



Faculty of Technology Management and Technopreneurship

**TECHNOLOGICAL RISK ASSESSMENT PROCESS FOR
TECHNOLOGICAL RISKS: PETROL AND DIESEL SUPPLY CHAIN
ACTIVITIES**

Choong Chien Khay

Master of Science in Technology Management

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**TECHNOLOGICAL RISK ASSESSMENT PROCESS FOR TECHNOLOGICAL
RISKS: PETROL AND DIESEL SUPPLY CHAIN ACTIVITIES**

CHOONG CHIEN KHAY

**A thesis submitted
in fulfillment of the requirements for the degree of Master of Science in Technology
Management**

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2019

DECLARATION

I declare that this thesis entitled “Technological Risk Assessment Process for Technological Risks: Petrol and Diesel Supply Chain Activities” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in the candidature of any other degree.

Signature :

Name : Choong Chien Khay

Date : 7th November 2019

APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Master of Science in Technology Management.

Signature :

Supervisor Name : Assoc. Prof. Dr. Mohd Syaiful Rizal Bin Abdul Hamid

Date : 7th November 2019

DEDICATION

To my beloved wife, mother and father; my family, supervisors, lecturers as well as my best friends Iqmal, Bun Jian, Franky, Heoyshin, Siew Yun, Hafiz, Jess, Azfar and Farahin.

Thank you for love, guidance, understanding and support.

ABSTRACT

The downstream supply chain activities of petroleum are conducting value added activities on crude oil. Each of the activities are in place to perform different function and involved different facility. In such high technological supply chain, risk assessment process is in place from top down to assess technological risks that embedded in each activity to minimize technological disaster incident, asset damage and losses of human life occur. The study of technological risk assessment process in supply chain is considerable as new and under-study kind of research. This is because, the existing risk assessment process are only in place to provide high level of guideline. The process to assess technological risks on each supply chain activities are still unknown. Therefore, it is time to establish a technological risk assessment process framework that provide technological risk assessment process and assess technological risks factors along crude oil supply chain activities. The research was based on interpretivism paradigms under an exploratory study. This research is focused on identifying the factors of technological risks that embedded on each activity and technological risk assessment process that can adopted by each similar high technological risk supply chain activity. By knowing the factor of technological risk and risk assessment process, root cause of technological risk can be identified and assessed. Therefore, this research gives a new vision on risk assessment process that can be used to assess technological risks. Single case study and in-depth literature review were employed as the research design approach. Two key data collection methods (qualitative methods) were used: Primary data from face-to-face interview with PETRONAS. Secondary data from official documents. Also, one methods of analysis were used, namely: Explanation building. The literature review on supply chain, supply chain risks, technological risks and risk assessment identifies the need of understanding the results of technological risk assessment process on supply chain activity, technological risk categorize and the risk assessment process. Review on the previous study allows the researcher to establish the theoretical framework. The case study analysis led to the identification on the real practices of high technological risk industry that embedded technological risk across the supply chain activity. Thus, the researcher gained the information on technological risk assessment process and also the technological risk factors that embedded on each activity. As a result, this study identified four technological risk factors on each supply chain activities and technological risk assessment process for each activity from case study. In turn, this research further underlines and suggested the framework of technological risk assessment process to assess technological risks across supply chain activities.

ABSTRAK

Aktiviti rantaian bekalan hiliran petroleum menjalankan aktiviti nilai tambah ke atas minyak mentah. Setiap aktiviti dalam hiliran petroleum mempunyai fungsi yang berbeza dan melibatkan kemudahan yang berbeza. Oleh itu, di rantaian bekalan teknologi tinggi seperti petroleum, proses penilaian risiko diperlukan untuk menilai risiko teknologi yang tertanam dalam setiap aktiviti supaya dapat meminimumkan kejadian bencana teknologi, kerosakan aset dan ancaman nyawa manusia. Kajian mengenai proses penilaian risiko teknologi dalam rantaian bekalan adalah penyelidikan yang baru dan belum diselidik dengan lanjut. Ini kerana, proses penilaian risiko yang sedia ada hanya disediakan untuk menyediakan garis panduan secara peringkat tinggi. Proses untuk menilai risiko teknologi pada setiap aktiviti rantaian bekalan masih belum diketahui. Oleh itu, sudah tiba masanya untuk mewujudkan rangka kerja proses penilaian risiko teknologi yang menyediakan proses penilaian risiko teknologi dan menilai faktor-faktor risiko teknologi yang tertanam di aktiviti rantaian bekalan minyak mentah. Kajian ini berdasarkan interpretivisme paradigma kajian berbentuk penerokaan. Kajian ini menumpukan kepada mengenal pasti faktor-faktor risiko teknologi yang tertanam pada setiap aktiviti dan proses penilaian risiko teknologi juga boleh diterima oleh rantaian bekalan yang mempunyai risiko teknologi yang sama. Dengan mengetahui faktor risiko dan proses penilaian risiko teknologi, punca risiko teknologi dapat dikenalpasti dan dinilai. Oleh itu, kajian ini memberikan visi baru mengenai proses penilaian risiko yang boleh digunakan untuk menilai risiko teknologi. Kajian kes berganda dan kajian literatur mendalam telah digunakan sebagai pendekatan reka bentuk penyelidikan. Dua kaedah pengumpulan data (kaedah kualitatif) telah digunakan: Data utama dari temu bual secara bersemuka dengan PETRONAS. Data sekunder dari dokumen rasmi. Selain itu, satu kaedah analisis telah digunakan, iaitu: Pembinaan Penjelasan. Kajian literatur tentang rantaian bekalan, risiko rantaian bekalan, risiko teknologi dan penilaian risiko mengenal pasti keperluan memahami proses penilaian risiko teknologi pada rantai bekalan, mengkategorikan risiko teknologi dan proses penilaian risiko. Justeru, hasil kajian dari kajian sebelumnya membolehkan penyelidik untuk membentuk rangka kerja teori. Kajian ini, ditambah pula dengan analisis kajian kes yang membawa kepada pengenalan kepada amalan sebenar industri berisiko teknologi tinggi yang merangkumi risiko teknologi di aktiviti rantaian bekalan. Oleh itu, penyelidik memperoleh maklumat tentang proses penilaian risiko teknologi dan juga faktor risiko teknologi yang berada pada setiap aktiviti. Hasilnya, kajian ini telah mengenal pasti empat faktor risiko teknologi pada setiap aktiviti rantaian bekalan dan proses penilaian risiko teknologi bagi setiap aktiviti dari kajian kes. Seterusnya, kajian ini menggariskan dan mencadangkan rangka kerja proses penilaian risiko teknologi untuk menilai risiko teknologi di aktiviti rantaian bekalan.

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TABLE OF CONTENTS

	PAGE
DECLARATION	
APPROVAL	
DEDICATION	
ABSTRACT	i
ABSTRAK	ii
ACKNOWLEDGEMENTS	iii
TABLE OF CONTENTS	iv
LIST OF TABLES	viii
LIST OF FIGURES	x
LIST OF ABBREVIATIONS	xi
LIST OF PUBLICATIONS	xii
 CHAPTER	
1. INTRODUCTION	1
1.1 Introduction	1
1.2 Background to the research	1
1.3 Point of departure of the research	2
1.4 Problem statement	3
1.5 Organization background	4
1.6 Research questions and objectives	6
1.7 Scope of the research	8
1.8 Significance of the study	9
1.9 Thesis organization	9
 2. LITERATURE REVIEW	12
2.1 Introduction	12
2.2 Supply chain management	12
2.2.1 Petroleum downstream supply chain	13
2.2.1.1 Malaysia petroleum downstream supply chain	14
2.3 Supply chain risks management	15
2.4 Supply chain risk factors and risk categorization	17
2.5 Technology risks	24
2.5.1 Technological risk-driving force	25
2.6 Risk management and risk assessment	27
2.6.1 Risk identification	29
2.6.2 Risk analysis	32
2.6.3 Risk evaluation	34
2.7 Theoretical framework	35
2.8 Summary	37
 3. RESEARCH METHODOLOGY	38
3.1 Introduction	38
3.2 Philosophy framework	38
3.2.1 Ontology	39
3.2.2 Epistemology	39
3.2.3 Research paradigms	39

3.2.4	Justification for interpretivism paradigms	41
3.3	Research approach	42
3.3.1	Deductive reasoning approach justification	44
3.4	Research design	44
3.4.1	Exploratory research design justification	46
3.5	Research methodologies	47
3.5.1	Qualitative research justification	48
3.6	Systematic literature review procedures	49
3.7	Research strategy	49
3.7.1	Case study research strategy justification	50
3.7.2	Sampling method and strategy	52
3.7.3	Company selection justification	53
3.8	Qualitative data collection	55
3.9	Case study protocol	57
3.9.1	Introduction to the case study and purpose of protocol	57
3.9.2	Data collection procedures	58
3.9.2.1	Semi structured interviews	58
3.9.2.2	Document analysis	58
3.9.3	Outline of case study report	58
3.9.4	Approaching the respondent for interview purposes	59
3.9.5	Case study questions	60
3.10	Research data analysis	64
3.11	Quality research establishment	65
3.11.1	Construct validity and internal validity	66
3.11.2	External validity	66
3.11.3	Reliability	67
3.12	Summary	67
4.	RESULT AND DISCUSSION	69
4.1	Case study background	69
4.1.1	PETRONAS	69
4.1.1.1	PETRONAS Penapisan (Melaka) Sdn Bhd	70
4.1.1.2	PETRONAS Dagangan Berhad (PDB)	71
4.1.1.3	Shaziman Transport Sdn Bhd (STSB)	71
4.1.2	Respondent details	71
4.2	Technological risks assessment process of petrol and diesel supply chain activities	74
4.2.1	Technology risk assessment process on the procurement	76
4.2.1.1	Technology risk identification on procurement	77
4.2.1.2	Technological risk analysis on procurement	78
4.2.1.3	Technological risk evaluation on procurement	80
4.2.2	Technology risk assessment process on the operation	81
4.2.2.1	Technological risk identification on the operation	82
4.2.2.2	Technological risk analysis on operation	85
4.2.2.3	Technological risk evaluation on the operation	87
4.2.3	Technology risk assessment on the distribution	87
4.2.3.1	Technology risk identification on the distribution	88
4.2.3.2	Technology risk analysis on the distribution	90
4.2.3.3	Risk evaluation on the distribution	90

4.2.4	Technological risk assessment process on procurement, operation, and distribution	91
4.3	Identify technological risk factors of petrol and diesel supply chain activity	96
4.3.1	Technical design factor	98
4.3.1.1	Technical design factor on the procurement	98
4.3.1.2	Technical design factor on the operation	99
4.3.1.3	Technical design factor on the distribution	100
4.3.2	Human factors	101
4.3.2.1	Human factors on the procurement	101
4.3.2.2	Human factors on the operation	102
4.3.2.3	Human factors on the distribution	103
4.3.3	Organization system factors	104
4.3.3.1	Organization system factor on the procurement	104
4.3.3.2	Organization system factor on the operation	105
4.3.3.3	Organization system factor on the distribution	106
4.3.4	Social-cultural factors	106
4.3.4.1	Social-cultural factors on the procurement	107
4.3.4.2	Social-cultural factors on the operation	107
4.3.4.3	Social-cultural factors on the distribution	108
4.3.5	Overall technological risk factor on procurement, operation, and distribution	108
4.4	Summary	113
5.	CONCLUSION AND RECOMMENDATION	114
5.1	Introduction	114
5.2	Discussion	115
5.3	Major findings in answering research questions	116
5.3.1	Research question 1: how PETRONAS assesses technological risks on petrol and diesel supply chain activities?	116
5.3.2	Research question 2: what are the technological risk factors that embedded on PETRONAS petrol and diesel supply chain activities?	120
5.3.3	Research question 3: what are the technological risks assessment framework for petrol and diesel supply chain activities?	123
5.4	Quality of research	125
5.4.1	Reliability	126
5.4.2	Validity	126
5.4.3	Construct validity	126
5.4.4	Internal validity	127
5.4.5	External validity	128
5.5	The contribution of research	129
5.6	Limitation of the research	129
5.6.1	Methodological limitations	130
5.6.2	Resources limitations	130
5.7	Recommendations for future research	131
5.8	Personal reflection	131

LIST OF TABLES

TABLE	TITLE	PAGE
1.1	Revenue and contribution of PETRONAS from 2011 to 2015 (PETRONAS annual report 2015)	5
2.1	Definition of supply chain risks	15
2.2	Supply chain risks category from several authors	17
2.3	Technological risk driving force and risk event	25
2.4	Method of identifying risk (Borghesi and Gaudenzi, 2013)	30
2.5	Techniques of risk analysis (Marhavilas and Koulouriotis, 2012)	33
3.1	Objectivism and subjectivism (Saunders et al., 2016)	40
3.2	Deduction and induction (Saunders et al., (2016)	43
3.3	Type of research design (Saunders et al., 2016)	45
3.4	Relevant situation for different research strategy (Yin, 2009)	50
3.5	Qualitative data collection type	55
3.6	Interview protocol form for PETRONAS supply chain activities	61
3.7	Four common test (L. Kidder and Judd, 1986; Yin 2014)	65
4.1	Respondent details	72
4.2	Technology risk assessment process availability in petrol and diesel supply chain activities	92

4.3	Technological risk assessment in petrol and diesel supply chain activities	92
4.4	Technological risk factor and risk event on supply chain activities	109

LIST OF FIGURES

FIGURE	TITLE	PAGE
1.1	Scope of the study	8
1.2	Structure of the thesis	11
2.1	Supply chain flow (Christopher, 2011)	13
2.2	Petroleum industry structure (Hilyard and Joseph, 2012)	13
2.3	Crude oil product consumption volume of Malaysia (2013-2014)	14
2.4	ISO risk assessment process	28
2.5	AS/NZS risk assessment process	29
2.6	Theoretical framework for this study	37
3.1	Letter of consent to the research interview participants	61
4.1	Petrol and diesel operation	70
5.1	Technological risk assessment framework	125

LIST OF ABBREVIATIONS

FRGS	-	Fundamental Research Grant Scheme
HSE	-	Health, Safety and Environment
ISO	-	International Organisation for Standardisation
LNG	-	Liquefied Natural Gas
OHSAS	-	Occupational Health and Safety Management Systems
PETRONAS	-	Petroleum Nasional Berhad
SCRM	-	Supply Chain Risk Management

LIST OF PUBLICATIONS

1. Choong, C. K., Hamid, S. R., and Chew, B. C., 2017. Technological Disaster Prevention: Technological Risk Assessment Process on High Technological Supply Chain Activities. *Journal of Advanced Manufacturing Technology (JAMT)*, 12(1), pp. 285-300.
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CHAPTER 1

INTRODUCTION

1.1 Introduction

High technology industry is embedded with technological risk and when such risk occurred it may cause delay or disrupt on the supply chain operation. Hence, besides supply chain risks, technological risks that embedded in each high technological supply chain activities are also important focus areas that needed to be aware by high technological risk organization. Risk recognition and risk rating form the risk assessment component to recognize risks and serve as the main input for risk stakeholder before determine treatment strategy. Comprehensive assessing process allowed the risk stakeholder to recognize the technological risks factors that embedded on each activity. Hence, this research aimed to identify the technological risk factors that embedded on high technology supply chain activities and also the technological risks assessment process for high technology supply chain activities. This chapter begins with the background of the research, the point of departure of the research, problem definition, research ideas and motivation of research, organization background, research questions and objective, the scope of the research, the importance of the study then lead to the summary.

1.2 Background to the research

The researcher has accumulated strong interest in the area of supply chain since enrolled with the subject of supply chain management, experienced internship in purchasing department and also constructed previous research on the green supply chain

management as final year project while pursuing the bachelor of degree. The knowledge of technological risk has been obtained by the researcher through attached himself as research assistant under the Fundamental Research Grant Scheme (FRGS) that related with technology disaster. Hence, with previous research interest and involvement on FRGS project. The researcher raised the ideas of integrate supply chain and technological risks.

1.3 Point of departure of the research

Global competition, technological change and the continuous search for competitive advantage motives organizations focus on risk management for supply chain. Manager is becoming aware that their company reputation, earnings consistency and ability to deliver better shareholder return are increasingly dependent on how well they manage supply chain disruptions (Kevin and Vinod, 2012). Previous studies concluded supply chain face disruptions risks and supply chain operational risks, whereby Sodhi and Tang, (2012) emphasize disruption to material flows anywhere in the supply chain are unpredictable and rare, but often quite damaging. What causes supply chain disruptions? Manmohan and Cristopher, (2012) states various natural and man-made disasters have caused major supply chain disruptions over the last two decades. Hence, the capability on managing supply chain disruption risks becomes one of the important areas to focus in order to sustain the organization supply chain and the organization reputation. However, not all man-made disruption risks in supply chain come in sudden and out of the organization control.

In additions, since the industrial revolution, we have created a cornucopia of technological systems. Sometimes these systems malfunction, and result in technological disasters (Ostrom and Wihelmsen, 2012). A technological disaster is one that brings on a major crisis, threatens the viability of a technological system, causes massive losses of life

and property, and may endanger the social environment in which it occurs. Evan and Manion, (2006) also explain technological disasters are glaring symbols of our limited capacity to control the technology that human beings create. They confound our expectations about the safety of technology and our social institutions abilities to manage technological risks. Chiles, (2002) gives examples such as computer networks are not supposed to crash; chemical production plants are not supposed to leak; airplanes are not supposed to crash, and nuclear power plants are not supposed to melt down. Hence, when they do, they confound their designers, operators, and owners who are usually unprepared to deal with such malfunctions.

According to Kildow, (2011) technological risk are one of the threats that can interfere with the supply chain operations, and they are threats to the entire enterprise as well. In more precise, minor technology failure on supply chain activities may impact in terms of performance, but major technology failure may cause massive losses of life, property or even endanger the social environment.

1.4 Problem statement

According to Wise Global Training, (2015) in the oil and gas industry there are inherent risks at the stage of refining and also final delivery of the product. Risk assessment process is a systematic, and step by step approach for the risk stakeholder to evaluation the risk that embedded (Ostrom and Wilhelmsen, 2012). The goal of risk assessment is to identify and evaluate each of the identified risk along the petroleum supply chain. As the petroleum industry are inherent with risks, there is a responsibility within the industry to identify and evaluate risks that embedded on each activity.

The major phases of downstream petroleum industry involved crude oil refinery and transportation of petroleum. Each of the activities are depending technology to perform

value added activity. According to Kildow, (2011) technological risk are one of the threats that can interfere with the supply chain operations, and they are threats to the entire enterprise as well. In more precise, minor technology failure on supply chain activities may impact in terms of performance, but major technology failure may cause massive losses of life, property or even endanger the social environment.

Knowledgeable on the operation and technological risk can make positive contribution to assess technological risk. Hence, regardless top management that managing overall supply chain activity or risk shareholder that managing operation activity. The technological risk assessment process of each activity and identify technological risk factors that may causes negative impact to the operation activity must be well known. Overall phenomena of the downstream supply chain activity, technological risks are yet addressed from the aspect of supply chain activities although it may cause disruption impact on high technological supply chain. Although most of the Malaysian manufacturing industry has built its risk management practices through the implementation of standardization such as ISO 31000:2009 and OHSAS 18000, but the best practices only capable to provides overall guideline for establish fundamental risk management.

Hence, existing risk management theory are yet compatible to assess technological risk on the petroleum supply chain until the gap of “how” and “what” has been filled up.

1.5 Organization background

In order to fill up the mentioned gap, high technological risk organization that focus on risk management practices and achieved high reputation on safety within the supply chain activities are the main criteria to be selected as the organization to study for this research. The commitment of Petroliam Nasional Berhad (PETRONAS) as committee on Malaysia Standard ISO 31000:2010 document, size of the organization and outstanding

achievement on Health, Safety and Environment (HSE) convinced the researcher to select PETRONAS as the study subject for this research.

The national oil company PETRONAS, was created in 1974. PETRONAS is Malaysia's fully integrated oil and gas multinational wholly-owned by the Malaysian Government. PETRONAS is now ranked amongst the largest companies in the world with a proven track record in integrated oil and gas operations spanning the entire hydrocarbon value chain. In terms of financial performance, PERONAS has generated more than RM 200 billion revenues annually and has contributed more than RM50 billion annually to the state and federal government through several of components. Table 1.1 below shows the annual contribution and revenue of PETRONAS.

Table 1.1: Revenue and contribution of PETRONAS from 2011 to 2015 (PETRONAS annual report 2015)

	Years				
	2011	2012	2013	2014	2015
	RM Billion				
Revenue	222.8	288.5	291.2	317.3	247.7
Components of Contribution	RM Billion				
Export Duty	1.1	1.2	1.1	1.2	0.6
Cash Payment	5.4	12.5	12.0	12.6	10.2
Taxes	21.9	38.3	33.3	32.5	15.9
Dividend	30.0	28.0	27.0	29.0	26
Total Contribution	58.4	80.0	73.4	75.3	52.7

PETRONAS upstream business encompasses exploration, development & Production, LNG Trading & Marketing, LNG Assets and Malaysia Petroleum Management. It is a fully integrated business covering a broad portfolio of resources and play types in more than 20 countries. As the custodian of Malaysia's petroleum resources, PETRONAS is focused to pursue sustainable value-driven production growth, monetize gas resources, strengthen core capabilities and build niche competencies. Proven capability and track record of successful onshore and offshore developments in oil and gas have earned PETRONAS reputable operatorship in many ventures across the world.

1.6 Research questions and objectives

If risks are to be assessed, the sources of risk must first be identified. Risk identification is defined as the process of finding, recognizing, and recording risks. Its purpose is to identify what might happen and/or the situations that could impact the system or organization (Bruce and Bruce, 2016).

In petroleum supply chain activities, technology is in place to perform refine and distribute the highly flammable hydrocarbon. Failure of technology on such high-risk supply chain not only may lead to technology breakdown but also may cause failure on controlling highly hazard hydrocarbon. According to Kildow, (2011) technological risk are one of the threats that can interfere with the supply chain operations, and they are threats to the entire enterprise as well.

In order to minimized technological risk, the sources of technological risk within petroleum supply chain activities need be identified and Wise Global Training, (2015) states that oil and gas industry has conducted risk assessments to ensure that risk control measures are put in place to prevent the realization of hazards to maintain a safe working environment. However, Malaysian manufacturing industry has built its risk management

practices through the implementation of standardization such as ISO 31000:2009 and OHSAS 18000, but the best practices only capable to provides overall guideline for establish fundamental risk management.

Hence to minimize technological risk, technological risk assessment process and sources of technological risk that embedded on such important and yet high technology risk supply chain are needed to be identified. The research then investigated the research questions as follows:

- I. How PETRONAS assesses technological risks on petrol and diesel supply chain activities?
- II. What are the technological risk factors that embedded on PETRONAS petrol and diesel supply chain activities?
- III. What are the technological risk assessment framework for petrol and diesel supply chain activities?

Consequently, thorough study on PETRONAS downstream supply chain it also led to achieve the research objectives as follows:

- I. To identify the technological risk assessment process of PETRONAS on petrol and diesel supply chain activities.
- II. To identify the technological risks factor that underlay on PETRONAS petrol and diesel supply chain activities.
- III. To propose new technological risk assessment framework for petrol and diesel supply chain activities.