Technological Environmental Innovations (TEIs)

One of the most important elements in EM is to have Technological Environmental Innovations (TEIs) such as sustainable resource management, clean technologies, substitution of harmful substances, environmental friendly product design, product stewardship, low emission processes etc. (Huber, 2008). The author has identified that one of the typical areas of TEIs is the regenerative and fuel-less type of energy, but the petrochemical industry at SPARK is not based upon renewable energy as the feedstock is from a carbon form, i.e. natural gas. SPARK is not replacing fossil fuels as raw materials in bio-feedstock. However, as mentioned earlier, methanol production and other petrochemical production in the future are, and will be, using clean technologies and low emission processes. Nevertheless, as noted previously, due to confidentiality issue, the details of the technological innovation cannot be exposed and therefore, it has hard to know whether or to what extent the technological innovation at SPARK is following the TEIs that are identified in EM.

9.3.2. Stringent regulation in eco-innovation

As indicated previously in this thesis, there is still no environmental regulation and laws in Brunei, although Brunei is following some international environmental guidelines and certifications and for an industrial development to be operated in Brunei, an EIA must be carried out. In order for an industry to follow the guidelines and acquire some certifications, eco-innovation should be put in place in the industry. In the case of SPARK, although it is following some environmental international standards, in the absence of environmental regulation and law in Brunei, there is a lack of any stringency in the regulation for eco-innovation.

9.3.3. Applicability of EM in Brunei

It was noted earlier in Chapter 4 that the concept of EM is less applicable in developing countries. This is due to the fact that for advanced industrial countries, there are prerequisites for green industrial restructuring, for instance, the presence of a welfare state, advancement in technological development as well as a state regulated market economy and widespread consciousness of the environment (Mol, 1995, as cited in Sonnenfeld, 2000). Advanced developed nations have well-developed consumer markets as well as high wage and raw material cost and EM in these countries combines environmental performance improvement with productivity gains and manufacturing efficiencies.

With reference to the SPARK development in Brunei, it is similar to the pulp and paper manufacturing in SEA, in that there is clean production at SPARK. It is also similar to the manufacturing development in SEA given that cleaner technologies at SPARK are acquired from more developed nations, notably from Japan. In terms of waste recycling and energy reuse, SPARK is also having positive results as scrap metals are being recycled and waste heat is reused back by other parts of the methanol plants. Moreover, the Government of Brunei is moving towards a collaboration with the Japanese companies at SPARK on putting clean technologies being put in place in order to reduce the impacts on the environment. This is beneficial to Brunei as the country is attracting more FDI into the country and thus adopting more advanced environmental technologies and as a result meeting international industrial standards.

However, dematerialisation of production is still not occurring in Brunei. In addition, similar to the case of EM in Viet Nam, in Brunei, there is no social movement from the public to put sufficient pressure on the government and industrial organisations for ecological reform, due to the lack of environmental awareness among the public.

9.4. Resource use conflict management and SPARK

It was mentioned in Chapter 4 that conflicts may arise between 1) two or more users who use the same resources or 2) an existing user with potential users or 3) between existing users. Some authors (e.g. Cicin-Sain and Knecht, 1998) identify two major types of coastal conflicts, namely, 1) conflicts among stakeholders and 2) conflicts among government agencies that administer coastal programmes. With reference to the conflict in coastal resources at SPARK, the conflict over resources happens between the project developer and other users of the Sungai Liang area. Even though the developers did not see any conflicts in the resources at SPARK, there seems to be some disputes not only in resources but also in opinions. Furthermore, the top to down approach in the development project has put a dispute between the developers and the communities as the communities' concern and anxiety were regarded as unnecessary and thus ignored by the developers. There is therefore a tension between the local communities near SPARK and the SLA, as both of them have their own priorities for the area.

It was mentioned earlier in Chapter 4 that there are various reasons why conflicts among users tend to occur. They include 1) competition for ocean space; 2) competition for the same resource; 3) competition for a linked resource; 3) if there are negative effects of one use on the coastal ecosystem another use; 4) competition among users for the same space onshore. With reference to the resource conflict issue at SPARK, the type of the conflict is more likely to be because of the negative effect coming from one use or stakeholder. This is because the resource conflict issue has started from the beginning of the industrial development.

At present there is no resource conflict management. However, there was some evidence of resource use conflict when the research was carried out. It is also believed that the tensions and conflict will increase when new petrochemical projects take place at SPARK. This is because as Brody, et al. (2004) mentioned, as coastal resources become scarcer and economic development on coastal areas intensified, conflicts between various stakeholders could be transformed into disputes. It was mentioned earlier in Chapter 4 that there is a challenge in solving conflicts in resource use in ICM as there is a tug-of-war between conservation programme and development interests (Brody, et al, 2004). It seems that this is also happening at SPARK, as in the case of the forest reserve at Sungai Liang versus SPARK.

9.5. Contribution of the research to the study of sustainability

This section discusses the contribution of the research on sustainable industrial development as SPARK to the study of sustainability. This section examines the usefulness of the three theoretical frameworks together with the theory of sustainable development in general in explaining the situation at SPARK. It then analyses the need to combine elements of the theories to provide a good explanation of what is happening at SPARK and lastly it also adds some elements to the theories that the empirical work has highlighted.

9.5.1. Usefulness of the theoretical frameworks to the research findings

By looking at the findings and discussions as well as the theoretical frameworks used in this research, there are some points that need to be addressed in studying about the sustainability of industrial development. The theories about sustainable development, SID, EM and resource use conflict in ICM are useful to help explain what is happening at SPARK in some ways. Firstly, the theory of sustainable development in general helps to explain the extent to which SPARK can achieve sustainability in industrial development. It does so by looking at the three interdependent pillars of sustainable development, i.e. economic health, social responsibility and environmental protection. Both the socio-economic and environmental impacts from SPARK are analysed and the three interdependent pillars help to explain those impacts and in turn, the sustainability of the SPARK development.

Secondly, the theory on SID also helps to explain what is happening at SPARK. The theory is mostly concerned about the advancement in technological innovation. Currently, methanol production at SPARK uses technologies that are trying to reduce the amount of pollutant emissions and recycles any heat waste from the methanol plant. However, the focus of the theory is mostly on how technological innovation helps to achieve sustainability in industrial development. It does not explain issues about economic health and social responsibility. Moreover, innovation in technologies can only be achieved by companies or countries that can afford to have them or those developed countries that are advanced in technological innovation. For a country like Brunei, technological innovation in their industrial development is still new and there are some innovative areas that are not present in Brunei. In a situation when the petrochemical industry is still new in Brunei and there is also a constraint on access to detailed information about the technologies used at SPARK due to the confidentiality issue, the theory has its own limitation.

In terms of the EM theory, this theory is also concerned about technological innovation but it is more focused on the application of environmental policy to positively influence economic efficiency as well as technological innovation, while still being able to harness the forces of business for environmental gain. The theory emphasizes the use of TEIs in industrial development as well as stringent regulation in eco-innovation. However, as there is no environmental law in Brunei, this theory is not really useful enough to explain what is happening at SPARK. It has some utility in explaining about TEIs at SPARK, but once again, since there is a confidentiality issue regarding the details of the technologies used at SPARK, it is difficult to use the theory to analyse the extent to which SPARK is developing in a sustainable way.

Lastly, the theory on resource use conflict management in ICM helps to identify the type of the conflict that is occurring at SPARK and the reasons behind the conflict. However, since there is no resource use conflict management currently in place at SPARK, it is hard to discuss the effectiveness of the management and to make comparison between the management at SPARK and the management in general.

9.5.2. Combination of elements of the theories

After looking at the usefulness of the theoretical frameworks in explaining the situation at SPARK, there are some elements of the theories that can be combined in order to provide a better explanation about what is happening at SPARK. Since the development of the petrochemical industry at SPARK is located in a coastal area, it is worthwhile to combine elements of SID and EM with ICM theory.

Apart from acknowledging the need for technological innovation in order to achieve sustainable development, as noted in both the theories of SID and EM, it would be better to include elements of ICM to analyse the management of the petrochemical industry at SPARK. For example, the element of coastal resource conflict that may be present as a result from any industrial development on a coastal area. This is because coastal area is the most inhabited area and this is not an exception for Brunei. It is helpful to include this element in the study of sustainable industrial development as the issues present may be different for an industrial area that is located away from the coastal area. It is no doubt that issues such as conflicts or disputes in coastal resources may affect the sustainability of industrial development as this is affecting the inhabitants and users of coastal area.

That is the reason on why coastal resources conflicts in ICM is also included as the theoretical framework of this thesis.

9.5.3. Addition of elements in the theories

There are some elements that are believed to be useful to add into the theoretical frameworks of the sustainability of industrial development, namely, sustainable development, SID, EM, and resource use conflict in ICM. There is a need to consider the applicability of the theories in countries like Brunei which is neither a developed nor developing country. The theories should look at the type of government as well as cultural issues of some countries that may challenge the way to sustainability. As it was mentioned earlier, for theories such as EM to be applicable across nations, it should be understood as something geographically or culturally specific. This research may add to the some of the factors such as type of government and cultural issues that need to be considered for the theories such as SID and EM to be adopted in order to achieve sustainability. One of the cultural issues that become the challenge to sustainability is the local communities' lack of awareness of a development project and low level of interest in public participation in the development project. The type of government in Brunei is also different for example public participation in development projects is still a top to bottom approach which is opposite to other countries such is in the North.

9.6. Conclusion

This chapter has examined the relationships between the petrochemical production at SPARK and the theoretical concepts of sustainable development, SID, EM and resource use conflict management in ICM. The aim of doing so was to find out whether the petrochemical industry at SPARK can be developed economically while still protecting the environment and maintain the health and safety of the population or the opposite.

In addition, this chapter has also discussed the contribution of the research to the theory of sustainability. The theories used in this thesis are useful to understand what is happening at SPARK in some ways. However, there are some elements of the theories that can be combined and there are some additional elements that are thought to be useful to add into the theoretical frameworks of the sustainability of industrial development, in order to provide a better explanation about what is happening at SPARK. Apart from acknowledging the need for technological innovation in order to achieve sustainable development as noted in both the theories of SID and EM, it would be better to include elements of ICM such as resource use conflict in to analyse the management of the petrochemical industry at SPARK. Lastly, there is a need to address the applicability of the theories in the countries like Brunei. The theories need to take account of the type of government as well as cultural issues of some countries that may challenge the way to sustainability.

CHAPTER 10 – CONCLUSIONS AND RECOMMENDATIONS

10.0 Introduction

This chapter provides a summary of the main findings, followed by the overall conclusion of the thesis based on the aim that was stated earlier in this thesis. Implications of the findings are also given in this chapter, as well recommendations to achieve better sustainability in industrial development suggestions for further research are also provided in this chapter.

10.1. Summary of the main findings

Based on the overall findings and discussions, the following main findings can be highlighted from the research:

1) The Petrochemical industry at SPARK helps to diversify the economy of Brunei away from the overreliance of oil and gas production. Even though petrochemical production at SPARK is still within the area of oil and gas industry, value is added to that natural resource. Furthermore, more employment opportunities are created from the development which improves the unemployment rate in Brunei. The standard of living of the local communities who live near to the industrial development is also improved through the infrastructural development in the neighbourhood.

However, there are more challenges than benefits from the socio-economic impacts of petrochemical development at SPARK. The main challenges are a) the development may require a long period to receive back revenues because of the small GDP contribution from the industrial project, the lengthy tax holiday, and high level of government subsidies; b) little benefit from spin-off activities; c) substantial competition from other petrochemical industries in the ASEAN states; and d) possible impacts upon the health and safety of the local communities and industrial workers.

2) There is also a minimal level of awareness and understanding about SPARK as well as a low level of public participation in the development project and the community involvement at SPARK is more on the top-down approach which is unsustainable. In addition, there are differing priorities of various stakeholders at and around the industrial area which leads to the occurrence of some conflict over resources at SPARK such as conflict over priorities and the space surrounding the industrial area as well as the presence of disputes over opinions between the developers and the local communities.

3) To date, there are no serious environmental impacts that are occurring at and around SPARK. However, there is potential for the development to affect the local population and the environment near to it as there is likely emissions of environmental pollutants, presence of vibration or noise pollution and, risk of industrial accidents from the handling and storage of petrochemicals. These risks are exacerbated by the lack of a competent environmental agency to manage and monitor SPARK where the management and monitoring of SPARK are carried by SLA and the tenant itself which is unsustainable. The absence of environmental law in Brunei may also lead to the unsustainable development at SPARK as its absence may give a license to the developers to pollute the environment.

10.2. Overall conclusion

The aims of this research were to investigate the issues involved in carrying out the Sungai Liang industrial Park (SPARK) and to find out whether economic diversification effort made by Brunei can be developed economically while making sure that there is still a protection on the environment and that the health and safety of the population is still prioritised. It can be said that the development of SPARK at the moment is not developing sustainably, since the main findings reveal more challenges in both the socio-economic and environmental impacts than there are benefits.

10.3. Implications of the findings

The findings of this research contribute to knowledge on sustainability by focusing on the sustainability of industrial development in a unique country like Brunei which is neither a developed nor a developing state and also a country that has its own cultural values and a different type of government.

This research adds to the literature on sustainability, especially in terms of the challenges to achieving sustainability in industrial development. The current theories that are used as frameworks in this thesis help to understand what is happening at SPARK, but there is a need to combine elements of the theories such as by combining aspects from SID and EM with ICM such as resource conflict resolution. Moreover, the research also discovered that there is a need to add some elements to the sustainability of industrial development literature, such as the issue of cultural limitations and the type of government. This is so that theories such as SID and EM can be adopted in a country like

Brunei such as by considering issues on cultural differences of different societies as it is more applicable and more specific geographically and culturally.

This research is useful for academic purposes, especially for those who are concerned about the issues raised by sustainable industrial development and for decision makers who are concerned to develop the country economically while still maintaining the environment and the people. This may help the decision makers to reconsider the need to look at environmental management and monitoring as well as the implementation of environmental law before beginning to open up any new industrial development in Brunei so that the sustainability of development can be achieved in the country. Moreover, this thesis may help the decision makers to Brunei to recognise other issues that may appear as a result of new industrial developments, such as the occurrence of resource use conflicts and health and safety issues of the local communities and industrial workers.

10.4. Recommendations for better sustainability in industrial development

For the purpose of achieving better sustainability of petrochemical industry and other industrial development of Brunei in the future, this thesis suggests some recommendations based on the findings of the research, as well as the experience of other petrochemical companies, which were that are presented earlier, in Chapter 3 of this thesis.

One of the recommendations in order to achieve the sustainability of petrochemical industry in Brunei is to relocate the local communities who live close to SPARK so that their health and safety can be secured. Since the surrounding area of SPARK is also where other industries (i.e. oil and gas) are located, it is worthwhile to relocate all the communities away from that area. If this seems not feasible, it is worthwhile to think about some strategies to increase the level of awareness and interest of the local communities about SPARK and to understand the risk of living close to petrochemical plants. With this in mind, there is a need for an effective risk communication by experts. Moreover, since there is evidence of the occurrence of resource use conflicts around SPARK, there is also a need to monitor these conflicts and to formulate resource use conflict management strategies.

Another recommendation is to accelerate the process of the implementation of an environmental law in Brunei so that the environment is well protected and preserved. The presence of an environmental law will deter foreign petrochemical companies from producing excessive pollutants from their operation and will encourage them to manage the environment, so that their operations will be allowed to stay in the country. In addition, as was highlighted earlier, since there is no competent power and technologies at present at DEPR, there is also a need for a competent third body environmental agency in order to manage and monitor both the socio-economic and environmental impacts from SPARK. The process of self-reporting and self-policing is not sustainable as it generates biasness.

In addition, SPARK as well as other future industrial development projects in Brunei should also follow examples from the HSSE programmes of other worldwide petrochemical companies and associations, such as those described in Chapter 4. Such measures could include implementing programmes such as RC, REACH, OIMS and GPS. The use of the LCA for the evaluation of the environmental aspects of the petrochemical product throughout every stage of its lifecycle is an excellent tool that SPARK may use. Moreover, the use of bio-based or renewable feedstock by using advanced technologies and the practical use of the ‘4R’ concept, emission reduction and energy savings, and water saving by ‘E4Water’ may also be carried out in order to move towards the sustainability of industrial development at SPARK. The use of environmental technological innovations such as for improving manufacturing process and to maximise yields and waste generation, as Shell is doing, as well as investing in R&D in technologies, should be practised by SPARK. In addition to that, SPARK could also offer awards and incentives for petrochemical companies that are performing well in their HSSE, as has been done by GPCA (e.g. RC awards programmes) and AFPM (e.g. safety awards programme).

10.4. Recommendations for further research

The methodologies used in this research are useful in answering the research questions of the thesis. However, it would be beneficial for fieldwork investigation to be carried out on the current quality of the air, water and land surrounding the industrial area, to provide knowledge of the current environmental state at the area is known. This will provide baseline data for analysis of environmental impacts from the industry. In this research, the environmental impacts from SPARK are analysed based on interviews and the analysis of the SPARK’s EIS only. Objective data on the quality of the surrounding environment at SPARK could compared with the responses from the local communities regarding their health experiences after the establishment of SPARK, to shed light on whether there is objective cause for concern about health impact from the project.

Moreover, the research would have been enhanced by full access to EIS, ERP and the master plan. If those were made available for further research, a clearer picture could be formed of the HSSE programmes that SPARK and its tenants applying in the management of the project. Lastly, the study could also be improved by comparisons between some other industrial developments in Brunei that are initiated for economic diversification in Brunei. Such comparison would enable firm conclusions to be drawn about whether or not the diversification of the Brunei's economy can be developed sustainably.

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APPENDIX 1

SCOPING CHECKLIST

Instructions

This checklist is designed to help users identify the likely significant environmental effects of proposed projects during scoping. It is to be used in conjunction with the Checklist of Criteria for Evaluating the Significance of Impacts. There are two stages:

- first, identifying the potential impacts of projects;
- second selecting those which are likely to be significant and therefore require most attention in the assessment.

A useful way of identifying the potential impacts of a project is to identify all the activities or sources of impact that could arise from construction, operation or decommissioning of the project, and to consider these alongside the characteristics of the project environment that could be affected, to identify where there could be interactions between them. The two parts of the Scoping Checklist have been developed to assist in this process.

Start with the checklist of questions set out below. Complete Column 2 by answering:

- yes - if the activity is likely to occur during implementation of the project;
- no - if it is not expected to occur;
- ? - if it is uncertain at this stage whether it will occur or not.

For each activity for which the answer in Column 2 is "Yes" or "?", refer to the second part of the Scoping Checklist which lists characteristics of the project environment which could be affected, and identify any which could be affected by that activity. Information will be needed about the surrounding environment in order to complete this stage. Note the characteristics of the project environment that could be affected, and the nature of the potential effects in Column 3.

Finally, use Checklist of Criteria for Evaluatin the Significance of Impacts to help complete Column 4. This will identify those impacts which are expected to be significant. The questions are designed so that a "yes" answer will point towards a significant impact. It is often difficult to decide what is or is not significant but a useful simple check is to ask whether the effect is one that is of sufficient importance that it ought to be considered and have an influence on the development consent decision. As much information as possible about the degree of significance should be included in Column 4 as a guide for planning the environmental studies.

Some examples illustrating how to use the checklist are given below.

No.	Questions to be considered in Scoping	Yes/ No/ ?	Which Characteristics of the Project Environment could be affected?	Is the effect likely to be significant? Why?
1. Will the project involve any actions during construction, operation or decommissioning which would create changes in the locality as a result of the nature, scale, form or purpose of the new development?				
1.6	Demolition works?	yes	Will require demolition of 2 historic buildings	Yes - Buildings are nationally designated
1.11	Dredging?	yes	Will involve dredging of canal to create new waterfront	No - Canal is regularly dredged anyway
2. Will the project use any natural resources, especially any resources which are non-renewable or in short supply?				
2.4	Aggregates?	Yes	Creation of development platform will use large amount of imported material – soil and aggregate. Indirect effect at extraction sites which are in greenfield area	Yes – major change in environment at extraction sites. Impact on large numbers of people nearby. Will place major strain on local supplies
3. Will the project involve use, storage, transport, handling or production of substances or materials which could be harmful to human health or the environment or raise concerns about actual or perceived risks to human health?				

3.4	Are there especially vulnerable groups of people who could be affected by the project eg hospital patients, the elderly?	Yes	Project location is adjacent to regional hospital and long term care centre. Potential for significant noise and other disturbance during construction	Yes - Hospital environment may become much noisier over one year construction period.
4. Will the project produce solid wastes during construction or operation or decommissioning?				
4.2	Municipal waste (household and or commercial wastes)?	Yes	New population will generate household and other wastes	No- there is ample local waste management capacity
5. Will the project release pollutants or any hazardous, toxic or noxious substances to air?				
5.5	Dust or odours from handling of materials including construction materials, sewage and waste?	yes	Earth moving during construction could be dusty in dry climate and affect neighbouring habitats and residents	Yes - Habitat is internationally protected and vulnerable to dust deposition. Condition of hospital patients could be worsened by exposure to dust
6. Will the project cause noise and vibration or release of light, heat energy or electromagnetic radiation?				
6.5	From construction or operational traffic?	yes	Heavy traffic flows for import of material during construction affecting residents and hospital	Yes – noise levels already elevated by traffic and industry
7. Will the project lead to risks of contamination of land or water from releases of pollutants onto the ground or into sewers, surface waters, groundwater, coastal wasters or the sea?				
7.2	From discharge of sewage or other effluents (whether treated or untreated) to water or the land?	Yes	Increase in municipal sewage flows from new residents	Possibly – depends on requirement for new treatment facilities
8. Is there a risk of accidents during construction or operation of the project which could affect human health or the environment?				
8.4	Could the project be affected by natural disasters causing environmental damage (eg floods, earthquakes, landslip, etc)?	yes	Development is within flood plain	Yes – Government policy cautions against development in areas susceptible to flooding
9. Will the project result in social changes?				
9.1	Changes in population size, age, structure, social groups etc?	yes	New population of 10,000 will increase number in immediate area from 5,000 to 15,000 and change character from rural to urban environment. Will affect existing community, cultural identity and economic conditions and introduce differential housing conditions	Yes – local community is small scale and well-established with strong community institutions and identity

When using this Scoping Checklist it is important to remember that **secondary and higher order effects** can occur as a result of a **primary interaction** between a project activity and the project environment. So for example, a change in site run-off can affect the hydrology of a watercourse; this can subsequently affect water quality and the ecology of the watercourse; and this can then affect fishing and other uses of the water. Where a primary effect is identified the user should always think about whether secondary or further effects on other aspects of the environment could arise as a result.

Users should also remember that effects can occur not only **permanently** and over the **long term** but also **temporarily**, for example just during construction, commissioning or decommissioning or just during certain phases of project operation, or that may occur only **intermittently**, for example during certain periods of activity or times of year or as a **result of abnormal events** affecting the project (accidents, freak weather conditions, earthquakes, etc.).

The Directive also requires EIA to consider effects that could arise **indirectly** from the project, for example as a result of other development which takes place as a consequence of the project e.g. to provide access, power or water supplies, sewage treatment or waste disposal, or to house or provide jobs for people attracted to the area by the project. It also requires consideration of **cumulative effects** that could arise from a combination of the project's effects with those of other existing or planned developments in the surrounding area. Further guidance is available from the Commission in "Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions". This document can be viewed at http://europa.eu.int/comm/environment/eia/eia-studies-and-reports/guidel.pdf.

A convenient way of thinking about this checklist is to visualise the two parts as the vertical and horizontal axes of a virtual matrix. The lists are too long to be practically presented as a real matrix and even if they could be the individual cells in the matrix would be too small to contain any useful information about the nature or significance of the effects, but the concept is a useful one when thinking about scoping.

Further instructions for using the second part of the checklist are given at the beginning of the Checklist of Criteria for Evaluating the Significance of Impacts.

Part 1 of The Scoping Checklist: QUESTIONS ON PROJECT CHARACTERISTICS

No.	Questions to be considered in Scoping	Yes/No/?	Which Characteristics of the Project Environment could be affected and how?	Is the effect likely to be significant? Why?
1. Will construction, operation or decommissioning of the Project involve actions which will cause physical changes in the locality (topography, land use, changes in waterbodies, etc)?				
1.1	Permanent or temporary change in land use, landcover or topography including increases in intensity of land use?			
1.2	Clearance of existing land, vegetation and buildings?			
1.3	Creation of new land uses?			
1.4	Pre-construction investigations eg boreholes, soil testing?			
1.5	Construction works?			
1.6	Demolition works?			
1.7	Temporary sites used for construction works or housing of construction workers?			
1.8	Above ground buildings, structures or earthworks including linear structures, cut and fill or excavations?			
1.9	Underground works including mining or tunnelling?			
1.10	Reclamation works?			
1.11	Dredging?			
1.12	Coastal structures eg seawalls, piers?			
1.13	Offshore structures?			
1.14	Production and manufacturing processes?			
1.15	Facilities for storage of goods or materials?			
1.16	Facilities for treatment or disposal of solid wastes or liquid effluents?			
1.17	Facilities for long term housing of operational workers?			

No.	Questions to be considered in Scoping	Yes/No/?	Which Characteristics of the Project Environment could be affected and how?	Is the effect likely to be significant? Why?
1.18	New road, rail or sea traffic during construction or operation?			
1.19	New road, rail, air, waterborne or other transport infrastructure including new or altered routes and stations, ports, airports etc?			
1.20	Closure or diversion of existing transport routes or infrastructure leading to changes in traffic movements?			
1.21	New or diverted transmission lines or pipelines?			
1.22	Impoundment, damming, culverting, realignment or other changes to the hydrology of watercourses or aquifers?			
1.23	Stream crossings?			
1.24	Abstraction or transfers of water from ground or surface waters?			
1.25	Changes in waterbodies or the land surface affecting drainage or run-off?			
1.26	Transport of personnel or materials for construction, operation or decommissioning?			
1.27	Long term dismantling or decommissioning or restoration works?			
1.28	Ongoing activity during decommissioning which could have an impact on the environment?			
1.29	Influx of people to an area in either temporarily or permanently?			
1.30	Introduction of alien species?			
1.31	Loss of native species or genetic diversity?			
1.32	Any other actions?			
2 Will construction or operation of the Project use natural resources such as land, water, materials or energy, especially any resources which are non-renewable or in short supply?				
2.1	Land especially undeveloped or agricultural land?			
2.2	Water?			
2.3	Minerals?			

No.	Questions to be considered in Scoping	Yes/No/?	Which Characteristics of the Project Environment could be affected and how?	Is the effect likely to be significant? Why?
4.9	Contaminated soils or other material?			
4.10	Agricultural wastes?			
4.11	Any other solid wastes?			
5. Will the Project release pollutants or any hazardous, toxic or noxious substances to air?				
5.1	Emissions from combustion of fossil fuels from stationary or mobile sources?			
5.2	Emissions from production processes?			
5.3	Emissions from materials handling including storage or transport?			
5.4	Emissions from construction activities including plant and equipment?			
5.5	Dust or odours from handling of materials including construction materials, sewage and waste?			
5.6	Emissions from incineration of waste?			
5.7	Emissions from burning of waste in open air (eg slash material, construction debris)?			
5.8	Emissions from any other sources?			
6. Will the Project cause noise and vibration or release of light, heat energy or electromagnetic radiation?				
6.1	From operation of equipment eg engines, ventilation plant, crushers?			
6.2	From industrial or similar processes?			
6.3	From construction or demolition?			
6.4	From blasting or piling?			
6.5	From construction or operational traffic?			
6.6	From lighting or cooling systems?			

No.	Questions to be considered in Scoping	Yes/No/?	Which Characteristics of the Project Environment could be affected and how?	Is the effect likely to be significant? Why?
6.7	From sources of electromagnetic radiation (consider effects on nearby sensitive equipment as well as people)?			
6.8	From any other sources?			
7. Will the Project lead to risks of contamination of land or water from releases of pollutants onto the ground or into sewers, surface waters, groundwater, coastal waters or the sea?				
7.1	From handling, storage, use or spillage of hazardous or toxic materials?			
7.2	From discharge of sewage or other effluents (whether treated or untreated) to water or the land?			
7.3	By deposition of pollutants emitted to air, onto the land or into water?			
7.4	From any other sources?			
7.5	Is there a risk of long term build up of pollutants in the environment from these sources?			
8. Will there be any risk of accidents during construction or operation of the Project which could affect human health or the environment?				
8.1	From explosions, spillages, fires etc from storage, handling, use or production of hazardous or toxic substances?			
8.2	From events beyond the limits of normal environmental protection eg failure of pollution control systems?			
8.3	From any other causes?			
8.4	Could the project be affected by natural disasters causing environmental damage (*eg* floods, earthquakes, landslip, *etc*)?			
9. Will the Project result in social changes, for example, in demography, traditional lifestyles, employment?				
9.1	Changes in population size, age, structure, social groups *etc*?			
9.2	By resettlement of people or demolition of homes or communities or community facilities eg schools, hospitals, social facilities?			
9.3	Through in-migration of new residents or creation of new communities?			
9.4	By placing increased demands on local facilities or services eg housing, education, health?			
9.5	By creating jobs during construction or operation or causing the loss of jobs with effects on unemployment and the economy?			

No.	Questions to be considered in Scoping	Yes/No/?	Which Characteristics of the Project Environment could be affected and how?	Is the effect likely to be significant? Why?
6.7	From sources of electromagnetic radiation (consider effects on nearby sensitive equipment as well as people)?			
6.8	From any other sources?			
7. Will the Project lead to risks of contamination of land or water from releases of pollutants onto the ground or into sewers, surface waters, groundwater, coastal waters or the sea?				
7.1	From handling, storage, use or spillage of hazardous or toxic materials?			
7.2	From discharge of sewage or other effluents (whether treated or untreated) to water or the land?			
7.3	By deposition of pollutants emitted to air, onto the land or into water?			
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8. Will there be any risk of accidents during construction or operation of the Project which could affect human health or the environment?				
8.1	From explosions, spillages, fires etc from storage, handling, use or production of hazardous or toxic substances?			
8.2	From events beyond the limits of normal environmental protection eg failure of pollution control systems?			
8.3	From any other causes?			
8.4	Could the project be affected by natural disasters causing environmental damage (*eg* floods, earthquakes, landslip, *etc*)?			
9. Will the Project result in social changes, for example, in demography, traditional lifestyles, employment?				
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9.3	Through in-migration of new residents or creation of new communities?			
9.4	By placing increased demands on local facilities or services eg housing, education, health?			
9.5	By creating jobs during construction or operation or causing the loss of jobs with effects on unemployment and the economy?			

PART 2 OF THE SCOPING CHECKLIST: CHARACTERISTICS OF THE PROJECT ENVIRONMENT

For each project characteristic identified in Part consider whether any of the following environmental components could be affected.

QUESTION - ARE THERE FEATURES OF THE LOCAL ENVIRONMENT ON OR AROUND THE PROJECT LOCATION WHICH COULD BE AFFECTED BY THE PROJECT?
 	
· Areas which are protected under international or national or local legislation for their ecological, landscape, cultural or other value, which could be affected by the project?
• Other areas which are important or sensitive for reasons of their ecology e.g.
  • Wetlands,
  • Watercourses or other waterbodies,
  • the coastal zone,
  • mountains,
  • forests or woodlands
· Areas used by protected, important or sensitive species of fauna or flora e.g. for breeding, nesting, foraging, resting, overwintering, migration, which could be affected by the project?
• Inland, coastal, marine or underground waters?
• Areas or features of high landscape or scenic value?
• Routes or facilities used by the public for access to recreation or other facilities?
• Transport routes which are susceptible to congestion or which cause environmental problems?
· Areas or features of historic or cultural importance?

1.1. *Question - Is the Project in a location where it is likely to be highly visible to many people?*
Question - Is the Project located in a previously undeveloped area where there will be loss of greenfield land?
Question - Are there existing land uses on or around the Project location which could be affected by the Project? For example: · Homes, gardens, other private property, · Industry, · Commerce, · Recreation, · public open space, · community facilities, · agriculture, · forestry, · tourism, · mining or quarrying
Question - Are there any plans for future land uses on or around the location which could be affected by the Project?
Question - Are there any areas on or around the location which are densely populated or built-up, which could be affected by the Project?
Question - Are there any areas on or around the location which are occupied by sensitive land uses which could be affected by the Project? • hospitals, • schools, • places of worship, • community facilities
Question - Are there any areas on or around the location which contain important, high quality or scarce resources which could be affected by the Project? For example: • groundwater resources, • surface waters, • forestry, • agriculture, • fisheries, • tourism, • minerals.
Question - Are there any areas on or around the location of the Project which are already subject to pollution or environmental damage e.g. where existing legal environmental standards are exceeded, which could be affected by the project?
Question - Is the Project location susceptible to earthquakes, subsidence, landslides, erosion, flooding or extreme or adverse climatic conditions e.g. temperature inversions, fogs, severe winds, which could cause the project to present environmental problems?
Question - Is the Project likely to affect the physical condition of any environmental media?

• The atmospheric environment including microclimate and local and larger scale climatic conditions? • Water - eg quantities, flows or levels of rivers, lakes, groundwater. Estuaries, coastal waters or the sea? • Soils - eg quantities, depths, humidity, stability or erodibility of soils? • Geological and ground conditions?
Question - Are releases from the Project likely to have effects on the quality of any environmental media? • Local air quality? • Global air quality including climate change and ozone depletion • Water quality – rivers, lakes, groundwater. Estuaries, coastal waters or the sea? • Nutrient status and eutrophication of waters? • Acidification of soils or waters? • Soils • Noise? • Temperature, light or electromagnetic radiation including electrical interference? • Productivity of natural or agricultural systems?
Question - Is the Project likely to affect the availability or scarcity of any resources either locally or globally? • Fossil fuels? • Water? • Minerals and aggregates? • Timber? • Other non-renewable resources? • Infrastructure capacity in the locality - water, sewerage, power generation and transmission, telecommunications, waste disposal roads, rail?
Question - Is the Project likely to affect human or community health or welfare? • The quality or toxicity of air, water, foodstuffs and other products consumed by humans? • Morbidity or mortality of individuals, communities or populations by exposure to pollution? • Occurrence or distribution of disease vectors including insects? • Vulnerability of individuals, communities or populations to disease? • Individuals' sense of personal security? • Community cohesion and identity? • Cultural identity and associations? • Minority rights? • Housing conditions? • Employment and quality of employment? • Economic conditions? • Social institutions?

Appendix 2

Information Sheet for Respondents
Geography Department, University of Hull
United Kingdom

Research title: Sungai Liang Industrial Park (SPARK): Can Brunei achieve its sustainable industrial development?

Aims of the research: to investigate the issues involved in carrying out the Sungai Liang industrial Park (SPARK) and to find out whether Brunei can develop economically while still protecting the environment.

Expected outcomes from the study: At the end of the research, the researcher hopes to find out what are the likely significant socio-economic and environmental impacts from the SPARK project. She also hopes to find out whether the project could lead to the sustainable industrial development or not.

Significance of the research: This study is important as it helps people to understand issues involved in big infrastructural project like SPARK with relation to the concept of sustainable development. There is also lack of studies on the coastal resources and environment in Brunei and thus, it is hoped that this research could contribute to knowledge and benefit those who concern about economic development as well as environmental protection and management.

Participation in the Study and data collected: Participation in this research is voluntary and participants could withdraw from it as they wish. All data collected will be protected in a secured filling cabinet at the researcher's home and office at the university.

Contacts

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Appendix 3

Geography Department, University of Hull
Hull, United Kingdom

Reference No.: ____________________________ Date: ______________________

Title of the research: Sungai Liang Industrial Park (SPARK): can Brunei achieve its sustainable industrial development?
Aims of the research: This study aims to investigate the issues involved in carrying out the BEDB's Sungai Liang industrial Park (SPARK) and to find out whether Brunei can develop economically while still protecting the environment.
Expected outcomes from the interview: At the end of the research, the researcher hopes to find out what are the likely significant socio-economic and environmental impacts from the SPARK project. She also hopes to find out whether the project could lead to the sustainable industrial development or not.

(A) Personal Information

No.	Personal Information	Answer
1	Sex type	
2	Age	
3	Educational level	
4	Occupation	
5	Name of village	

(B) Opinions on SPARK

1) Are you aware of the SPARK project? What do you know about it?
2) What is your opinion on the project?
3) Is there anyone or organisation who has briefed you about SPARK?
4) Were you given opportunities to be involved in the discussions before the project commence?
5) Does SPARK give benefits to you? How does it benefit you? Please focus on the following potential benefits:
a) Environmental
b) Social
c) Economic
d) Community
6) Do you think that SPARK will benefit the country? Does the Government take into account your interests and needs when planning big projects like SPARK? How are community interests expressed and handled in Brunei?

7) How do you feel living/doing your activities near to the SPARK industrial site?
8) Do the activities involved in SPARK change or affect your livelihood?
9) During the construction of the project, do you find anything changes/disruption in your life, e.g. Does it impact on your community, work, environment, etc?
10) Do you experience any changes in your health from the construction and operation of the project? What risks do you think might be associated with the project and how would you rank these risks?
11) Do you feel any uneasiness from the construction/operation of the project? e.g. not enough sleep? Feeling disturbed because of the noise?
12) Do you think that the project may affect the environment positively or negatively or no change at all?
13) Have you engaged in any meetings, discussions or consultations around the new development? How are your views heard?
14) In few years time, after the whole project is completed, do you see any more changes will occur in your area? How does this benefit/disrupt you?

Appendix 4

Geography Department, University of Hull
Hull, United Kingdom

Reference No.: ____________________________ Date: ______________________

Department/Organisation: ____

Name of Interviewee(s) & Designation: ____

Title of the research: Sungai Liang Industrial Park (SPARK): can Brunei achieve its sustainable industrial development?
Aims of the research: This study aims to investigate the issues involved in carrying out the Sungai Liang industrial Park (SPARK) project and to find out whether Brunei can develop economically while still protecting the environment.
Expected outcomes from the interview: At the end of the research, the researcher hopes to find out what are the likely significant socio-economic and environmental impacts from the SPARK project. She also hopes to find out whether the project could lead to the sustainability of industrial development or not.

(A) Nature of the Development

1) What are the motivations for this particular development of petrochemical industry to be developed in Brunei? In other words, why petrochemical industry?
2) Why Sungai Liang was chosen to be the site/location for the industry?
3) Can you explain in details, what kind of technologies that SPARK is and will be using for its operation? Are they environmentally innovative technologies in terms of the processes, products and management?
4) What is the type of waste management being practiced in SPARK? In other words, how does effluents from the industry be treated and managed?

(B) Benefits from the Development

5) Please describe and account for the benefits of SPARK to Brunei with respect to each of the following:
a) Economic development
b) Social conditions
c) Environment
6) What are the main functions of SPARK in diversifying the economy of Brunei?
7) How does the Government benefit from the project?
8) How does Foreign Direct Investment (FDI) benefit SPARK and Brunei?
9) How many job opportunities have been and will be created from SPARK (from construction and operation)?
10) How many local people have been and will be hired working in the industrial area? What kind of jobs that is and will be created?
11) How much profit has SPARK earned since its operation began?

(C) Challenges/potential problems

12) What are some of the risks, challenges and costs of SPARK in terms of economy, society and environment?
13) Being located on a coastal zone, is there a chance that the ecosystem and environment of the zone be disturbed or changed? If there is, what has been or will be done in the future in order to prevent or reduce the negative impacts?
14) Given the fact that SPARK is also located around residential areas, is there a chance that the development may affect the well-being of the communities living surrounding the project? If there is, what has been or will be done in the future in order to prevent or reduce the negative impacts?
15) How can Brunei compete with other competitors in petrochemical industry inside and outside the South East Asian region (foreign and domestic markets)?
16) Given that there is volatility in the methanol and other petrochemical products price, how can SPARK be secured?
17) Based on previous research, big infrastructural projects often face typical problems e.g. delay in the operation of the project, overestimation of returns, etc. Does SPARK also face this kind of problems? Explain the role of economic, environmental and social factors in contributing to these delays.

(D) Monitoring and Mitigation of Impacts

18) Is there any environmental management plan, environmental audits that have been carried out for the project?
19) Is there any environmental monitoring activities of the SPARK area being or will there be carried out in the future?
20) Some studies have concluded that methanol and other activities petrochemical industry may affect the people's health and the environment. What is your opinion about this and how can SLA prevent this from happening?
21) What measures have been taken to help SPARK in contributing to environmental sustainability in the long term? In answering this question, please mention the role of government policy, corporate policy and community activity.

(E) Stakeholders' Involvement in the Project

22) Who are the main stakeholders in the development of SPARK?
23) Is there any consultation with local communities and other stakeholders prior to the development of SPARK and also during the current operation of the development?
24) Is there any information provided about the project to local communities and other stakeholders?
25) How often does the consultation or meeting with the communities and stakeholders be carried out?
26) What kind of information are given to the community and stakeholders and what kind of issues are raised during dialogue meetings?

(F) Sustainable Development and SPARK

27) How do you define 'sustainable development'?
28) How do you relate the development of SPARK with sustainable development?

__Appendix 5__

Geography Department, University of Hull
Hull, United Kingdom

Reference No.: ______________________ Date: ___________________

Department/Organisation: ____

Name of Interviewee(s) & Designation: ____

Title of the research: Sungai Liang Industrial Park (SPARK): can Brunei achieve its sustainable industrial development?
Aims of the research: This study aims to investigate the issues involved in carrying out the Sungai Liang Industrial Park (SPARK) and to find out whether Brunei can develop economically while still protecting the environment.
Expected outcomes from the interview: At the end of the research, the researcher hopes to find out what are the likely significant socio-economic and environmental impacts from the SPARK project. She also hopes to find out whether the project could lead to the sustainability of industrial development or not.

(A) Nature of the Development

1) What is the motivation for the development of methanol production in Brunei?
2) Can you explain in details, what kind of technologies that BMC is using for its operation? Are they environmentally innovative technologies in terms of the process, products and management?

(B) Benefits from the Development

3) Please describe and account for the benefits of methanol production to Brunei with respect to each of the following:
a) Economic development
b) Social conditions
c) Environment
4) What are the main functions of methanol production in diversifying the economy of Brunei?
5) How does the Government benefit from the project?
6) How many job opportunities have been and will be created from methanol production (from construction and operation)?
7) How many local people who have been and will be employed in the industrial area? What kind of jobs that is and will be created for them?
8) Is it profitable to have methanol production business in Brunei?
9) To which countries are methanol products exported? How many years do the contract of trade agreements with the importers of the products will last?

(C) Challenges/potential problems

10) What are some of the risks, challenges and costs from the production of methanol in terms of economy, society and environment?
11) Given that there is volatility in price of the methanol products, how can the methanol production in Brunei be secured?
12) How can Brunei compete with other competitors in the methanol production industry inside and outside the South East Asian region (foreign and domestic markets)?
13) Based on the previous research, big infrastructural projects often face typical problems e.g. delay in the operation of the project, overestimation of returns, etc. Does BMC also face these kinds of problems? Explain the role of economic, environmental and social factors in contributing to these delays.

(D) Monitoring and Mitigation of Impacts

14) How does effluents and other waste from the methanol production is treated and disposed? Is there any specific industrial dumping station/area?
15) How much effluents are emitted daily or over a period of time e.g. per month/per year?
16) Is there any recycling activities going on in the operation of methanol production?
17) What kind of resources that is used in methanol production? Is it renewable or not?
18) Do you follow any environmental laws or guidelines that been set up for industrial development in Brunei?
19) Is there any environmental management plan that has been carried out for the project?
20) Are there any environmental monitoring activities of the SPARK area that is being or will be carried out in the future?
21) Some studies have concluded that methanol production industry may affect the people's health and the environment. How can BMC prevent this from happening? What are the contingency plans that have been produced in order to prevent negative impacts to the surrounding people and the environment from the production?
22) What measures have been taken to help BMC to contribute to environmental sustainability in the long term? In answering this question, please mention the role of government policy, corporate policy and community activity.

(E) Stakeholders' Involvement in the Project

23) Is there any consultation with local communities and other stakeholders prior to the development of methanol production?
24) What kind of information that is provided to the community and other stakeholders and what kind of issues that are being raised during dialogue meetings with them? What are the main concerns of the stakeholders about the development?
25) How many people who usually come to the dialogue meetings? Who are they mostly? How they react or respond to the dialogue?
26) How often does the consultation or meeting with the communities and stakeholders be carried out?
27) Is there any beneficial relations between the stakeholders that have priorities around the location of methanol production at SPARK?
28) Is there any existing or potential conflict of coastal resources between stakeholders?
29) Is there any monitoring system of existing and potential conflicts between the stakeholders?

(F) Future Plans for Methanol Production in Brunei

30) What are the future plans of BMC?
31) Will there be any exchange of resources, waste among the tenants of SPARK in the future?

(G) Sustainable Development and Methanol Production

32) How do you define 'sustainable development'?
33) How do you relate the development of methanol production with sustainable development?

Appendix 6

Geography Department, University of Hull
Hull, United Kingdom

Reference No.: ____________________________ Date: ______________________

Department/Organisation: ____

Name of Interviewee(s) & Designation: ____

Title of the research: Sungai Liang Industrial Park (SPARK): can Brunei achieve its sustainable industrial development?
Aims of the research: This study aims to investigate the issues involved in carrying out the Sungai Liang industrial Park (SPARK) project and to find out whether Brunei can develop economically while still protecting the environment.
Expected outcomes from the interview: At the end of the research, the researcher hopes to find out what are the likely significant socio-economic and environmental impacts from the SPARK project. She also hopes to find out whether the project could lead to the sustainability of industrial development or not.

1) In your opinion, what are major benefits of SPARK to the economy of Brunei?
2) What are the main functions of SPARK in diversifying the economy of Brunei?
3) How does Foreign Direct Investment (FDI) from various companies in SPARK may benefit Brunei?
4) How much does the contribution of petrochemical industry to the Brunei's GDP?
5) Does the employment opportunities created from SPARK enough to reduce the high unemployment rate in Brunei?
6) Apart from the economic benefits, is there some of the risks, challenges and costs that SPARK may experience?
7) Given that there is volatility in the methanol and other petrochemical products price, how can SPARK be secured?
8) How can Brunei compete with other competitors in petrochemical industry inside and outside the South East Asian region (foreign and domestic markets) given that others have already built their reputation in the production of petrochemical industry?
9) Based on previous research, big infrastructural projects often face typical problems e.g. delay in the operation of the project, overestimation of returns, etc. Do you think that big infrastructural project at SPARK may also face this kind of problems?
10) What can you see in the future the development of SPARK in achieving sustainable development (not only economic development but also environmental protection and improvement in social well-being)?

Appendix 7

Geography Department, University of Hull
Hull, United Kingdom

Reference No.: ____________________________ Date: ______________________

Department/Organisation: ____

Name of Interviewee & Designation:
____

Title of the research: Sungai Liang Industrial Park (SPARK): can Brunei achieve its sustainable industrial development?
Aims of the research: This study aims to investigate the issues involved in carrying out the BEDB's Sungai Liang industrial Park (SPARK) and to find out whether Brunei can develop economically while still protecting the environment.
Expected outcomes from the interview: At the end of the research, the researcher hopes to find out what are the likely significant socio-economic and environmental impacts from the SPARK project. She also hopes to find out whether the project could lead to the sustainable industrial development or not.

(A) Involvement in SPARK and Sustainable Development

1) Have the department involved in the development of SPARK e.g. in initial planning stages or in Environmental Impact Assessment (EIA)?
2) How did the department involve in the development of SPARK?
3) In your opinion, how do you relate the SPARK development with sustainable development? How do you define 'sustainable development' itself?

(B) Impacts/Changes from SPARK

4) Please describe and account for the benefits of SPARK to Brunei with respect to each of the following:
a) Economic development
b) Social conditions
c) Environment
5) Will there be any possibilities that SPARK may create changes to the ecosystem and the environment of its surrounding areas? If so, how and what will be changed?
6) Does the clearance of forest for the SPARK project create any change to the forest reserves in Brunei? If so, how and what will be changed?
7) Does the operation of SPARK create any changes to the seawater route for fishing, navigation, etc.? If so, how and what will be changed?
8) Is there any potential for activities in SPARK affect the safety of the seawater (e.g. accidents from the operation)? If so, how and what will be affected?

(C) Mitigation Plans/Environmental Policy

9) Is there any environmental law or guidelines for an industry such as SPARK to abide or follow in order to minimize its impacts to the environment?
10) Is there any contingency/mitigation plans if there is anything happen to SPARK (e.g. accidents, environmental pollution, etc)?
11) Does the DEPR monitor the SPARK project, in terms of the environmental safety of the site?

Appendix 8

A PROFORMA FOR

STAFF AND POSTGRADUATE RESEARCH STUDENTS BEGINNING A RESEARCH PROJECT

Department of Geography

Research Proposer(s): ……………………………………………………………................................

Programme of Study (postgraduate students).…………………………………………………………………………………..

Research Title: ……………………………………………….................

……

Research (brief):

Source of Research Funding (where appropriate) ……………………………………………………..

Proforma Completion Date: ……………………………………………………………………………......

This proforma should be read in conjunction with the ethical principles. It should be completed by the researcher. It should be sent on completion, together with a brief (maximum one page) *summary of ethical issues raised by the proposed research, for approval to the Geography Ethics Officer prior to the beginning of any research.*

Part A

1. Will your research involve animal experimentation? Y / N.

If the answer is 'YES' then the research/teaching proposal should be sent direct to the University Ethics Committee to be assessed.

2. Will your research involve human participants? Y / N

If the answer to both questions is 'NO', there is no need to proceed further with this proforma, and research may proceed (however, please send a copy of the form to the Ethics Officer). If the answer is 'YES' please answer all further relevant questions in part B.

Part B

3. Will the research involve people under 18 years of age? Y / N

If yes, have you taken the following or similar measures to deal with this issue?

(i) Informed the participants of the nature of the research? Y / N

(ii) Ensured their understanding? Y / N

(iii) Gained the non-coerced consent of their parents/guardians? Y / N

4. Will you obtain written informed consent from the participants? Y / N

If yes, please include a copy of the information letter requesting consent

If no, what measures will you take to deal with obtaining consent?

5. Issues for participants. *Please answer the following and where you respond YES in any case, state how you will manage perceived risks:*

a) Do any aspects of the study pose a possible risk to participants' physical well-being?	YES NO
b) Will any important information about the research be deliberately withheld from the participants?	YES NO
c) Are there any aspects of the study that participants might find humiliating, embarrassing, ego-threatening, in conflict with their values, or be otherwise emotionally upsetting?*	YES NO
d) Are there any aspects of the study that might threaten participants' privacy (e.g. questions of a very personal nature; observation of individuals in situations which are not obviously 'public')?*	YES NO
e) Does the study require access to confidential sources of information (e.g. medical records)?	YES NO
f) Could the intended participants for the study be expected to be more than usually emotionally vulnerable (e.g. medical patients, bereaved individuals)?	YES NO

*Note: if the intended participants are of a different social, racial, cultural, age or sex group to the researcher(s) and there is **any** doubt about the possible impact of the planned procedures, then opinion should be sought from members of the relevant group.

6. Might conducting the study expose the researcher to any risks (e.g. collecting data in potentially dangerous environments)? Y / N

7. Is the research being conducted on a group culturally different from the researcher? Y / N

If yes, are sensitivities and problems likely to arise? Y / N

If yes, please *describe how you have addressed/will address them.*

8. Does the research conflict with any of the Department's research principles? (please see attached list, page 7). Y / N

If yes, describe what action you will take to address any conflicts?

9. Will the research require the consent of any outside organisation?

Y / N

If yes, describe how you will obtain consent.

Name of Researcher ……………………………………………………………………

Signature ………………………………………………… Date …………………………….....

This research proposed in this proforma must gain recommendation for approval from the Geography Ethics Officer. Once this is gained, formal approval will be given by the Geography Ethics Committee.

It is recommended that the research referred to in this proforma is given approval by the Geography Ethics Committee. Y / N

Name of Ethics Officer ……………………………………………………………………

Signature ………………………………………………… Date…………………………………

Appendix 9

DEPARTMENT OF GEOGRAPHY - THE UNIVERSITY OF HULL

STUDENT RISK ASSESSMENT FORM FOR GENERAL OVERSEAS FIELDTRIP

General Description of Trip:		**Names & Mobile Number**:
Trip Date:	**First aid cover for the trip**:	**Details of Venue, Location & Accommodation Address & Telephone**:
Competency of participants to complete the task (to be completed by the supervisor see note 4):		
Transport Information Flight Times and Dates: Road Arrangements: Maximum Driving Time in Hours:		**Pre-requisites** Personal details form ☐ Briefing from supervisor ☐ Briefing to all participants ☐ Code of Conduct understood and signed ☐ Optional: Register with FCO 'LOCATE' servi ☐ (allows embassy to contact you in an emergency, web site also gives latest travel advice) http://www.fco.gov.uk/en/travel-and-living-abroad/staying-safe/Locate/

Evacuation and Repatriation Procedures

Local Hospital:

Local Contact Details:

British Consulate Address and Telephone Number:

Departmental Contact During Visit:

Hazards Identified:	How might someone be harmed:	Ratin g (HML) :	What has Been Done Already:	What Further Action is Required	Action by:
			Are These Measures Adequate?		
			Are These Measures Adequate?		
			Are These Measures Adequate?		

			Are These Measures Adequate?		

Significant Residual Risks: Are These Measures Adequate?

Student Name:	Signature:	Date:
Academic Supervisor:	Signature:	Date:
Assessment received by Safety Officer (Paul McSherry)	Signature:	Date:

Notes:

1. A suitable reporting in procedure must also be arranged following discussion with your supervisor and PMCS. If the reporting in procedure is with someone outside the University such as with parents, then they must be given clear instructions when to report to the University.
2. Work is outside the UK you must submit a completed Personal Details Form which is available at http://www.hull.ac.uk/geog/resources/safety.htm
3. You must also ensure that appropriate travel insurance is in place. This can be arranged through the University Insurance Office via Paul McSherry (PMCS). However if arranging private travel insurance you must first check with the company that they are happy with the activities that you are doing. Once a policy has been taken out you must provide us with the insurance company name, policy number and emergency contact number provided by the company.
4. Competency of participants to complete the task. Supervisors of students should ensure that suitable training or instruction is given for the tasks or activities.
5. The risk assessment should be taken into the field.
6. Hazard Checklist (hazard - **potential** of a substance, activity or process to cause harm): THE FOLLOWING HAZARD CHECKLIST SHOULD BE USED WHEN PREPARING ASSESSMENTS ALTHOUGH IT IS LIKELY THAT OTHER HAZARDS MAY BE PRESENT:

- TRAVELLING TO SITE
- TRAVELLING ONCE ON LOCATION
- SECURITY RISK (TERRORISM OR PERSONAL)
- HAZARDS FROM EQUIPMENT (DEFECT/FAILURE, HANDLING AND OPERATION, NOISE, VIBRATION, FUMES)
- MANUAL HANDLING (LIFTING OR MOVING EQUIPMENT OR MATERIALS)
- DEFECT/FAILURE OF EQUIPMENT
- UNSAFE ACCOMMODATION
- CONTACT WITH THE PUBLIC
- ENVIRONMENTAL ADVERSE EFFECTS (EXTREMES OF WEATHER,
- SUNSTROKE/HYPOTHERMIA)
- HAZARDS ASSOCIATED WITH AREAS OF WORK (SEA OR WATER COURSES, LANDSLIDE, ROUGH TERRAIN, WORK IN TRENCHES, QUARRIES, AVALANCHE, ROAD TRAFFIC)

- CONTACT WITH HAZARDOUS FLORA AND FAUNA
- URBAN ENVIRONMENT (GETTING LOST, ROAD TRAFFIC, ABUSE, ATTACK, ROBBERY)
- DISTANCE FROM MEDICAL FACILITIES
- SUPERVISION/LONE WORKING
- COMPETENCE OF LEADERS AND PARTICIPANTS
- HAZARDOUS ACTIVITIES OR SPORTS (DIVING, SNORKELLING, SWIMMING, CAVING, CLIMBING)
- COMMUNICATION DIFFICULTIES
- ABILITY TO DEAL WITH AN EMERGENCY/CONTINGENCY PLANNING
- DEALING WITH OTHER PEOPLE, OTHER PEOPLES HOMES
- IDENTIFICATION OF INDIVIDUALS WHO MAY NEED SPECIFIC SUPPORT
- ENVIRONMENTAL IMPACT
- STUDENT BEHAVIOUR

UNIVERSITY OF Hull

Department of Geography
Travel Policy

March 2011

Department of Geography Travel Policy

This document outlines the Department of Geography travel policy for all members of staff and research students who are travelling either independently or as small groups. It should be read in conjunction with the University of Hull Policy on Work Related Travel (WRT). All members of the department must use the checklist regarding any trip overseas. Travel in relation to field courses is covered in a separate policy (Policy on the Management of Field Courses).

Planning Trips - Prior to any planned travel overseas, permission should be sought from the Head of Department (HOD) or equivalent. Planning should follow the procedures set out in WRT.

UK Travel - Travel within the UK should follow existing risk assessment procedures that apply to visits to remote areas or for hazardous activity. Details of low risk visits that do not require a specific risk assessment should be included on the Academic Day Planner and a mobile phone contact number must be kept in the Departmental Office.

Risk Category Determined - The person making the trip or the project/trip leader should determine if a full written risk assessment is required.
Risk Category 1 (Low Risk). Low risk trips which do not require a specific risk assessment to be completed for each visit. Examples include; attendance at short conferences, regular teaching slots in non volatile and easily accessible environments, hosted visits to Overseas Universities. There should be no significant additional risks associated with the trip and nothing on the FCO website which indicates a high risk status in any respect.
Risk Category 2 (Medium to High Risk). Examples of visits in category two include; visits to areas for any purposes where the travel advice states there is a high risk for security and terrorism, visits to remote areas, fieldwork in an overseas location, any recruitment activities to new or existing areas. If there is a need to obtain vaccination prior to travel this may be an indication that there are risks associated with the visit which require special control measures being adopted.
Written Risk Assessment. A written risk assessment must be completed for any travel categorized as Risk Category 2 (medium to high risk) and approved by the HOD and DSO. The completed checklist should be attached to the risk assessment.

Pre-Departure - All staff should complete the following actions prior to departure.

- Pre-Departure Checklist Form (copies of this policy and the checklist are available on e-bridge)
- Copy of passport
- Copy of itinerary
- Ensure personal details form is up to date

Please note that all documents will be filed in the Departmental Office and will be treated in strict confidence, however for some category 2 trips it may be prudent for copies of documents to be kept in Health & Safety Services where the duty officer will have immediate access should they be required.

In Country - It is good practice that you regularly alert the department or colleagues to your whereabouts, particularly if your plans in country change. If you encounter difficulties overseas, the following procedure is suggested:

In the event of a medical emergency
Contact Chubb Assistance on +44 207 895 3364
Note: date of birth of casualty is often requested

For a non medical issue, contact your colleagues and/or in country staff, agents or contacts
University of Hull Report Centre +44 01482 465555

Follow guidelines as per Control Risks: 24hr Security Assistance Programme
Americas: (1) (215) 942 8226
Asia and the Pacific: (65) 6338 7800
Europe and Africa: (44) (20) 8762 8008
Paris, France: (33) 155 633 155

Post Overseas - Information on accidents, incidents or altercations must be fed back to the Departmental Safety Officer and if required an accident report form completed.

Other Information - It may be useful when undertaking overseas trips to inquire about the latest travel advice from the following.

- FCO travel advice http://www.fco.gov.uk/en/travel-and-living-abroad/
- Control Risks http://www.crg-online.com (log-in and password is 14ACRS000002)
- University of Hull Insurance Office: Helen Ralph tel 6403 h.ralph@hull.ac.uk

Department of Geography
Travel Pre-Departure Checklist Form (Use in conjunction with the Policy on Work Related Travel)

GENERAL INFORMATION		
Name(s)		
Country visiting		
Proposed Dates	Outbound	
	Return	
Purpose of Visit		

Risk Category	√
Category 1 (Low Risk)	
Category 2 (Medium or High Risk)	

SECTION A: Actions for all overseas trips	√
Take note of relevant Embassy Contact details http://www.fco.gov.uk/en/travel-and-living-abroad/	
Read university risk consultants advice-Control Risks http://www.crg-online.com (log-in and password is 14ACRS000002)	
Optional: Register with FCO 'LOCATE' service (allows embassy to contact you in an emergency) http://www.fco.gov.uk/en/travel-and-living-abroad/staying-safe/Locate/	
Personal details form submitted/updated	
Wherever possible travel and accommodation should be arranged through University travel supplier.	
Details of travel and accommodation supplier attached if not arranged with University travel supplier. In difficult circumstances this information may enable the University to provide support and assistance.	
Visa and other documents or permissions required	
Insurance arranged through University Insurance Office	
Itinerary attached	
On site contact details established and provided	
Home contacts/communication established	
Emergency Home Contact arrangements established	
Emergency in country contact established	

SECTION B: Additional actions essential for medium to high risk destinations	√
Risk assessment written	
Risk assessment approved by HOD and DSO and checklist attached	
Reporting in procedure established	

Signature Date

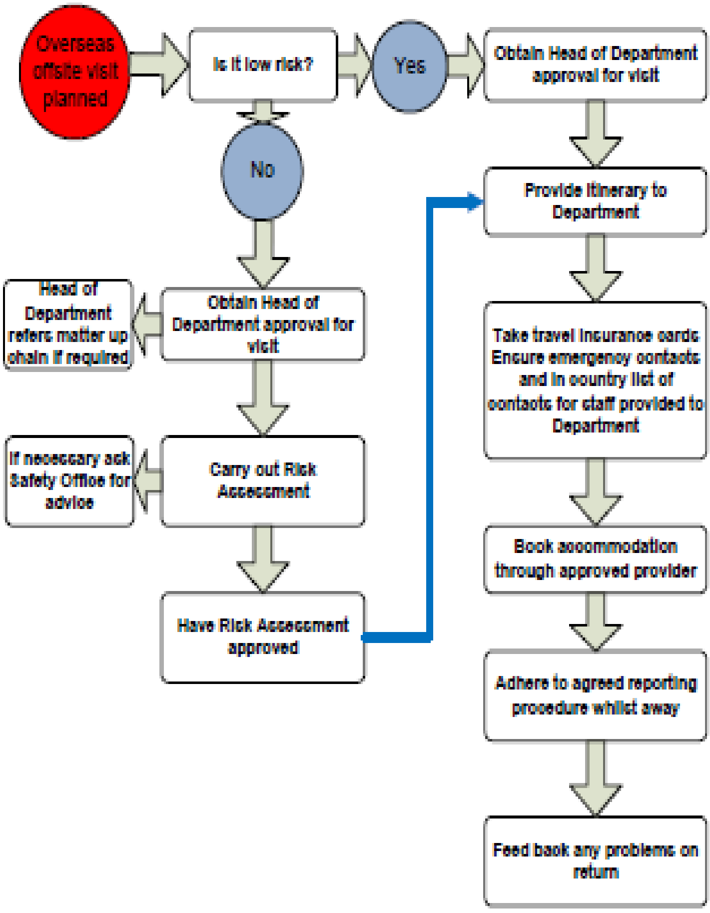
Research students: approval of academic supervisor Date

Approval: Head of Department Signature Date

Appendix 1

OVERSEAS TRAVEL RISK ASSESSMENT FLOW CHART

Flow Chart for those intending to travel overseas on University Business (Use in conjunction with Section 4)



Appendix 11

**Name of interviewees*
**Designation*
**Name of company/department*

5th April 2012

Dear Sir/Madam,

Re: Permission to conduct a PhD research study entitled "Sungai Liang Industrial Park (SPARK): Can Brunei achieve its sustainable industrial development?"

I am a postgraduate research student at the Department of Geography, University of Hull who is currently conducting a research study entitled "Sungai Liang Industrial Park (SPARK): Can Brunei achieve its sustainable industrial development?". The aim of the research is to investigate the issues involved in carrying out the Brunei Economic Development Board's Sungai Liang industrial Park (SPARK) and to find out whether Brunei can develop economically while still protecting the environment. My research study is supervised by Professor David Gibbs, Dr Pauline Deutz and Professor Andrew Jonas from the Department of Geography, University of Hull, United Kingdom.

I would like to request for a permission to interview your personnel from your organisation for my research study and also to pay a site visit to the SPARK area. This study is important as it helps people to understand issues involved in big infrastructural project like SPARK with relation to the concept of sustainable development. There is also lack of studies on the coastal resources and environment in Brunei and thus, it is hoped that this research could contribute to knowledge and benefit those who concern about economic development as well as environmental protection and management in order to achieve sustainable development.

Kindly, I would like to request for the interviews and site visits to be carried out next Friday, 13th and 20th of April respectively. If this is not possible, I would have no problems for it to be postponed to other dates so as long as it can be carried out on Friday. For your information, some of the questions that will be included in the interviews are; 1) opinions about sustainable development with regards to the development of SPARK; 2) nature of the SPARK development (e.g. functions of SPARK in diversifying the economy of Brunei, technologies used in SPARK, how the location of SPARK is chosen, etc.); 3) benefits from the development (e.g. to the socio-economy, environment, etc.); 4) challenges to SPARK (e.g. international market competition, effects to the environment, etc.) 5) environmental monitoring of SPARK and 6) stakeholders involvement in the SPARK project.

Participation in this study is voluntary and you may withdraw from participating as you wish. All the data collected from the interview (if you agree to participate) will be protected and stored in a secured filling cabinet at the researcher's home and office at the university. The interview may minimally disrupt some of the office hours of the participants (probably one to two hours) and I would like to take this opportunity to apologize for the discomfort in taking out the office hours.

This study has been cleared in accordance to the ethical procedures from the Department of Geography, University of Hull. Should you have any concerns about the conduct of this research study, please contact the Ethic Officer, Department of Geography, University of Hull, Cottingham Road, Hull, HU6 7RX; Tel No: + (44) (0) 1482 465320.

Yours faithfully,

Miss Sarinah Binti Omar
Postgraduate Research Student
Department of Geography
University of Hull
United Kingdom
e-mail: s.b.omar@2010.hull.ac.uk
Tel: +673 8802839 (Brunei Darussalam)
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Professor David Gibbs
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Dr Pauline Deutz
Co-Supervisor
E-mail: p.deutz@hull.ac.uk
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Professor Andrew Jonas
Co-Supervisor
E-mail: a.e.jonas@hull.ac.uk
Contact No: **+44 (0) 1482 465368**

Telephone: Students Unit (020 7402 0045)
Students Hostel (020 7402 0953)
Fax: 020 7262 8406
Website: www.upp.org.uk
Email: admin@upp.org.uk

سوروهنجاي تيڠڬي نڬارا بروني دارالسلام

SURUHANJAYA TINGGI NEGARA BRUNEI DARUSSALAM
HIGH COMMISSION OF BRUNEI DARUSSALAM

(STUDENTS UNIT)
35 – 43 Norfolk Square
London W2 1RX

BS28307/S5828

12 March 2012

TO WHOM IT MAY CONCERN

Dear Sir / Madam,

PHD RESEARCH STUDY
DAYANG SARINAH BINTI OMAR, PHD PHYSICAL GEOGRAPHY, UNIVERSITY OF HULL

Kindly be informed that Dayang Sarinah binti Omar, recipient of the Government of His Majesty the Sultan and Yang Di-Pertuan of Brunei Darussalam Scholarship and a PhD Physical Geography at the University of Hull, United Kingdom is currently conducting a research study entitled "Sungai Liang Industrial Park (SPARK): Can Brunei achieve its sustainable industrial development?".

The main aim of the research is to investigate the issues involved in carrying out the Brunei Economic Development Board's Sungai Liang Industrial Park (SPARK) and to find out whether Brunei Darussalam can develop economically while still protecting the environment.

In the process of gathering research data, Dayang Sarinah will be conducting interview to relevant government departments, semi governments and private organisation as well as public participants. All data collected from the interview will be protected and stored confidential.

In this regard, I would be grateful if you could kindly rendered your assistance and support in order for Dayang Sarinah to gather the essential information that would be deemed necessary for his research.

Thank you for your kind cooperation and assistance in making Dayang Sarinah's research possible.

Yours sincerely,

DAYANG HAJAH AZIZAN BINTI DATO PADUKA HAJI OTHMAN
Acting Director of Studies
Brunei Students Unit
For High Commissioner

Note: This letter has been issued on the request of Dayang Sarinah.

Appendix 13

DEPARTMENT OF GEOGRAPHY, UNIVERSITY OF HULL
CONSENT FORM: PUBLIC PARTICIPANTS

I, ____

of ____

Hereby agree to participate in this study to be undertaken

By **Miss Sarinah Binti Omar**

and I understand that the purpose of the research is **to investigate the issues involved in carrying out the BEDB's Sungai Liang industrial Park (SPARK) and to find out whether Brunei can develop economically while still protecting the environment.**

I understand that

1. Upon receipt, my questionnaire will be coded and my name and address kept separately from it.
2. Any information that I provide will not be made public in any form that could reveal my identity to an outside party ie. that I will remain fully anonymous.
3. Aggregated results will be used for research purposes and may be reported in scientific and academic journals.
4. Individual results **will not** be released to any person except at my request and on my authorisation.
5. That I am free to withdraw my consent at any time during the study, in which event my participation in the research study will immediately cease and any information obtained from me will not be used.

Signature: Date:

The contact details of the researcher are: Miss Sarinah Binti Omar, tel. +6738802839 (Brunei); +447758107179 (United Kingdom)

The contact details of the Geography Ethics Officer are: Department of Geography, University of
Hull, Cottingham Road, Hull, HU6 7RX, tel. 01482-465320.