TECHNOLOGICAL DISASTER PREVENTION: TECHNOLOGICAL RISKS ASSESSMENT PROCESS ON HIGH TECHNOLOGICAL RISK SUPPLY CHAIN ACTIVITIES

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ABSTRACT: Technological risks approach silently and yet deadly. Once overlooked, technological disaster incident may occur- asset damage or even losses of human life. Negative impact of technological disaster may lead to organization supply chain toward disruption as organization facilities and labor force been impacted. Based on the circumstances, it is time to establish a technological risk assessment process to identify and assess technological risks along high technological supply chain activities. One of the largest petroleum organizations "Organization P" has been selected to investigate how the company assesses technological risks on supply chain activities and the technological risk factors that contain in each supply chain activities. A series of interview was conducted to collect respondent's answer, while collected data were analyzed qualitatively. As conclusion, organization P obtained great achievement on technological disaster prevention as risk assessment process been enforces to assess risks on each supply chain activities. The technological risk assessment process contributes on preventing supply chain disruption while the identified technological risks demonstrated the high technological risk supply chain which contains double types of risks.

KEYWORDS: *Technological Disaster; Technological Risks; Supply Chain Disruption; Technological Risk Assessment Process*

1.0 INTRODUCTION

Managers are becoming aware of their company reputation, earnings consistency and ability to deliver better shareholder return, which are

increasingly dependent on how well they manage supply chain disruptions [1]. Natural and man-made disasters have caused major supply chain disruptions over the last two decades [2]. However, not all man-made disruptions risks occurred suddenly and out of the organization control. Since the Industrial Revolution, a cornucopia of technological systems has been created. Sometimes, these systems malfunction and result in technological disasters [3]. A technological disaster is the 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. Technological are one of the threats that can interfere with the supply chain operations and they are threats to the entire enterprise as well [4].

1.1 Problem Definition

Current supply chain risk management is still in infancy stage, and clearly there is also no agreement on what components and definitions constitute a "standard" supply chain risk management process yet. There is a shortage of empirical research in the area of SCRM and this shortage is especially critical in addressing the question of current practice. On the other sides, although the Malaysian manufacturing industry has built its risk management practices through the implementation of standardisation such as ISO 31000:2009 and OHSAS 18000, the best practices are only capable to provide overall guideline for establishing fundamental risk management. The OHSAS 18000 standard is also only intended to address occupational health and safety, but not intended to address other health and safety areas, such as property damage or environmental impacts. Most of the risk management criteria are emphasized on the insurance and safety management issues, best practices, as recommended by the ISO 31000:2009 and OHSAS 18000.

Such phenomena address, technological risks has not been addressed from the aspect of supply chain activities although it may leads to supply chain disruption. Meanwhile, SCRM and risk management theory are also yet to compatible for assessing nor managing technological risk on the high technology supply chain until the gap of "how" and "what" has been filled up. Hence, the research investigated the research questions as follows:

i. How does organization P assesses technological risks on motor petrol and diesel supply chain activities?
ii. What are the technological risks factors that underlay on organization P motor petrol and diesel supply chain activities?

Consequently, thorough study on organization P supply chain activities also led to achieve the research objectives as follows:

i. To investigate the technological risk assessment process of organization P on motor petrol and diesel supply chain activities.
ii. To identify technological risks factors that underlay on organization P motor petrol and diesel supply chain activities.

1.2 Literature Review

Supply chain is a network of entities such as manufacturer, suppliers and distributors working together to transform goods from raw material to final product while moving them to the end customer [5-6]. In a broad sense, supply chain is consists of two or more legally separated organizations, being linked by material, finance and information flows [5]. Figure 1 shows a flow of material and the related information along organization supply chain activities.

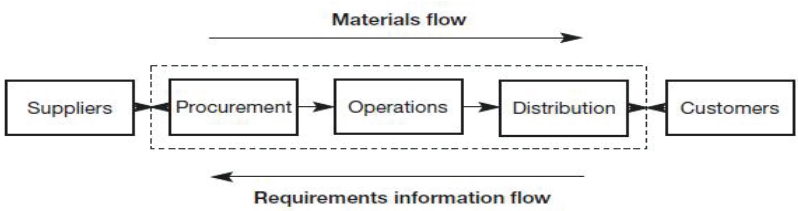

Figure 1: Supply chain flows [5]

Supply chain risk is the potential variation of outcomes that influence the decrease of value added at any activity cell in a chain, whereby the outcome is described by the volume and quality of goods at any location and time in a supply chain flow [6]. Study of several types of supply chain risks can cause different degree of impact on supply chain [6]. Delay is defined as small and somewhat expected fluctuations of matching supply to demand; while disruption are huge and unexpected mismatch of supply to demand due to a big failure with either the supply or the demand collapsing.

In general, supply chain risks can be raised from several channels and also supply chain activities. Reviews on the identified supply chain risk factor from previous studies not only provide clearer view on the current identified supply chain risk event, but also provide a brighter view on how each supply chain risks event been categorized accordingly.

Table 1: Supply Chain Risk Factors [6, 7, 9-13]

Factors, Description and Risks Event
Supply Risk Originates from the upstream member enterprises, including potential or actual disturbance in the flow of raw materials, components, and information in supply chains. i. Supplier failure ii. Supply Commitment iii. Supply Cost
Process Risk Process risk is defined as disturbances in production and management activities within enterprises. i. Faulty Design ii. Yield uncertain iii. Inventory iv. Capacity
Demand Risk Demand risk is defined as a potential disturbance in capital flow, information flow and logistics in downstream enterprises in supply chains. i. Errors in demand prediction ii. Increase changeability in sequential arrangement iii. Excessive response to orders iv. Excessive cut in inventory v. Lack of communication and collaboration between upstream and downstream. vi. Delay in information flow and logistics
Control Risk The control refers to the design rule, system and procedure that guide and control the process of manufacturing and management. i. Uncertainty of order quantity ii. Design of the batch sizes iii. Setting of safe inventory

Environmental Risk
Environmental risks are extrinsic and the majority of these risks is uncontrollable and difficult to predict the factor that contribute to environmental risks can be political environment, economic events and natural disasters. i. Changes in Political Environment ii. Changes in Economic Event iii. Natural Disaster iv. Disruption in Customs and Harbors v. Paralysis of Traffic System vi. Fire and Terror Attacks

However, supply chain risk can be also conducted through technology [10]. To be more precise, minor technology failure occurs in supply chain activities may affect in terms of performance on value added activities, while major technology failure occurs may cause massive losses of life, property or even endanger the social environment. Technological risk arises when some technical artefacts are deployed in a situation where its operation can result in adverse consequences [14-15]. Technological risk driving forces are as table below:

Table 2: Technological Risk Factors [14-16]

Technological Risk Driving Factors, Description and risks event
Technical Design The technical design factor occurs when the design engineers are constantly working under constraints such as limited date on the properties and reliabilities of the various materials they use. i. Faulty design ii. Defective equipment iii. Contaminated or defective materials iv. Contaminated or defective supplies v. Faulty testing procedures
Human Factors Human-factors deals with various cognitive, perceptual, and workplace design problems specific to technological systems operated by human begins, especially in the ever-increasing complexities of human-machine interfaces. i. Human-machine mismatches ii. Operator error iii. Perceptual constraints iv. Fatigue or stress v. Ignorance, hubris, or folly

Organization System The organization context in which technological system operate add to their complexity and susceptibility to failure i. Communication failures ii. Faulty group decision making iii. Policy Failures iv. Cost pressures curtailing attention to safety
Social-Culture The social- cultural factors combine sociological and anthropological concepts of social structure and culture. i. Cultural values and norms ii. Institutional mechanisms iii. Regulatory iv. Educational system

In overall, the literature of technological risks demonstrated the four driving factors that lead to technological disaster. In order to prevent technological disaster on supply chain activities, the researcher has illustrated the overview of risk management and then looks into the available risk assessment process. All activities of an organization involve risks [17] and risk cannot be eliminated, hence organizations need to manage all the factors that increase and reduce those risks [18]. Risk management is a continuous management process with the objective to identify, analyse, and assess potential hazards in a system or related to an activity, and to identify and introduce risk control measures to eliminate or reduce potential harms to people, the environment or other assets [19]. Figure 2 shows the risk assessment process that has been proposed by MS ISO: 31000.

Figure 2: Risk assessment process

Firstly, risk identification identifies sources of risk, areas of impacts, events (including changes in circumstances) causes and potential consequences to generate a comprehensive list of risks based on those events that might create, enhance, prevent, degrade, accelerate or

delay the achievement of objectives. Secondly risk analysis involves developing an understanding of the risk which consideration of the causes and sources of risk. Thirdly risk evaluation is to assist in making decisions, based on the outcomes of risk analysis, about which risks need treatment and the priority for treatment implementation.

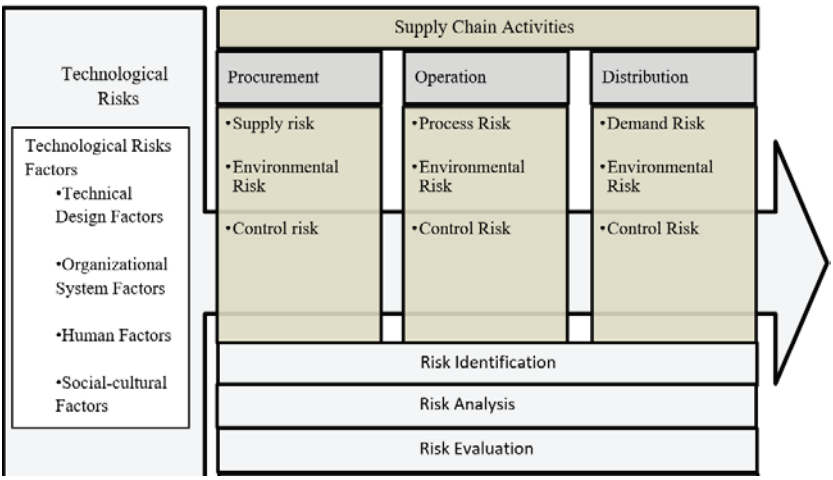

Figure 3: Theoretical framework

2.0 METHODOLOGY

The research is an exploratory study because it is conducted to discover the real facts and to study in depth about a particular topic of interest (technological risk on supply chain activities). Whereby qualitative case study method has been adopted in order to provide a systematic means to examine the real-life contexts, as this research aimed to discover the risk assessment process and technological risks that occur on high technology supply chain activities.

The research has adopted four data collection methods to achieve the purpose of triangulation. Primary data is collected from face to face research interview, while secondary data is collected from journal articles, magazines, annual report, organization company's official websites and online news, and document review. High technological risk organization "P" that focuses on risk management practices and achieved high reputation on safety within the supply chain activities has been selected as the organization to study for this research. In term of size, organization "P" has the biggest petroleum refinery

operation in Malaysia which able to refine 170,000 barrels of crude oil per day. It also had been awarded gold class by Malaysia Society for Occupational Safety and Health (MSOSH) Awards due to performing well in occupational safety and health aspects. Furthermore, organization "P" is also one of the technical committee on risk management under MS: ISO 31000.

After completing the data collection, explanation interpretation that dedicated to explaining how or why events came about, or alternatively how or why people were able to pursue particular courses of action [20] has been conducted in order to in line with the research. All the collected data will be arranged accordingly to build clear explanation on the technological disaster prevention on high technological supply chain.

3.0 RESULT AND DISCUSSION

3.1 The organization and Respondents Background

The qualitative case study is conducted through in-depth interview with total fifteen of executive, analyst, or leader that involved in Organization "P" downstream business. A petroleum (motor petrol and diesel) supply chain activity is made up of multiple businesses and plays the role in enhancing value to molecules. The diverse activities are such as crude oil refinery and the distribution of motor petrol and also diesel to petrol station. Table 3 shows the background of respondents that were qualified to be the subject for investigation.

Table 3: Background of respondents

No.	Respondent Position
1.	Head of Business Continuity, Group Risk Management
2.	Head of Group Risk Management
3.	Head of Procurement Planning
4.	Manager of Fleet Management, Supply and Distribution
5.	Manager of Refinery Procurement
6.	Manager of Product Sourcing and Planning, Supply and Distribution
7.	Senior Manager of Fleet Management
8.	General Manager of Fleet Management
9.	Refinery Blending Analyst
10.	Executive of Risk Management

11.	Custodian of Risk Management
12.	Light Distillate Planner
13.	Refinery Planner
14.	Black Product Analyst
15.	Executive from procurement

3.2 Technological Risk Assessment Process of Organization "P" Supply Chain Activities

The risk assessment process that proposed by MS: ISO 31000 demonstrates the general assessment that can be applied by most of the organization and supply chain activities. All of the respondents have given feedback for supply chain activities, are referring to risk assessment process that been proposed by ISO: 31000. However, eight respondents that involved on top management pointed out that each of the supply chain activities are performing different activities. Hence, each activity required to establish their own risk identification method and assessment measurement, in order to assess risk that may cause negative impact on the activities. On top of that, technological disaster is one of the risks that fall in the category of high impact risk within three supply chain activities.

Respondents that involved in procurement activity stated that each supplier will be carefully assessed by the procurement team before given license as qualified vendor. Only vendor that obtains the license will be allowed to submit a project or service tender. Assessment will be re-conduct again before and after a project or contract assigned to the qualified vendor. In overall, the assessment on supplier will be conducted two times in total. The first assessment is to ensure that supplier fulfilled the minimum requirement as qualified vendor or service provider for such high technological risks supply chain activities. Procurement team will conduct a background check through vendor submitted application document that contains details of vendor background, vendor qualification, technology technical capability and previous performance record. The second assessment will be conducted by procurement team, end user and related team such as Health Safety Environment (HSE) department to assess all tender's qualification and capabilities in details. Related team will identify technological risks through vendor submitted application document and the evident that contains details of vendor labor

qualification, labor skill and facility capability and previous performance record. Once the risks are identified through the application, certified personnel from each team will conduct the risk analysis and then risk evaluation will be conducted accordingly based on the risks matrix to determine the level of risks.

Meanwhile, the respondents from the refinery operation state that refinery operation relying on high technological facility to refine crude oil into motor petrol and diesel. The refinery process consists of crude blending, heater and crude oil distillation, catalytic reforming and motor petrol blending activities. Refinery operator, technology equipment and data of crude essay are in place to identify technological risks on such high technological facility. Risk assessment will be constructed before and during crude refinery operation. Before operation begins, planner will identify risk through crude essay to ensure the crude acidity level and the ratio of sulfur are suitable to feed in the refinery facility to prevent corrosive of the facility. Meanwhile operator will perform onsite inspection on the facilities in order to identify any leaking or abnormal condition on the facility. Besides onsite inspection, planner will also conduct simulation by using software such as Petro-SIM and Unit Optimizer to simulate the process before started the actual refinery operation. While the refinery process ongoing, the assessment will be conducted ongoing, as the control operator and technology facility that connected with heat sensor will be the channels to identify potential risks. All reported risks will be then used to perform future risk analysis and evaluation accordingly by the process safety management, Health Safety Environment (HSE) department and Tech Department.

Distribution of motor petrol and diesel to allocated petrol station are still relying on road tanker and truck driver. Respondents from distribution activities stated that the distribution activities are consist of motor petrol and diesel loading, delivery and offloading. Risk assessment will be performed before and during delivery on-going. Truck driver's feedback, public complaints, technology tools and on-site operator are the risk identification channel for distribution activities. Truck driver is required to perform pre-departure inspection on truck by using the pre-departure check list before

proceed with any delivery. On top of that, driver working hour's list will also be used to identify drivers that had performed delivery for more than nine hours per day. When delivery is ongoing, technology equipment such as global positioning system (GPS), on truck closed circuit television (CCTV), on truck computer and phone call from public complaints will be used to identify potential risks along the delivery journey. Moreover, driver is also required to report if any hazard is identified on loading site, offloading site and on road that will endanger the distribution, loading and offloading activities. All reported risks will be then used for future risk analysis and risk evaluation accordingly by the Health Safety Environment (HSE) department and fleet supervisor.

In overall, the researcher found out that even though the risks assessment process is similar, but each high technological risk supply chain activities is contains of different type of technological risk that may occur technological disaster. Hence different risk identification tools have been adopted by organization P in order to identify risks along the supply chain activities. Specifically risk identification techniques are designed to provide the organization with the capability to identify potential unfavorable events [17]. In addition, the researcher also found out that in such high technological supply chain actives, technology tools started to play a significant role as one of the risk identification tools.

Table 4: Technological risk factor and risk event on supply chain activities

	Procurement	Refinery Process	Distribution
Technical Design Factors	<u>Supplier Capability</u> Capability to provide complex service or high technology material supply i. Technology Capability ii. Engineering Capability iii. Completeness of Facility	<u>Refinery Facility</u> Faulty planning, testing and defective facility. i. Miss used high acidity and high corrosive crude oil as input. ii. Overloaded operation planning iii. Defective facility.	<u>Distribution Truck</u> -Faulty truck and defective equipment. i. Defective tires ii. Defective on safety signal iii. Defective on breaking system

Organization System Factors	Supplier Organization Structure Completeness of organization structure to monitor and conduct proper decision making. i. Supplier organization policy ii. Structure of supplier organization (HSE department, risk management)	Governed Structure Degree of each department curtailing attention to safety. i. The level of enforcement and compliant of safety policy ii. Equal Safety awareness level on top and bottom.	Governed Structure Degree of each department curtailing attention to safety. i. Driver Monitoring Policy ii. Cost pressures cur on truck maintains
Human Factors	Workforce Qualification Capability of supplier workforce to perform service on complex and high-risk technology facility or equipment. i. Education qualification ii. Legal license qualification iii. Workforce experiences	Workforce Qualification Capability to perform and operate complex and yet high technology facility or equipment. i. Education qualification ii. Legal license qualification iii. Experiences iv. Safety record and previous performance.	Workforce Qualification Capability to perform and operate complex and yet high technology truck. i. Education qualification ii. Legal license qualification iii. Driving Experiences iv. Previous Driving record
Social Culture	Supplier Safety awareness and culture. Previous Accident incident and safety achieve reflect the level of safety culture on supplier. i. Supplier safety record ii. Supplier safety achievement	Safety awareness and culture. Different background operator contains different concept on safety. i. Equivalent of safety concept ii. Equivalent of safety measurement and judgement	Safety awareness and culture. Different background driver contains different concept of safety while driving. i. Equivalent of safety concept on driver and public road user. ii. Equivalent of road safety measurement and judgement.

Besides that, as technological risks may occur on anytime and anywhere, risks assessment are required to be applied before and while the activities are performing.

3.2 Technological risks factors on High Technological Supply Chain Activities

In oil and gas industry, technology and often chemistry, affects every decision on procurement, installation, and logistics [21]. Organization P always continues its effort to improve product safety management across the upstream and downstream business. The company is committed to Health, Safety and Environment (HSE) excellence in all activities wherever it operates. The aim is to safeguard people, contractors and assets, the local community members and the environment. Hence, in order to prevent technological disaster that will endanger organization P supply chain activities, people and the local community, each technological risks event that may occur technological disaster has been identified.

Each of the supply chain activities may contains different risk events that contribute to technological disaster. Through the data collection from the respondent thus Table 4 shows the identified technological risks event and technological risks factors that occur on each organization P supply chain activities.

4.0 CONCLUSION

As conclusion, the researcher identified high technological risks supply chain activities assessment technological risks by following ISO: 3100 proposed risk assessment process. Specific technology tools have been implemented on each supply chain activities in order to identify technological risk events that may lead to technological disaster. The assessment will be conducted before or during the operation of each activity in order to ensure safety on each operation activities. The identified risk event shows that high technological supply chain not only contains supply chain risks, but also disclosed with technological risks. The researcher believes that technological risk assessment process is useful and able to adopt by any similar high technological risks industry. Besides that, the researcher also believes that by raising awareness of technological risks, it will increase the effectiveness of preventing technological disaster. Risk mitigation strategy of technological risks is the potential area to be conducted as future research topic. With complete technological risk

management on high technological supply chain activities, it is able to enhance the sustainability of our nation high technological supply chain industry.

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