A Risk Assessment in Natural Gas Supply

*Mohd Azril Ismail[#*1], Kamal Imran Mohd Sharif[#*2], Zulkifli Mohamed Udin[#*3], Mohamad Ghozali Hassan[#*4], Mohd Nasrun Mohd Nawi[#*5], Zahril Anwar Malek Abdol Hamid[#*6], Jafni Azhan Ibrahim[#*7], Abdul Aziz Othman[#*8]*

[#]School of Technology Management and Logistic
[*]College of Business, Universiti Utara Malaysia
06010 Sintok, Kedah, MALAYSIA

[1]azril@uum.edu.my

Abstract **--- The purpose of this study is to identify the risk of natural gas supply. There are two modes of delivering the natural gas which are the pipeline system and ships. In view of this, there are risks faced by producer in dealing with the supply of natural gas. The risk can be categorized as market risk, supply risk, and transportation risk. Market risk refers to the risk of macroeconomic, supply risk refers to risk of physical distribution in gas supplies and transportation risk refers to a set of accidental leakage scenarios that happen when the delivering occur.**

Keywords --- Market risk, supply risk, natural gas and transportation risks

1. INTRODUCTION

Energy supply and environment sector are disciplines that aimed at natural scientists, technologists, social sciences and policy communities covering the direct and indirect environmental impacts of energy acquisition, transport, production and use. It covers the social and political aspect of several issues at every level. The technological and scientific aspects of energy and environment are covered in various ways, including the relationship of such questions to wider economic and socio-political issues [1].

Natural gas is a fossil fuel formed by when layers of buried plants and animals are exposed to intense heat and pressure over thousands of years. The energy that the plants and animals originally obtained from the sun is stored in the form of carbon in natural gas. Natural gas is combusted to generate electricity, enabling this stored energy to be transformed into usable power [2]. In view of this, this study provides a model for assessing risk in natural gas pipelines and for classifying sections of pipeline into risk categories.

1.1 Problem Statement

Most of the countries rely on the advantages and the importance of using natural gas in their daily lives. However, during the processes of delivery of the natural gas, there is always a serious of leaking in the gas tanker problem that results in the disruption of the transportation process. It leads to gas supply interruption and distribution bottlenecks. Moreover, the uncertainty of price and capacity for transportation has resulted to the price volatility in the natural gas industry [3]. On the other hand, the high dependency over longer distance among the countries in Asia has increased the unstable interest among the parties [4].

2. LITERATURE REVIEW

In the last two decades, risk assessment techniques have been successfully applied in the fields of aerospace, nuclear and chemical engineering. For instance, NASA established the Safety, Reliability, Maintainability and Quality Assurance Office (SRM&QA) in the disaster of the Space Shuttle Challenger accident in 1986 [5]. Risk assessment and management has two important steps which are determination of the risks associated with the system and acceptability of those risks [1]. In specific, the risk is identified as a risk process that deals in a decision-making for identifying and evaluating of significant risks, and there for mitigation [5]. The definition of risk in this study is a combination of the probability of an event and its consequences [6].

In natural gas business, the possibility for an investor to experience losses is due to factors that affect the overall performance of the financial markets. Market risk, also called "systematic risk," cannot be eliminated through diversification, though

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it can be hedged against. The risk that a major natural disaster will cause a decline in the market as a whole is an example of market risk. Other sources of market risk include recessions, political turmoil, changes in interest rates and competition [7].

Market risk refers to the potential for an investment's value to decrease due to factors affecting the entire market. Also called systematic risk or undiversifiable risk, this type of risk cannot be minimized through diversification because the entire market is impacted. Hedging (taking two positions that will offset each other if prices change) is the only technique that offers some level of protection from market risk. There are four main types of market risk: equity risk (stock prices), interest rate risk, currency risk, and commodity risk.

Supply chain risk can formally be defined as the potential loss resulting from a variation in an expected supply chain outcome. It is the mismatch between supply and demand. Supply chain risk was often the result of inadequate spend visibility, lack of deep supplier and market information, poor inventory management, poor supplier collaboration, and inefficient coordination heightened by a lack of infrastructure, skills, resources, researches, and technology as well as language and cultural barriers [6]. Supply chain management is the active management of supply chain activities to maximize customer value and achieve a sustainable competitive advantage. It represents a conscious effort by the supply chain firms to develop and run supply chains in the most effective & efficient ways possible. Supply chain activities cover everything from product development, sourcing, production, and logistics, as well as the information systems needed to coordinate these activities [8]. Exposure to loss arises from activities such as designing and engineering, manufacturing, technological processes and test procedures.

Technical risk analysis only reveals the odds of a failure. Risk mitigation is reducing the danger of system failure if the single failure occurs. The process of performing technical risk analysis and then designing to minimize risk is called risk engineering [9].

3. METHODOLOGY

The purpose of this study is to identify problems or risks inherent in the topic of natural gas supply. This study uses the method of natural gas usage problem. These problems affect the user, system, company, and market demand. There are five steps in the process to systematic review (refer to Figure 1)

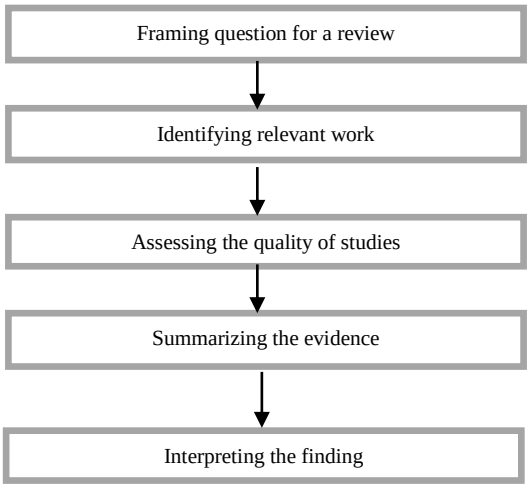

***Figure 1**: Process to identify a problem*

3.1 Framing question for a review.

Before determining the cause of a problem, we need to collect as much information as you can about the natural gas and what the general risk in natural gas. The following sections raise some basic questions that will help to identify the important information. For this stage, the issue of natural gas has been identified and the focus of studies has been highlighted, basically, this study will focus on the related risk of natural gas.

3.2 Identifying relevant work.

In this research, the cause of the problem is the availability of natural gas risks in the process or application. So, there are risks that have been identified of which is the risk in the market, supply chain, and technical aspect.

3.3 Assessing the quality of studies.

This study identifies three general risks of natural gas; market, supply chain, and transportation. Two methods of transportation are used in delivering natural gas; through the pipeline and by ship. In this area, there are risks associated including in supplying natural gas to customers, the importance of natural gas to consumers that result in market competition, and risk to employees working situations.

3.4 Summarizing the evidence.

Data synthesis consists of tabulation of study of characteristics, quality and effects as well as the use of statistical methods in exploring the differences between studies and combining their effects (meta-analysis).

3.5 Interpreting the findings.

The issues highlighted in each of the four steps above should be met. The risk elements that are biased should be explored. Any recommendations should be graded by referring to the strengths and weaknesses of the evidence**.** Through this study, we have been able to create a framework that can explain the overall risk of natural gas. This can help workers, companies, and consumers avoid the risk involved in this area.

4. FINDINGS

The main focus of this study is to discuss the risk assessment on the use of natural gas. There is some risks in the use of natural gas which can be categorized into market, supply chain, and technical risk (refer to Figure 2).

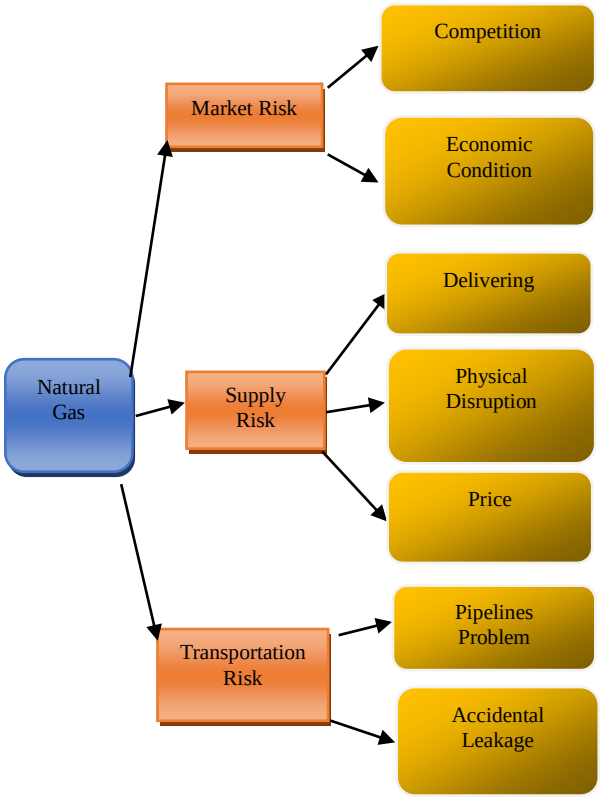

***Figure 2**: Risk in natural gas framework*

4.1 Market risk

Market risk cannot be eliminated through diversification, though it can be hedged against. The risk that a major natural disaster will cause a decline in the market as a whole. Other sources of market risk include recessions, political havoc, changes in interest rates and competition among suppliers [6]. In the use of natural gas, the market is a critical element of the process gas operations. Therefore, there is a risk that the market should emphasize especially in terms of competition of gas market price [3]. Natural gas markets have been opened up to competition with the creation of open access to pipeline transportation and storage and unbundling of sales from pipeline transportation [10].

In the natural gas industry, however, more attention to price volatility is focused on basis differentials between markets, driven by the uncertainty in prices and capacity for transportation. Marketers encounter difficulty in attempting to apply short-run fundamentals to assess overall gas commodity prices [3]. Market risk also refers to the risk of the macroeconomic effect due to a shortage of gas supply and price changes in the gas market [4]. Exposure to market risks such as an increase in inflation and unemployment rate and adverse effects on the balance of payments of the higher gas prices making economies vulnerability. Factors affecting demand generally include weather conditions and aggregate of economic conditions [11]. The theory of price determination for a storable commodity suggests the price of natural gas should increase as supplies decline or demands increase [5].

4.2 Supply chain risk

Supply chain risk can formally be defined as the potential loss resulting from a variation in an expected supply chain outcome. It is the mismatch between supply and demand. Supply chain risk has often been the result of inadequate spend visibility, lack of deep supplier and market information, poor inventory management, poor supplier collaboration, and inefficient coordination heightened by a lack of infrastructure, skills, resources, research, and technology as well as language and cultural barriers [6].

Supply risk refers to risks of physical disruption in gas supplies. Exposure to supply risks such as an insufficient supply due to geopolitical insecurities contributes to vulnerability. A number of indicators have been used in the literature to measure supply risk. These include factors such as level of domestic reserves relative to consumption, domestic production relative to gas consumption, the level of

imports, diversification of supply sources, political risk in the supplying countries, and market liquidity [4].

In the operation of delivering supplies to certain parties, there are some problems. Gas supply interruptions, increasing gas prices, transportation and distribution bottlenecks, and a growing reliance on imports over longer distances have renewed interest on gas vulnerability in Asia [12]. Gas prices are tanked to oil in Japan and Korea, but with a formula that differs from that of European gas users. In Australia and New Zealand, prices are set by gas-on-gas or gas-on-coal competition [2].

This study concentrates on several aspects of supply chain management and economic valuation of real options in the natural gas and liquefied natural gas industry, including gas pipeline transportation, ocean LNG shipping logistics, and downstream storage [11]. Factors that influence supply conditions are stock levels of gas in storage, pipeline capacity, operational difficulties, and imperfect information on the part of the suppliers [11].

4.3 Technical risk

Exposure to loss arises from activities such as designing and engineering, manufacturing, technological processes and test procedures. The technical risk analysis only reveals the odds of a failure. Risk mitigation is reducing the danger of system failure if the single failure occurs. The process of performing technical risk analysis and then designing to minimize risk is called risk engineering [9]. In the natural gas industry hazard, risks during operation is very important, especially during the gas transfer process involving two types of processes, namely through the pipeline and ship. This is categorized as a technical element [13].

In this section, accidental leakage scenarios is presented based on studies from the literature which analyze pipeline risk [14]. When pipelines are damaged, natural gas is released through every puncture in the pipe, which creates dangerous situations that may include explosions and fires. Different accident scenarios may result from a combination of events responsible for a natural gas leakage and evolve into a serious outcome [15].

Hazardous liquid and natural gas transmission pipelines have received limited attention by planning scholars even though local development decisions can have broad consequences if a rupture occurs [16]. There are several factors which come together to cause different probabilities to each section of the pipelines which comprise the type of land occupation, third-party interference, distance to ignition sources, and existence of confinement barriers in the region. Surrounding each section of pipeline are examples of such factors [10].

These probabilities can be obtained from either historical data and data reports of accidents and leakages or expert prior knowledge, obtained by means of structured Bayesian elicitation procedures [17].

5. CONCLUSION

Overall, natural gas is one of the critical resources of the world as it is used widely in human life. Its consumption is expected to increase in the future due to its low environmental impact, ease of use and the increase in the number of natural gas fired power plants. However, there are several risks that have been identified in this industry; with three risks being highlighted in this study; market, supply chain, and technical risks.

The first risk is terms of market, we have been able to identify what needs to be concerned is the price competition and unstable economic situation. While in terms of the supply chain risk, it is related to delivering supplies, physical disruption, and price. And the last risk is related to technical comprising accidental leakage and pipeline problems. These risks have a significant impact on the market as well as to the employees [18]. For example, in technical risks, risk assessment is incomplete in terms of the need to take into consideration the multi-dimensional consequences that an accident in natural gas pipelines may impose. It is a fact that nowadays, risk management must reconcile with the concern of society, the state and the gas companies with regard to the operation and safety of pipelines [19].

The finding of this study can be regarded as the preventive mechanism to the business planner to avoid the risks existing in this industry. It provides a framework that explains the risks in natural gas, so to enable them to plan the methods to overcome this risk more effectively. The rules designed not only can be used in this industry, but can be recommended to other industries such as manufacturing industry, marketing, and so on. It will also have a positive impact on the company management in the process of decision making based on the problems that have occurred.

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