

RISK FACTOR ANALYSIS OF LIQUIFIED NATURAL GAS (LNG) SUPPLY PROCESS CHAIN IN INDONESIA

Rahmat Nurcahyo, Farid Akbar, Yadrifil
Kampus UI Depok Indonesia
rahmat@eng.ui.ac.id

ABSTRACT

Utilization of natural gas as one of energy resources is improving significantly every year. It has impact to the growth of Liquefied Natural Gas (LNG) industry in Indonesia. The main activity in LNG industry is to liquify the natural gas from exploration process into its liquid form. Next process relates with LNG supply chain. The objective of this research is to analyse any possible risk at LNG supply chain which categorized as critical and plan its risk mitigation strategy. It was found there are four risk factor such as supply risk, operations risk, demand risk and environment risk. There are 30 risk factors that potentially having significant impact to the LNG industry process chain

Key words: Risk analysis, LNG process chain,.

1. INTRODUCTION

Indonesia is the fourth largest country in the world with a big amount of oil consumption level. Indonesia was previously acknowledged as an oil producer country and registered as an OPEC member. However Indonesia now switched into oil importer to fulfill its domestic requirement. In 2011, Indonesia fuel oil consumption had reached 1 millions barrels per day [Indonesia Ministry of Energy and Mineral Resources, 2011] while Indonesia oil production rate in Indonesia only 329 million barrels per year. The oil reserves in Indonesia will only be able to cover its upcoming oil demand for approximately 23 years.

On the other hand Indonesia has big natural gas reserves potential and is ranked at 15th in the world's largest natural gas reserves with the approximate volume around 152.89 trillion square cubic feet (TSCF) [Indonesia Ministry of Energy and Mineral Resources, 2012].

Delivery of natural gas in the form of LNG will have significant role in fulfilling natural gas demand in the future. In order to cover domestic natural gas demand in 2030, Indonesia has to build several LNG regasification terminals with the capacity equals to 4,500 mmscfd [Indonesia Ministry of Energy and Mineral Resources, 2010]. As the consequence of the increase of LNG demand, LNG industry will be growing

significantly. LNG industry consists of a process chain which started from exploration and production of natural gas, continued to the liquefaction process of natural gas into LNG and ended by delivering LNG to the LNG users [Dobrota, D., Lalic, B., & Komar, I, 2013]. There are some risks at each stage in the LNG industry process chain. The unmanaged risks could bring the objective of LNG industry process chain, produce and deliver LNG in accordance with the relevant safety regulation and agreed delivery schedule, become unable to be achieved. Risk analysis shall be implemented to minimise possibility of risk occurrence and reduce potential damage caused by a risk. By conducting risk analysis, any potential risk can be identified in advance and mitigation plan to control the risk can be prepared.

2. THEORETICAL BACKGROUND

2.1. Natural Gas and LNG

Natural gas is a fossil based energy in the form of gas located many miles under the surface. The main composition of natural gas is methane. Natural gas has been utilised as the resources for power generation, transportation and households. Natural gas has lower emission level rather than oil and coal. Dangerous substances contained in natural gas, such as Sulphur

and Mercury, are also the lowest compared to other fossil based energy.

LNG is defined as the liquid form of natural gas that being freezed in a temperature equals to -256oF atau -161oC at atmospheric condition. The first LNG plant was build in United States in 1912 and commenced its operation 5 years later. LNG was initially exported from Algeria to England. The success of LNG delivery between two countries became a milestone for any LNG industry in the world. As of 2014, there are 26 LNG plants operated in 15 Countries and 60 regasification terminals operated in 18 Countries. EIA stated new 65 LNG plant projects and new 181 Regasification terminals are currently being constructed all over the world. While in Indonesia, 3 LNG plants are being operated such as Bontang LNG Plant (East Kalimantan), Arun LNG Plant (Aceh) and Tangguh LNG Plant (West Papua). There are 2 other LNG plants being constructed such as Donggi Senoro LNG Plant (Central Sulawesi) and. Masela LNG Plant (Arafura Ocean).

2.2. LNG Industry Process Chain

The LNG industry process chain is consisted of the following main stages [Dobrota, D., Lalic, B., & Komar, I, 2013]:

1. Extraction and Production In this stage, drilling activity shall be conducted to lift natural gas from its reservoir. Once arrive at the surface, natural gas shall be cleaned from any unused particles and flow it to the liquefaction facilities through gas transmission pipeline.
2. Liquefaction
The liquefaction process is conducted at the LNG processing plant and objected to ensure natural gases experiencing condensation and refrigeration to become LNG. Liquefaction facilities also completed with several equipments and freezer, turbin generator, gas compressor and etc.
3. LNG Storage and Transportation
LNG produced shall be stored in the customised tank before transferred to the LNG carrier ship through a facility called the Loading Arm. During the voyage from LNG processing plant to the

regasification terminal, the tanks on the ship will be adjusted as the LNG temperature in order to minimise LNG vapourisation due to the natural heat.

4. Regasification and Distribution

LNG ship that has been arrived at Buyer's terminal shall be transferred to the storage tank before processed back into its gas form which called regasification process. Afterward, natural gases will be distributed to the end user such as electric company

2.3. Supply Chain Risk Management

Supply chain is the network between facilities and choices of distribution channel that showing the function of procuring raw material, manufacturing process into finished products and distribution to end user [Ganeshan, R., Harrison, T.P, 1997]. The supply chain also defined as a network of several independent organizations that connected between each other and mutually cooperated in controlling, managing and improving the flow of material and information until they reach the end user. Activity and process within the supply chain shall be started by the demand from user and ended when such demand has been fulfilled.

The risk will be attached to all phases in the supply chain. Supply chain risk is the complex phenomena that can be divided two categories, source and type [Svensson, Goran, 2002]. In the context of supply chain, risk is the distribution of working result, showed in the form losses, probability, time of occurrence, losses period, time required to detect the event and the frequency of such event [Manuj, I. & Mentzer, J.,T, 2003]. Supply chain risk can be triggerred from both external and internal. Internal risk is any risk factor that sourced from the organization itself while external risk is any risk factor that sourced from the outside of organization. [Christopher, M., & Peck, H, 2004] explained that the source of risk in a supply chain shall be divided into 4 categories, namely supply risk, process & control risk, demand risk and environmental risk. The interconnection amongst sources of supply chain risk is shown in figure 1 below.

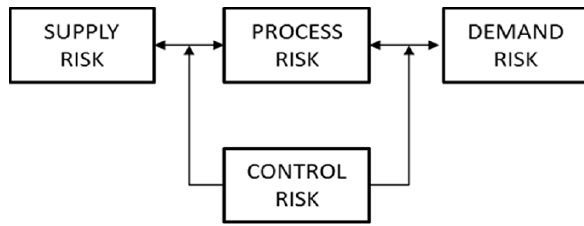


Figure 1. Sources of Supply Chain Risk

Supply chain risk management is a sequence of activities which involving analysis, evaluation and control in order to reduce any impact that can be caused by the risk. Contingency plan shall be developed to manage any possible response to handle the risk. Identification, assessment, controlling and monitoring are the main principles within the risk management process. The process of risk management is described in figure 2.

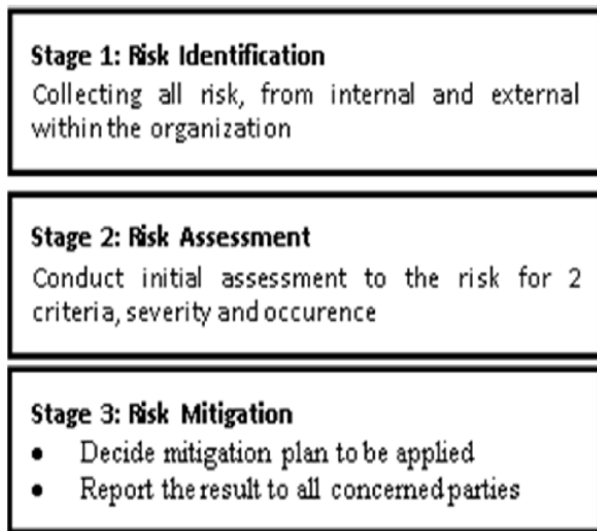


Figure 2. Risk Management Process

The objective for analysing a risk is to bring assistance in reducing the current risk occurrence and anticipate any possibility of risk occurrence in the future in which the decision maker within the organization undertakes all necessary action. The supply chain can actually be managed in much the same way as product and process defects.

3. RESEARCH METHOD

In accordance with the objective of this research, the methodology steps implemented in this research are as follow:

- The first step is data collection to identify any potential risk that might occurs in the LNG industry process chain.
- The second step is conduct calculation and analysis on the assessed data referring to any potential risk.

4. RESULT AND DISCUSSION

LNG industry studied in this research is constructed in Indonesia and was planned to start its operation mode by the end of 2014. The natural gases that will be processed into LNG were originated from 3 gas wellheads and flowed into the LNG Plant by using gas pipeline with length about 20 kilometers. The LNG plant can produce LNG up to 2 million tonnes per year and the produced LNG will be delivered to several electric companies in Japan and South Korea using LNG ship carried. The investment cost required to build both upstream facilities and LNG plant is estimated around USD 2.5 billion. Based on the data collection, there were four risk categories and thirty risk factors that potentially occurred in the LNG industry as detailed in table 1.

Table 1. Risk Category and Risk Factor

Supply Risk
Uncertainty in daily natural gas production (X1)
Uncertainty in gas specifications (X2)
Uncertainty in natural gas reserves (X3)
Operations Risk
Interruption on the gas production facilities (X4)
Damage on gas metering system (X5)
Damage on gas purification facility (X6)
Damage on gas turbin generator (X7)
Gas pipeline leakage (X8)
LNG pipeline leakage (X9)
Corrosion on pump and valve (X10)
Damage on Heat Exchanger (X11)
Damage on Scrub Column (X12)
Crack on the LNG storage tank (X13)
Collapse on LNG storage tank (X14)
Damage on Loading Arm (X15)
Damage on LNG jetty terminal (X16)

Table 1. Risk Category and Risk Factor

LNG ship sink during voyage (X17)
LNG ship getting collision during voyage (X18)
IT system interruption (X19)
Demand Risk
Uncertainty of global economic situation (X20)
Finding of new energy resource (X21)
LNG demand fluctuation (X22)
Environmental Risk
Tsunami (X23)
Earthquake (X24)
Terorism (X25)
Social conflict (X26)
Hurricane (X27)
Political instability (X28)
Government regulation changes (X29)
Currency changes (X30)

5. CONCLUSION

The LNG industry process chain has certain risks originated from both internal and external that have to be managed carefully in order that LNG demands can be fulfilled in safely and timely manner. Based on this research, below findings were concluded

- LNG industry process chain is classified into 4 categories: supply risk, demand risk, operations risk and environmental risk.
- Operations risk has 7 risk factors which considered as critical.
- There are 30 risk factors that potentially having significant impact to the LNG industry process chain where 14 of them are classified as critical

6. REFERENCES

- (a) Christopher, M., & Peck, H. (2004) "Building the resilient supply chain". *International Journal of Logistics Management*, 15, 1-28.
- (b) Dobrota, D., Lalic, B., & Komar, I. (2013). "Problem of boil-off in LNG supply chain". *Transactions on Maritime Science*, 02, 91-100.

- (c) Ganeshan, R., Harrison, T.P. (1997) "Introduction to Supply Chain Management". Department of Management. Science and Information Systems, Penn State University.
- (d) Indonesia Ministry of Energy and Mineral Resources (2011) , Data and Information Centre.
- (e) Indonesia Ministry of Energy and Mineral Resources (2012) Directorate General of Oil and Gas,.
- (f) Indonesia Ministry of Energy and Mineral Resources (2010), Indonesia Energy Outlook,
- (g) Manuj, I. & Mentzer, J.,T. (2003) "Global supply chain risk management". *Journal of Business Logistics*, 29, 133–155.
- (h) Svensson, Goran (2002). "A Conceptual framework of vulnerability in firms inbound and outbound logistics flows". *International Journal of Physical Distribution and Logistic Management*, 32, 110-132.

AUTHOR BIOGRAPHIES

Rahmat Nurcahyo is a senior lecturer in Industrial Engineering Department, Faculty Engineering, Universitas Indonesia. He received her Master of Engineering Science from Univeristy of New South Wales, Australia and Dr from Universitas Indonesia. Her research interests are in the area of Production Planning & Control, Lean Manufacturing. Email address is <rahmat@eng.ui.ac.id>