RISK ASSESSMENT IN WASTE SAMPLING ACTIVITY FOR A SELECTED FOOD INDUSTRY

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RISK ASSESSMENT IN WASTE SAMPLING ACTIVITY FOR A SELECTED FOOD INDUSTRY

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ABSTRACT

Waste sampling is one of the main activities during environmental audit. This activity has been estimated as a non-risky activity and lead to inadequate risk assessment in the activity. The purpose of this study is to create a safer workplace for enforcement body in general and DOE officer in specific during waste sampling activity. Main objectives are to identify the hazards, further assess the hazards and determine the control measure to reduce the hazards. Observation and on-the-job training have been conducted to three food industry located in Shah Alam to identify the hazards. Structured surveys were conducted with 293 participants to further identify hazards among DOE officers. Risk assessment and risk control have been tabulated in HIRARC form after hazards identification process. The study showed that there were potential concerns in chemical, physical, biological and ergonomic hazards in waste sampling activity during environmental audit. The analysis from survey showed that the officers were aware of the hazards exposed but lack of implementation in risk control. Most of the respondents agreed that risk control could eliminate or reduced the hazards exposure. From HIRARC form, there were 3 high risk hazards from the total of 43 hazards identified which needed immediate action in order to eliminate or reduced the risk. Risk control has been suggested in this study including the involvement of premises to provide a safer waste sampling point. It can be concluded that there are significant hazards in waste sampling activity although most of them are at low and medium risks. Without proper action taken by the employer and officer, these hazards can be a threat to life and property damage.

Keywords: Waste Sampling, Risk Assessment, Risk Control, Environmental Audit, HIRARC

ABSTRAK

Aktiviti persampelan buangan adalah salah satu aktiviti utama semasa audit alam sekitar. Aktiviti ini sering disalah anggap sebagai aktiviti yang tidak berisiko dan perkara ini telah menyebabkan kepada penilaian risiko yang tidak mencukupi. Tujuan utama penyelidikan ini adalah untuk mewujudkan tempat kerja yang selamat kepada semua pegawai penguatkuasa secara amnya dan kepada pegawai Jabatan Alam Sekitar (JAS) secara khususnya semasa aktiviti persampelan buangan. Objektif penyelidikan ini adalah untuk mengenalpasti bahaya, menilai dengan lebih lanjut terhadap bahaya dan mengenalpasti langkah kawalan bagi mengurangkan bahaya tersebut. Pemerhatian di lapangan dan latihan aktiviti persampelan telah dijalankan di tiga buah industri makanan untuk mengenalpasti bahaya. Survei berstruktur juga telah dijalankan kepada 293 responden di kalangan pegawai JAS untuk mengenalpasti bahaya dengan lebih lanjut. Penialaian dan kawalan risiko telah disenaraikan di dalam borang HIRARC selepas proses pengenalpastian bahaya. Hasil kajian mendapati terdapat potensi bahaya kimia, fizikal, biologi dan ergonomik di dalam aktiviti persmpelan buangan semasa audit alam sekitar. Analisis daripada survei menunjukkan pegawai menyedari bahaya yang terdedah walaubagaimanapun kurangnya pelaksanaan kawalan risiko. Kebanyakan responden bersetuju kawalan risiko dapat menghapuskan atau mengurangkan bahaya. Daripada borang HIRARC, terdapat 3 bahaya berisiko tinggi daripada keseluruhan 43 bahaya yang dikenalpasti dan memerlukan tindakan segera untuk menghapuskan atau mengurangkan risiko. Kawalan risiko telah dicadangkan di dalam kajian ini termasuk penglibatan premis di dalam penyediaan lokasi persampelan yang selamat. Kesimpulannya, terdapat bahaya yang ketara di dalam aktiviti persampelan buangan walaupun kebanyakannya berisiko sederhana dan rendah, tanpa sebarang tindakan daripada majikan dan pegawai, ianya boleh mengancam nyawa dan harta benda.

Kata kunci: Persampelan Buangan, Penilaian Risiko, Kawalan Risiko, Audit Alam Sekitar, HIRARC

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LIST OF SYMBOLS AND ABBREVIATIONS

APHA	:	American Public Health Association
AN	:	Ammoniacal Nitrogen
BOD	:	Biological Oxygen Demand
CHRA	:	Chemical Health Risk Assessment
COD	:	Chemical Oxygen Demand
DOE	:	Department of Environment
ERP	:	Emergency Response Plan
ERT	:	Emergency Response Team
EIA	:	Environmental Impact Assessment
EQA	:	Environmental Quality Act
ETA	:	Event Tree Analysis
EEZ	:	Exclusive Economic Zone
FTA	:	Fault Tree Analysis
HAZOP	:	Hazard and Operability Study
HIRARC	:	Hazard Identification, Risk Assessment and Risk Control
IER	:	Industrial Effluent Regulation
MIDA	:	Malaysian Investment Development Authority
MSD	:	Muscular Skeletal Disease
OSHA	:	Occupational Safety and Health Act
O&G	:	Oil and Grease
OV	:	Organic Vapor
PHA	:	Preliminary Hazard Assessment
PPE	:	Personal Protective Equipment
RCA	:	Root Cause Analysis

SWR	:	Scheduled Waste Regulation
SiRAC	:	Simple Risk Assessment and Control for Chemicals
SOP	:	Standard Operating Procedure
SS	:	Suspended Solid
SWIFT	:	Structured "What-if" Technique
US EPA	:	United States Environmental Protection Agency

LIST OF APPENDICES

CHAPTER 1: INTRODUCTION

1.1 Background of Study

Every human being is responsible to safeguard the safety of our one and only home planet. The sustainability of Earth is not an option but in fact, an obligatory action to ensure the well-being of the future generation. However, the industrial revolution has led to unprecedented rise in the rate of manufacturing sectors, along with the accumulation of chemical wastes and pollution. As people continue to modernize with technology and the upsurge of industries without realizing its long-term effect towards the environment, the condition of Earth would continue to worsen. In the middle of 1900, health problems began to arise. The public became conscious that the importance of controlling pollution by treating industrial wastes goes along with the magnitude of development.

Without proper act and regulation, there would not be any guidelines for industrial players to refer on how or why they need to treat their wastes. Not until 1970, the United States Environment Protection Agency (US EPA) was then established, which became a turning point towards improving the condition of public health and managing pollution. Since then, US EPA has been the reference to many countries including Malaysia in terms of environmental safety. The revolution of Malaysian industry began in the 1960s, which was driven by the demands for rubber and palm oil. In 1974, Malaysia introduced its own environmental act known as Environmental Quality Act (EQA) 1974 (Act 127). It was enforced by the Department of Environment (DOE) Malaysia (AuYang, H. N., et al 2019). In the article titled 'Malaysia's Industrial Growth Complements Global Supply Chain', the Malaysian Investment Development Authority (MIDA) stated that the economic growth in Malaysia was due to its strategic location and efficient trade infrastructure, thereby, it is expected that the manufacturing practices in Malaysia would trigger environmental issues.

Environmental audit is one of many favorable ways to cope with environmental issues. A DOE officer audits the operation of a given industry and detects any possible wastes generated from the process. Every industry has different processes based on their product thus producing different waste that comes along with it. Supposedly each environmental audit will be different from one another. The officer in charge would normally gather samples of the waste to be analyzed by the Department of Chemistry. Usually, sampling is done for wastewater, sewage, hazardous waste substance or scheduled waste, and leachate.

Safety as defined by Oxford Dictionary is the condition of being protected from, or unlikely to cause danger, risk or injury. Safety element has been the main issue to consider among the DOE officers, especially when involving sampling activities. The American Public Health Association (APHA) published a standard method of sampling wastewater, sewage and leachate, on which chemicals are used as preservative for the sample. Based on the data of DOE in their 2018 annual report, more than 1000 samples have been taken each year, including wastewater, leachate and scheduled waste samples to validate its compliance with the EQA. Apart from the physical safety issue during sampling, a major concern is the safety in handling chemicals for preservation of the samples. It is likely that the technical staff would take the matter lightly due to lack of information. Unsafe acts or conditions are not being reported to the management because there is no proper channel in doing so. As a result, no proper documentation is recorded for any danger occurrence thus no control measure is being implemented to avoid injury.

1.2 Problem Statement

Despite being the main activity during environmental audit, sampling is still lacking proper risk measures documentation to adhere to. Inherent culture in sampling procedure among senior officers also contributes to the incorrect procedure that is risky and can lead to injury. Transfer of officers to other state department can lead to different approach of auditing. Therefore, a written document regarding precautions and standard risk management instructions is necessary as reference for the entire department.

2019 has been recorded as the most challenging year for DOE where the dreadful tragedy of Sungai Kim Kim had hit Malaysia (The Star, 2019). Illegal dumping of scheduled waste was found on the riverbank of Sungai Kim Kim, Pasir Gudang, Johor and the leachate had flown into the river which caused major health problems to thousands of citizens in Pasir Gudang. Not long after the unfortunate event of the contamination of Sungai Kim Kim, another public health issue arose in Taman Mawar, also in Pasir Gudang which had affected almost 20,000 residents. It was reported that 16 schools, 69 preschools and one university were forced to close down (Berita Harian, 2019).

These two tragedies show the risk that has to be faced by DOE technical staff who performs sampling and the possibility of frequent exposure towards the risk. In March

2019, a technical staff from DOE fainted while handling a sample in an exhibit store (Sinar Harian, 2019). Normal routine inspection also includes sampling of waste in the industry. Unless a proper risk management guideline is available, inadequate precaution would still become the main issue during sampling, especially when dealing with high-risk samples.

Environmental audit activity has been underestimated to be a non-risky activity. This presumption often leads to inadequate risk assessment in the activity. Although DOE has already been equipped with safety policy, there is still no proper documentation in the risk assessment aspect. Thus, this study intends to focus on the risk of waste sampling activity exposed by DOE officers and initiate control measures to reduce the risk.

1.3 Aim & Objectives

The aim of this study is to create a safer workplace during environmental audit and create awareness among DOE officer regarding risk exposure and safety culture. Thereby, the objectives concern these matters:

a) To identify the potential hazards during waste sampling activity among DOE officers.

b) To assess the potential risks exposed during waste sampling activity using quantitative risk assessment technique.

c) To determine the control measure to be taken for waste sampling activity using hierarchy of control to reduce the risk exposed.

1.4 Scope of Study

This thesis centers upon waste sampling activities conducted by DOE officers in Selangor, Putrajaya and Kuala Lumpur. The term waste in this study refers to solid waste which includes hazardous substances or scheduled waste and also liquid waste which is industrial effluent or wastewater. The main observation sites would be on selected food and beverages industry in Shah Alam that generates both solid and liquid wastes. Central to this study is the physical, chemical and biological hazards exposed by the DOE officers during the sampling activity. Procedure of sampling strictly follows the APHA method and guidelines by DOE.

1.5 Significance of Study

It is anticipated that the risk assessment framework established in this study would benefit any agency involved in waste sampling. Food industries might also be introduced with a proper risk assessment practice, especially the small and medium food industry. The current risk assessment system is mainly for high-risk processes and waste management is frequently overlooked. Other than that, risk assessment framework for environmental audit is not fully organized and this would be a trigger point for the management. Furthermore, with the establishment of this upgraded risk assessment program, unwanted accidents leading to life and asset loss can be avoided and thus improve safety awareness among DOE officers.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction to Hazard and Risk

In general, the word 'hazard' is a significance of harm. Most studies and literature are agreeable upon the term hazard, as any condition or behavior that might cause injuries, be it fatal or minor, as well as consequences that lead to damages of assets, environment or equipment (Gul & Ak, 2018). According to DOSH (2008), hazard can be interpreted as health hazard, safety hazard and environmental hazard.

2.1.1 Hazard in Sampling Activity

Health hazard normally defines any agent that brings illness or disease to an exposed individual, which eventually causes acute or chronic illness. The illness can affect any part of the body that includes the external part or internal organ. The affected individual might be unaware of the illness because the symptoms may appear later or until it has worsened. The most common causes of health hazard include chemical, biological, physical and ergonomic factors. Table 2.1 listed some examples of health hazards in a waste sampling activity.

Safety hazard can be defined as any strong force that can cause injury, fatality or damage to assets. Usually, the effect of safety hazard is immediate or obvious. The impact of improper safety precaution leads to safety hazard. Thus, safety hazard can easily be eliminated or reduced if adequate measures are taken. Table 2.2 shows some examples of safety hazard in a sampling activity.

Table 2.1: Example of health hazard in waste sampling activity

Health Hazard	Contributing Factor
Chemical hazard	Handling chemical for preservation
	Wrong labelling of chemical
	Fume from chemical for preservation
Biological hazard	Wild animal appears while sampling
	Sampling at bush area tends to expose to venomous animal
Physical hazard	Improper manage of electrical wire
	Extremely hot weather
	Noise from mechanical part
Ergonomic hazard	Awkward position while sampling
	Limited movement due to limited space

Table 2.2: Example of safety hazard in waste sampling activity

Safety Hazard	Contributing Factor
Physical Hazard	Slippery area
	Working at height
	Heavy weight lifting of sample box
	Working in confined space
	Working without supervision or buddy

Environmental hazard happens when a substance, a state or event which has the potential to threaten the natural environment or adversely affect people's health from natural disasters such as storms and earthquake. Apart from that, any emission, disposal and discharging of waste towards the environment without proper management directly affects the safety of the environment. The outcome from environmental hazard is rarely instantaneous; disposing hazardous wastes without proper management may release toxic substances into the air or land a few years after the incident.

2.1.2 Risk Assessment in Sampling Activity

Risk is the measure of chance if any hazard would actually cause harm to a person or environment, in terms of the expected value of an undesirable outcome. This involves the probability of various possible events and assessments of the corresponding harm that are combined into a single value. Therefore, the value of risk can be high or low, which is associated with the formula:

$$\text{Risk} = (\text{Probability of the accident occurring}) \times (\text{Expected loss in case of accident})$$

Risk assessment allows better understanding of the risk associated with each of the hazard identified in order to take the countermeasures. Muhammet et al. (2018) highlights four main phases in risk assessment that starts with identifying hazards, followed by assessing associated risk, controlling risk and reviewing control measure. The risk assessment, as illustrated in Figure 2.1 is a continuous process which occurs as a loop.

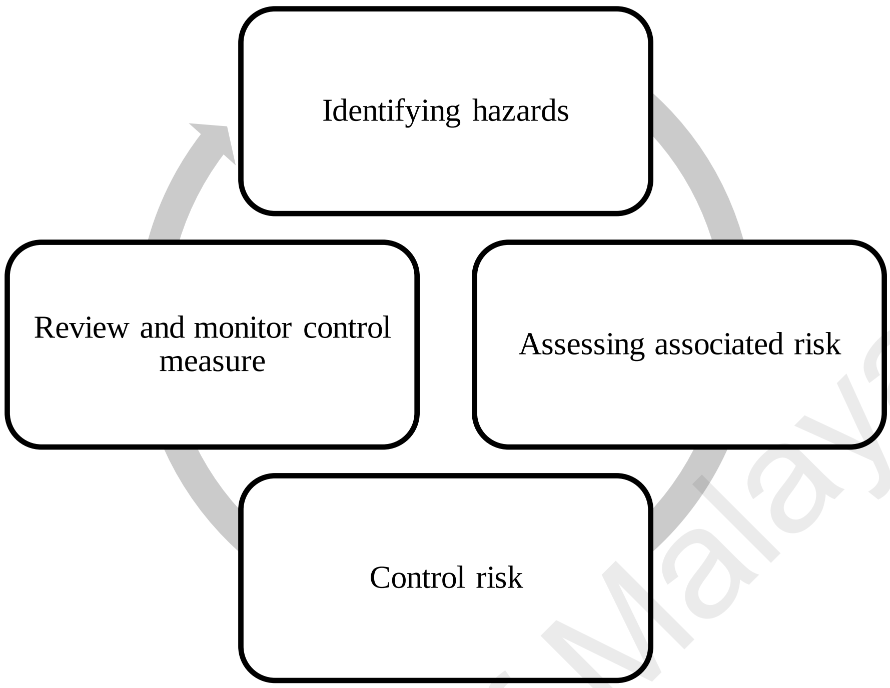

Figure 2.1: Risk assessment loop

This method has been extensively used to denote occupational and environmental health implying the cumulative risk assessed in the workplace, of which covers environment, occupational, individual and the community (Fox et al., 2018). Gathering information from various works, risk assessment can be determined from cumulative risk assessment, quantitative risk assessment, or mathematical modelling which depends on the circumstances. Petrovic et al. (2018) suggested cumulative risk assessment for contaminated ambient air. Jacxsens et al. (2016), Jusoh et al. (2016), Hamka et al. (2017), Gul et al. (2018), Zio et al. (2018), and Pasman et al. (2018) have all substantiated that quantitative risk assessment or 5x5 matrix method gives a reliable result for most hazards. Landberg et al., (2018) and Pasman et al. (2018) proposed mathematical modelling to assess risks related to mixtures of chemical exposures. Meanwhile, post event analysis, also known as fault tree analysis, is also one of the methods in risk assessment, suggested by Pasman et al. (2018) and Hamka et al. (2017).

Many other methods used for risk assessment has been summarized by Valis et al. (2009):

1. Brainstorming

A method that involves conversation among those knowledgeable about a process. Brainstorming the potential hazards, risk associated to the hazard, and control measures taken is most common in higher level discussions. This method can be used in conjunction with other risk assessment method while encourage imaginative thinking to resolve the risk at hand.

2. Delphi technique

A procedure to obtain a reliable consensus of opinion from a group of expertise. Unlike brainstorming, the keyword here is expertise involvement. The expertise may share their opinion freely regarding the hazard and view other's expertise opinion. This method can be applied at any stage of risk management.

3. Checklist

The hazard, risk and control measure is compiled as a set of checklist that is developed based on experience. This helpful technique can be applied to all life cycle or process and is useful to cross-check whether the control measure taken is effective or needs to be improved further.

4. Preliminary Hazard Assessment (PHA)

PHA is usually applied in the early stages of a project or process, where information on the operating procedure, system designs or design detail is scarce. Usually, when this method is used, the project has to be constantly monitored after completion or while the process is fully running to attain the actual overview. On the other hand, the method is helpful as reference when the process needs more extensive technique.

5. Hazard and Operability Study (HAZOP)

A structured and systematic examination of any process, system or procedure to identify risk towards people, equipment or environment. HAZOP is a qualitative technique based on use of guide words such as MORE, FEW, LESS and others. HAZOP is widely used in oil and gas sector, chemical industry and industry involving pressure unit.

6. Toxicity Assessment

Environmental risk assessment that involves risk assessment for animal, plants and human as a result of exposure to a range of environmental hazards. This type of method uses a pathway analysis where it is useful for identifying treatments to reduce the risk.

7. Structured "What-if" Technique (SWIFT)

It is a simpler alternative to HAZOP, a systematic and team-based study. This method utilizes "what-if" type phrases to investigate how the system or process will be affected by deviations from normal conditions. Unlike HAZOP, SWIFT is less detailed and usually applied at a lower level risk system or process.

8. Scenario Analysis

A development of descriptive model of how to identify the risk by reflecting the future development and exploring their implications. The scenario considers changes in technology, consumer preferences, social attitudes and a few more circumstances for the past 50 years. This method is helpful to assist policy making and planning for future strategies while considering existing activities.

9. Root Cause Analysis (RCA)

This method focuses on analyzing the root cause of major incidents to prevent reoccurrence of the event. It is recognized that corrective action may not always be entirely effective, and that continuous improvement may be required.

10. Fault Tree Analysis (FTA)

A technique for identifying and analyzing factors that can contribute to top event. The factors identified in the tree can be events that are associated with human or technical errors. This method can be either qualitative or quantitative.

11. Event Tree Analysis (ETA)

Different from FTA, ETA uses graphical technique to represent mutually exclusive sequence of events following an initiating event in order to outline the effectiveness of a system design to mitigate its consequences. This method can be either qualitative or quantitative.

12. Cause and effect analysis

The most essential step in risk management is identifying the possible cause and consequences of an undesired event as the initial step of the process. Usually the information is organized in the Fishbone or Tree Diagram. The people involved would further establish a potential hypothesis formally as a countermeasure.

Among the variety of methods, none was proven to be the best method to fit every situation since each approach has its limit. The risk in every situation is known to be unique, where the process or lifecycle is different most of the time, one should choose and apply a suitable method for risk assessment.

2.1.3 Simple Risk Assessment and Control for Chemicals (SiRAC)

According to APHA (2017), wastewater sampling activity involves the use of chemicals as preservative. This stipulates a proper storage design for chemicals that must include cabinet ventilation, temperature and humidity controls, smoke detection and a security panel to prevent unauthorized access (Kshah 2019).

A manual of recommended practice that was published by Department of Occupational Safety and Health (DOSH), and Simple Risk Assessment and Control for Chemicals (SiRAC) can be used as reference for primary assessment. The required information is the hazard classification (according to CLASS Regulations 2013), physical form, boiling point or vapor pressure and operating temperature of the chemicals (where applicable), the quantity used and total duration of exposure to the chemicals.

As shown in Figure 2.2, the process flow of SiRAC approach may be conducted if the chemical is listed in the chemical register and not being classified as Carcinogenicity Category 1, Mutagenicity Category 1, or Respiratory Sensitization Category 1.

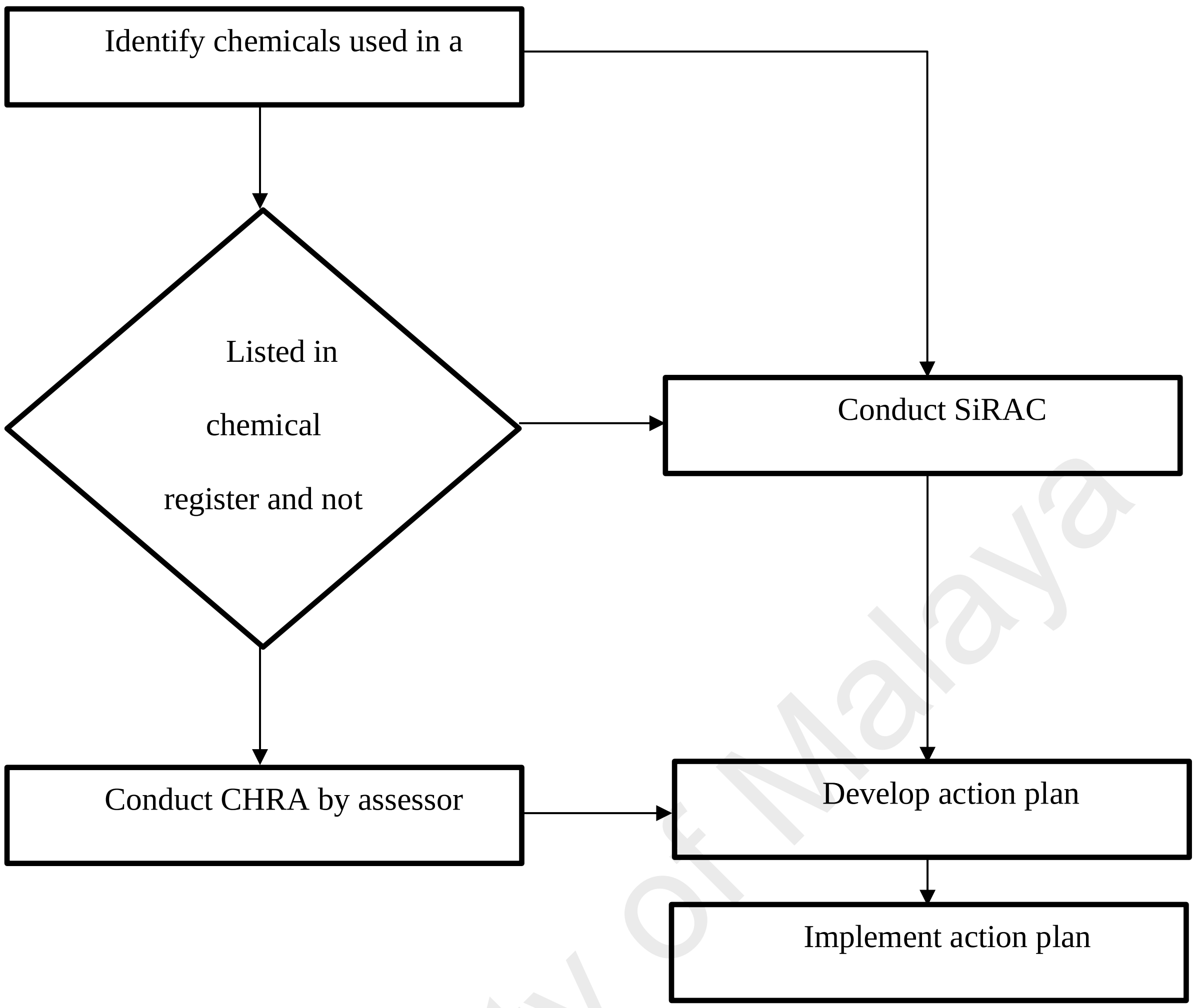

Figure 2.2: Process flow in Chemical Hazardous Risk Assessment (CHRA) recommended by DOSH

2.2 Waste in Food Industry

2.2.1 Introduction of Waste

Waste in any process is inevitable because normally, raw materials end up as a product, some by-products, and a residual waste (Jamin et al., 2015). Figure 2.3 outlines the stages involved in soymilk production (Lien 2014). Figure 2.3 implies that in the case of soymilk production, wastes can be generated from multiple stages within the process. For example, the washing process dried raw materials, tank washing maintenance and off specification product. Waste needs to be managed properly in order to prevent pollution.

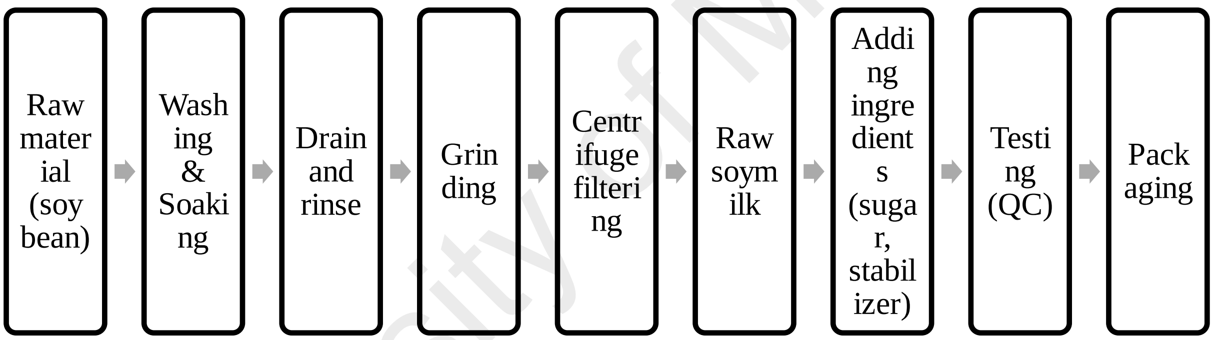

Figure 2.3: Process involved in production of soymilk

Waste can be divided into three categories which is solid, liquid and air. Solid waste is commonly phrased as scheduled waste, liquid waste as wastewater, while air waste phrased as air emission.

2.2.2 Scheduled Waste

Scheduled waste is classified as any waste listed in the First Schedule in Scheduled Waste Regulation (SWR) 2005. Scheduled waste is considered as waste that possesses hazardous characteristics and has the potential to adversely affect public health and environment. In Malaysia, cradle to cradle concept has been widely used instead of cradle to grave (AuYong et al. 2019). Cradle to cradle can save nearly 50% of the waste than just dispose it.

According to SWR 2005, all scheduled waste generated must be stored with proper storage design. Notification of the generated scheduled waste is essential and an inventory of each generation must be kept every month. Scheduled waste can only be stored for a maximum of 20 metric tonne or 180 days before disposal. Disposal of scheduled waste must be at a prescribed facility registered with DOE and all movement of scheduled waste should have a consignment note. Table 2.3 is the scheduled waste generated by a food industry. With proper management, scheduled waste can turn into less hazardous waste or ultimately turn into a useful product.

Table 2.3: Scheduled waste generated from food industry

Process	Scheduled waste
Wastewater treatment	SW109 – COD vial test kit SW204 – sludge from the wastewater treatment SW411 – Spent activated carbon
Maintenance	SW110 – Discarded electrical waste SW305 – Spent lubricating oil SW408 – Contaminated soil or debris from cleaning up chemical spill SW409 / SW410 – Disposed container, gloves, bags, rags, plastics contaminated with mineral oil
Off specification product	SW426 – Off specification products from production

2.2.3 Wastewater

Influent for wastewater in the food industry mainly comes from the washing of raw materials and tank. The influent from these stages of the process usually contain high load of Biological Oxygen Demand (BOD) due to the organic matter in the influent. Other than BOD, other parameters that are emphasized in the food industry is temperature, pH, Chemical Oxygen Demand (COD), Suspended Solid (SS) and Oil and Grease (O&G). Thus, the treatment for influent should be a physical-chemical process combined with biological process. Table 2.4 is the ideal recommended process for food industry wastewater treatment (Metcalf & Eddy, 2013). The treatment can be broken down into three stages; primary, secondary and tertiary stage.

Wastewater parameter limit is tabulated in the Fifth Schedule, Industrial Effluent Regulation (IER) 2009. Every industry needs to check their premises subjected to Standard A or Standard B in the Fifth Schedule. Referring to the IER 2009, industries need to notify their wastewater treatment design as stipulated in the Second Schedule. After the design has been approved by DOE, industries may build the wastewater treatment facility. Wastewater treatment facilities must be supervised by a competent person to ensure the process in each unit operation is fully functioning. IER 2009 requires the industry to do performance monitoring to ensure each unit operation is functioning well. The importance of constant monitoring would prevent future failure in the system.

Table 2.4: Primary, secondary and tertiary treatment in wastewater treatment

Stage	Unit Process	Parameter
Primary	Pretreatment – Remove large particulate	
	Equalization tank – Ensure consistent flow rate	
	Chemical & Physical treatment – Coagulation and flocculation	pH adjustment SS
Secondary	Aerobic Tank – Using activated sludge to consume the organic contaminants in wastewater with the supply of oxygen	BOD COD SS
	Anaerobic Tank (usually if influent BOD is higher than 5000) – Denitrification process with no supply of oxygen.	
Tertiary	Clarifier – Settling down the sediment and remove the clear water by overflow	O&G SS
	Belt Press – Dry the sludge. Water from this process returns to the system.	

2.3 Sampling Activities in DOE

Sampling is the most fundamental aspect in environmental audit, especially when dealing with water and land pollution. Water pollution mainly comes from industrial wastewater, leachate from landfills, sewage water from sewage treatment plants, and scheduled waste from industries. Other than that, reading samples from underground water, rivers and sea water provide indicators of pollution.

2.3.1 Liquid Waste Sampling

Sampling wastewater, sewage or leachate can be conducted using a few methods. One of the known methods is introduced by the APHA for examination of waste and wastewater. Grab sampling is being used, and each parameter such as BOD and COD has its own procedure, as shown in Table 2.5. The variable of each method is the minimum quantity of the sample, type of container used for sampling, and type of chemical for preservation.

Table 2.5: Some sampling methods of wastewater in industry

Parameter	Minimum quantity of sample	Preservation	Reference
BOD_5&SS	1 L in plastic bottle	Refrigerate	APHA, the American Water Works Association and the Water Pollution Control Federation of the United States APHA, Standard Methods, 21st Edition
COD & Ammoniacal Nitrogen (AN)	100 mL for COD and 500 mL for AN inplastic bottle	H_2SO_4 to pH <2 and refrigerate	
O&G	For industry except palm oil mill, 1 L in glass bottle For palm oil mill, 500 mL in glass bottle	HCl to pH<2 and refrigerate H_2SO_4 to pH<2 and refrigerate	
Metal	1 L in plastic or glass bottle	HNO_3 to pH<2	
Cyanide	1 L in plastic or glass bottle	NaOH to pH>12	
BOD_3	2 L in plastic bottle	Refrigerate	Revised Standard Method (1985) for Analysis of Rubber and Palm Oil Mill Effluents, Third Edition (2011)

2.3.2 Solid Waste Sampling

Based on Standard Operating Procedure (SOP) titled '*Persampelan Buangan Terjadual di Bawah Seksyen 48AB, Akta Kualiti Alam Sekeliling 1974*', sampling for scheduled waste is slightly different from wastewater. Scheduled wastes can be grabbed or exist as a composite sample. Scheduled waste sample does not require preservation, unlike liquid wastes. In short, this shows that sampling methods vary according to the type of waste; thereby it is likely that different hazard is expected in terms of safety aspect.

2.4 Environmental Quality Act 1974

EQA 1974 is an act relating to the prevention, abatement, control of pollution and enhancement of the environment and for the purposes connected therewith (EQA 1974). DOE is the enforcement body responsible to execute the act. DOE's vision is to conserve the environment for the well-being of people while carrying the mission to ensure sustainable development in the process of nation building. According to EQA, the act covers for air, water and land pollution in Malaysia, except the Exclusive Economic Zone (EEZ).

Since its establishment in 1975 (DOE, 1995), DOE has been operating in all states in Malaysia including Wilayah Persekutuan Labuan. In the early years, there were three core businesses which were development, control and prevention division. Presently, in the DOE headquarters, the division is divided into two core businesses which are development and operation. The development division incorporates the Assessment Section, Strategic Communication Section and Environment Institution. Meanwhile, the operation division embodies the Enforcement Section, Hazardous Substance Section, Air Section and Water and Marine Section. The divisions in DOE headquarters are illustrated in Figure 2.4.

DOE headquarters is responsible for looking into policies, guidelines and department directions from time to time. Apart from the headquarters, the state DOE implements the policies and directions from the headquarters and focus more on fieldwork. Continued emphasis is given to the prevention and controlling of water pollution, air pollution and scheduled waste management, as well as the promotion of green industrial practices. Inspections on polluting sources are heightened and legal actions are taken against perpetrators (DOE Annual Report, 2011). Environmental audit is carried out to check the compliance of the act.

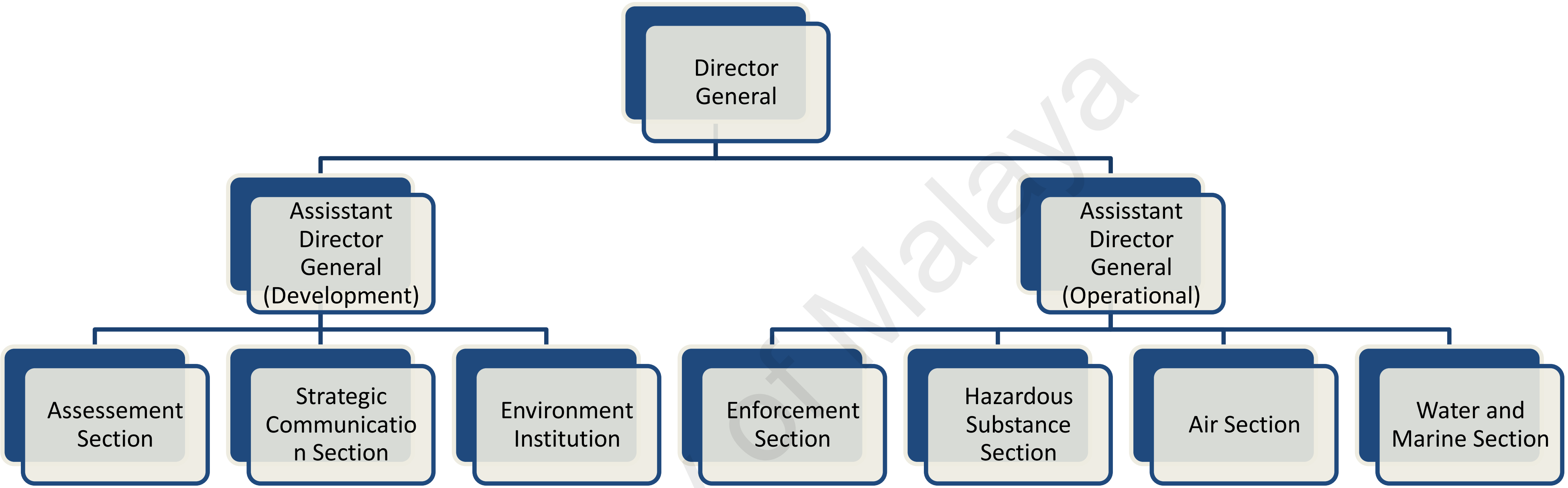

Figure 2.4: The divisions in DOE headquarters led by Director General

Source : DOE Malaysia (2019)

2.4.1 Environmental Audit

There are many tools to ensure the compliance of EQA 1974 such as online system checking, environmental audit and the guide of self-regulation. According to Fatma, et. al. (2019), environmental audit is one of the tools that are likely to provide higher quality environmental information. Li He et al. (2017) mentions that environmental audit represents a direct and practical way to access physical features of environment-associated activity. These statements are testimonies of the main job scope of DOE, which is environmental audit. Depending on the background of the case, each audit is unique according to the area or places, type of waste, and type of industry. Thus, the resulting type of hazard also varies. Table 2.6 are the list of environmental audit type in DOE and the area involved.

Based on DOE Annual Report 2018, the total of environmental audit for non-licensed premises is 5,663. Of those, 624 premises are categorized under food industry. The audit focuses on scheduled waste, air pollution and industrial effluent. Here, sampling activity is required, especially for scheduled waste and industrial effluent. From the SOP for environmental audit, DOE introduced the buddy system as a safety element. The audit team should consist of at least two officers to audit an unfamiliar area (industry or new places).

Table 2.6: Type of environmental audit and area involved

Type of environmental audit	Area involved
Licensed premises	Consisting of palm oil mill, rubber mill and scheduled waste facility. Waste generated is palm oil mill effluent and scheduled waste.
Non-licensed premises	All other industries except those listed in licensed premises. Various waste generated depends on the type of industry.
Illegal dumping	No specified area or industry. Waste generated is scheduled waste but unknown waste.
Vehicle source	Audit at roads and premises for vehicles using diesel.
Environmental Impact Assessment (EIA)	Ongoing project area that falls under EIA Order 2015.
Marine and river surveillance	Sampling point at the sea and river. Audit also includes underground water sampling.

2.4.2 DOE Safety Culture

Occupational Safety and Health Act (OSHA) 1994 is the safety regulation in Malaysia. Based on the act, workplace safety is the responsibility of both the employer and employee. OSHA 1994 states that DOE falls under public services in the First Schedule that allows any part of the act to be imposed to DOE. Table 2.6 shows that the DOE initiative complies with OSHA 1994. The latest directive from the Director General of DOE (2020) is to ensure the safety and health of their officers who have been exposed to external risks, as well as emphasizing on creating a stress-free work life.

Table 2.7: DOE initiative to comply with OSHA 1994

Section in OSHA 1994	DOE Initiative
Section 15 – General duties of employer to their employees	a) Supply Personal Protective Equipment (PPE) for all officers (*Peralatan Perlindungan Diri, 2018*) b) SOP for all activities in DOE (ATOP *Siri* I to V, 2015) c) Conduct training at EiMAS (*Institut Alam Sekitar*) to train new officers and refresh senior officer's knowledge d) Emergency response team (ERT) and emergency response plan (ERP) at every state DOE and headquarters

Section in OSHA 1994	DOE Initiative
	e) Supply of first aid kit and drinking water at the office
Section 16 – Duty to formulate safety and health policy	DOE always renew its safety policy from time to time. Figure 2.5 shows the safety policy of DOE signed by the Director General.
Section 17 – General duties of employers to person other their employee	DOE has very strict policy for visitors, where they cannot enter the officer's workplace to reduce exposing them to unnecessary risk. Safety briefing for all contractors entering the premises.
Section 30 – Establishment of safety and health committee at place of work	Safety committee is established at DOE state level and headquarters. Director General of DOE also emphasizes committee meeting to be held quarterly, as the requirement for all state DOE (*Arahan Pejabat DOE Bil.X/2020*.

KESELAMATAN DAN KESIHATAN PEKERJAAN
JABATAN ALAM SEKITAR

JABATAN ALAM SEKITAR SENTIASA MEWUJUD, MENGAMAL SERTA MEMBUDAYAKAN SISTEM KERJA SELAMAT DAN SIHAT KEPADA SEMUA KAKITANGAN SERTA MEREKA YANG TERLIBAT DENGAN AKTIVITI JABATAN BERLANDASKAN UNDANG-UNDANG DAN KODA AMALAN YANG DITETAPKAN. SEMUA WARGA JABATAN SENTIASA BERUSAHA UNTUK MENCAPAI DASAR INI MELALUI:-

SENTIASA MENGEKALKAN PRESTASI KESELAMATAN DAN KESIHATAN PADA TAHAP TERTINGGI

AMALAN PENINGKATAN PEGAWAI YANG BERKOMPETEN DAN MENGARUSPERDANAKAN PROGRAM PEMBANGUNAN PROFESIONAL BERTERUSAN

FAKTOR KERJA BERPASUKAN DIBUDAYAKAN BAGI MENCAPAI SISTEM KERJA SELAMAT SEMASA MENJALANKAN TUGAS

EHWAL BERKAITAN KESELAMATAN DAN KESIHATAN PEKERJAAN SENTIASA MENJADI KOMITMEN DALAM MELAKSANAKAN PENAMBAHBAIKAN SEPANJANG MASA

DENGAN INI ADALAH MENJADI TANGGUNGJAWAB JABATAN ALAM SEKITAR UNTUK MELAKSANAKAN KEHENDAK-KEHENDAK AKTA KESELAMATAN DAN KESIHATAN PEKERJAAN 1994 SERTA PERATURAN-PERATURAN DIBAWAHNYA BAGI SEMUA AKTIVITI JABATAN.

"SELAMAT DAN SIHAT
TANGGUNGJAWAB BERSAMA"

KETUA PENGARAH
JABATAN ALAM SEKITAR MALAYSIA
25 MEI 2018

Figure 2.5: Safety policy for DOE signed by the Director General

CHAPTER 3: METHODOLOGY

3.1 Introduction

The methodology is divided into three subsections comprising hazard identification, risk assessment and risk control. First, hazard will be identified through site observation and on-the-job training. From here, work activity is then listed, and possible hazards would be identified. Second, more data on the possible hazard is comprehended by extracting information from the technical staff using a survey. The third and final part is data collection, in which each information on possible hazard, risk assessment and risk control is tabulated accordingly using qualitative risk assessment method.

3.2 Site Observation and On-The-Job Training

Observation of the sampling process will be carried out together with the technical staff from the DOE which enables better understanding of the procedure. Two main areas included for site observation are the office and the sampling area. Initially, the office or chemical store area will be observed, focusing on where the chemicals are stored and how they are prepared.

The essential tool used in the sampling area is the sampling kit. Therefore, observing the handling of sampling kit is also an important criterion to determine the potential hazard during on-the-job training. Three different food processing facilities in Shah Alam are selected to obtain varying overview of hazards and risks. Data from the observation and on-the-job training consists of work activity list and determination of possible hazard. Information taken from interviewing technical staff would supplement the research as professional overview.

3.3 Survey

As mentioned in the previous section, the survey would be conducted using questionnaires to gather data of accidents or near-miss experiences, as well as the awareness regarding safety measures among workers. Three hundred technical workers from DOE Putrajaya, Kuala Lumpur and Selangor would be randomly picked as respondents.

The questionnaire is divided into four sections enclosing demographic knowledge on safety and occupational health, hazard identification and risk control. Two open ended questions are also included with the aim to learn the risk and risk control that the workers are exposed to.

Section A is the checklist of respondent's profile which listed 7 items, including gender, age, group of service, education level, education background, service experience and section experience in the agency.

Section B acquires the knowledge on safety and health of the respondents. This section concerns the safety initiative that has been taken by the employer and the perception of respondents towards the initiative. Format of Section B of the questionnaire is in the form of Likert scale point rating, by which the respondent's opinion is scored (1= Strongly disagree to 5= Strongly agree).

Section C is intended to identify hazard from the experience of respondents, specifically during sampling activity. Four main categories of hazards are to be identified. Those are chemical, biological, physical and ergonomic hazard. Section C of the questionnaire is also in the form of Likert scale point rating (1= Never to 4= always) to interpret the likelihood of risk exposure.

Section D evaluates the effectiveness of risk control management that has been implemented while dealing with risk exposure so far. The opinion of respondents in Section D is scored based on the Likert scale point rating as well (1= Strongly disagree to 5= Strongly agree). In addition, the two open ended questions in this section allow subjective views to be given by the respondents regarding risk exposure and control.

All data from section B to section D will be calculated to an average value based on below formula:

$$\frac{\sum_{i=1}^{n} P_i \ x \ W_i}{\sum_{i=1}^{n} P_i}$$

Where P = Percentage of selected scale

W = Likert scale or weightage

i = Number of questions

3.4 Research Flow

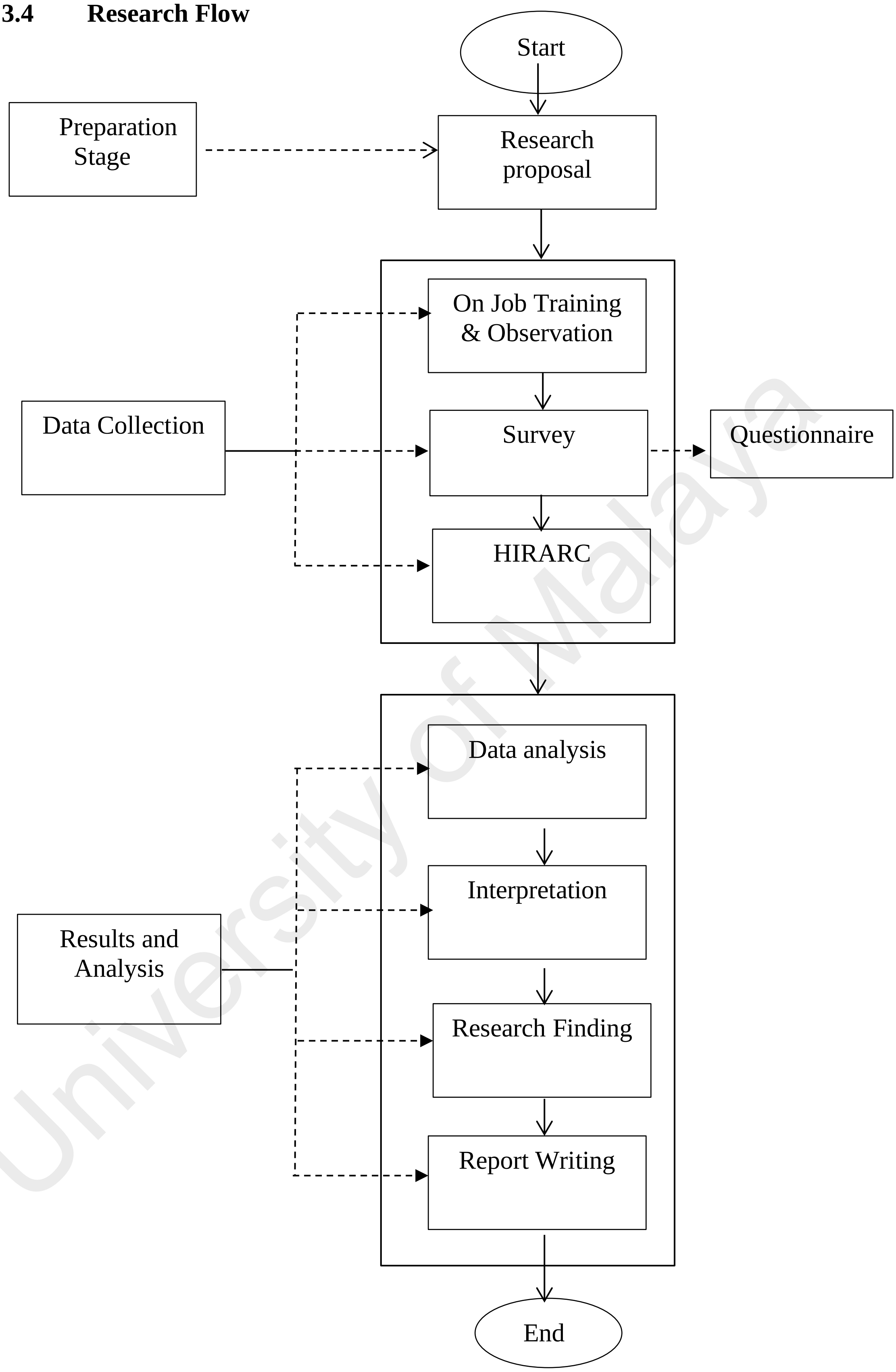

Figure 3.1: Research Flow

3.5 Risk Assessment and Risk Control

Potential hazards from the observation, on-the-job training and survey analysis will be listed and assessed using Hazard Identification, Risk Assessment and Risk Control (HIRARC) form as presented in the Appendix B and the risk matrix from Table 3.1 is then referred to measure the risk. These two forms follow HIRARC guidelines published by DOSH. From these two assessment forms, control measures will be suggested for further implementation. HIRARC for sampling activity and chemical risk assessment will be documented and used as generic document for all sampling activities in DOE. Recommendations of risk control in this study will follow the hierarchy of risk control presented in Figure 3.1.

Table 3.1: Risk matrix used in the HIRARC form to indicate risk

Likelihood \ Severity	1	2	3	4	5
1	**5**	**10**	**15**	**20**	**25**
2	**4**	**8**	**12**	**16**	**20**
3	**3**	**6**	**9**	**12**	**15**
4	**2**	**4**	**6**	**8**	**10**
5	**1**	**2**	**3**	**4**	**5**

<u>Likelihood scale</u>

1 – Improbable, so unlikely it can be assumed the occurrence may not be experienced

2 – Remote, unlikely but possible to occur

3 – Occasional, Likely to occur sometime in the future

4 – Probable, will occur several times and not something unusual

5 – Frequent, likely to occur frequently

Severity scale

1 – Negligible, minor abrasions, bruises, cuts, first-aid-kit type injury

2 – Minor, disabling but not permanent injury

3 – Serious, non-fatal injury but permanent disability

4 – Fatal, approximately one single fatality, major property damage if hazard is realized

5 – Catastrophic, numerous fatalities, irrecoverable property damage and productivity

Explanation Table 3.1

15 – 25: High risk requires immediate action to control the hazard as detailed in the hierarchy of control.

5 – 12: Medium risk requires a planned approach to controlling the hazard and applies temporary measure if required.

1 – 4: Low risk, further reduction may not be necessary

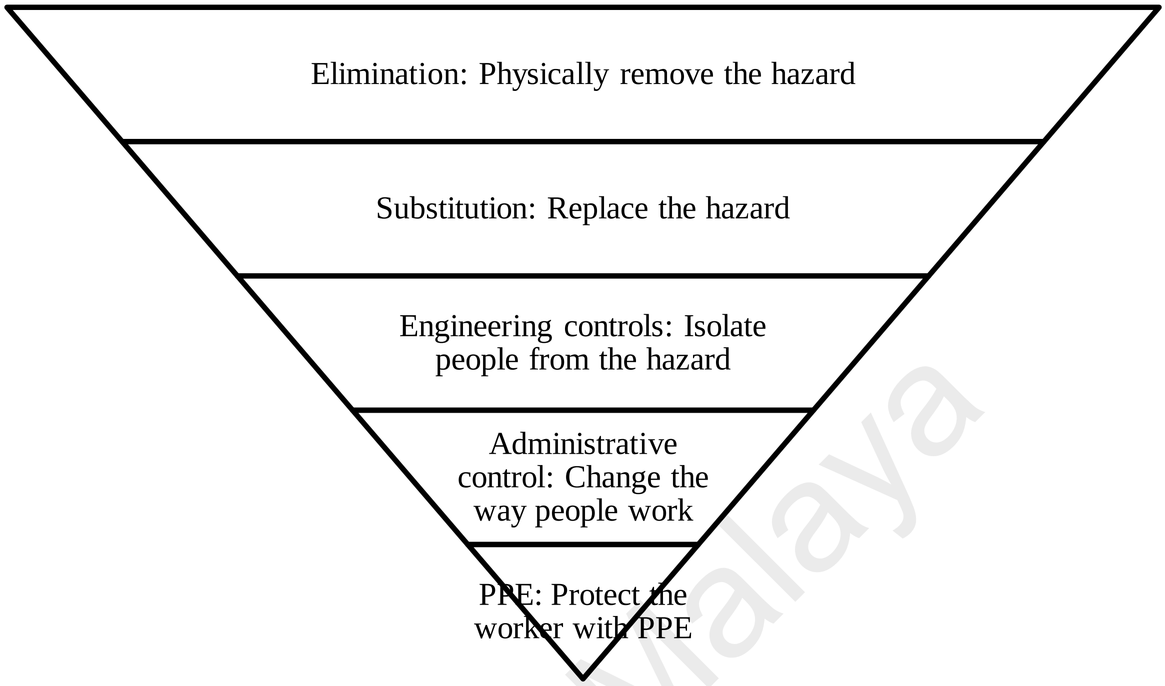

Figure 3.2: Hierarchy of control

CHAPTER 4: RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter thoroughly elaborates the outcome of the research in three consecutive parts. First, sampling process is described, followed by survey output and finally HIRARC. The result highlights the three objectives of this study which are to identify the hazard, assessment of risk and the control of risk. Recommendation for safety improvements ends this chapter.

4.2 Sampling Process Description

Observation and on-the-job training took place at a soy-based food factory, a chocolate malt manufacturing and a sauce factory in Shah Alam. It was emphasized that the wastes taken for sampling were from these locations, and in the form of scheduled waste and industrial effluent. Preparation of the sampling activity was done first. After taken the sample of waste from each location, the samples were immediately delivered to the Department of Chemistry for analysis. It was noted that during the preparation, sampling of waste and the analysis, the officer had been exposed to different types of risk, however some of the risk was controlled accordingly. Figure 4.1 shows the general procedure in the waste sampling activity. Each stage mentioned earlier will be discussed further in the section that follows.

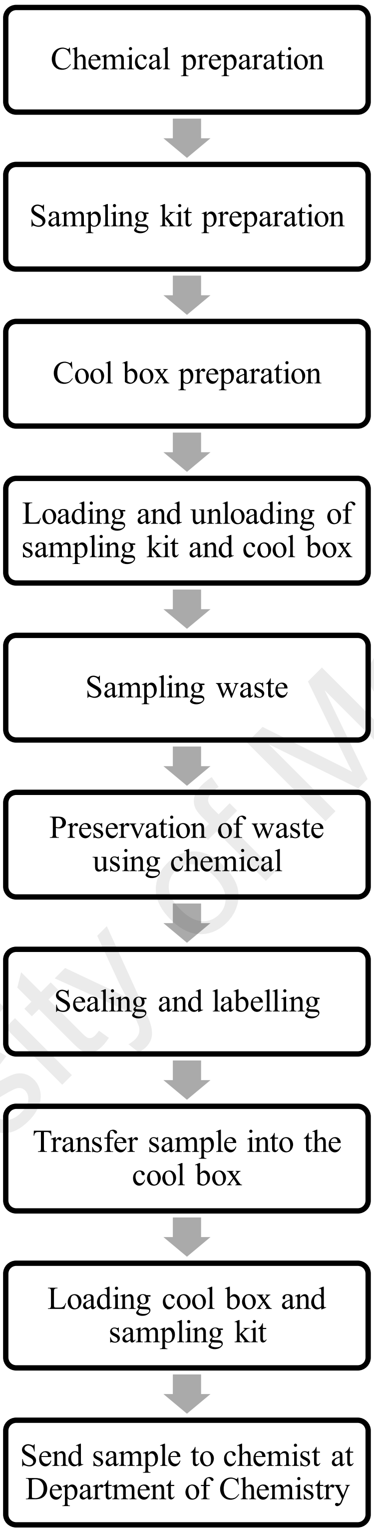

Figure 4.1: Waste sampling procedures in general

4.2.1 First Stage

Sampling process is not as easy and simple as it seems because it usually involves the use of chemicals. Generally, the sampling process started at the workstation of DOE. Here, the officer in charge had to clearly justify the type of chemical to use and which sample bottle was suitable for the sample waste that needed to be taken. The uniqueness of sampling was that each sample required different chemical for preservation. Purchasing of chemical was usually done by the administration and all chemicals had their own bottle. The chemical purchased were normally diluted to the required concentration. For example, sulfuric acid for COD sampling was bought at 50% concentration. Occasionally, in some isolated cases, the chemical was purchased at 80% concentration and thus further dilution had to be performed by the officer at the chemical storage room (all chemicals were kept in the chemical storage room which could only be accessed by authorized person). Figure 4.2 showed the example of a chemical storage area in one of the DOE's office. The chemical storage in this DOE office was lacking in terms of isolation and engineering control. Chemicals and other things such as PPE, exhibit and disposal items were all put in one storage area. The idea of Kshah (2019) was noteworthy, by which the author emphasized that a chemical store should stand alone and kept only suitable chemicals. On the other hand, DOE chemical storage did not have enough ventilation without an exhaust fan.

Figure 4.2: Example of chemical storage

Sampling kit is a tool-box kind of box where all the sampling equipment is kept. The equipment compulsory in the sampling kit is listed in Table 4.1. Each chemical needs to have its own apparatus and cannot be shared. Thus, the apparatus is usually labelled according to the corresponding chemical. Cool box is needed in the sampling activity to maintain the temperature of the samples between 2℃ to 6℃. Either ice or cool packs are used for this purpose. It was found that a common hazard while preparing the chemical for waste sampling was chemical spillage or splash. Although it might not be as serious as it seemed, it was irresponsible to ignore such hazards. A proper chemical storage with good ventilation needed to be provided by the employer to avoid unsafe condition.

Table 4.1: Equipment list in the sampling kit

Equipment	Purpose
Pipette 5ml and its pump	To transfer chemical to sampling bottle
Sampling bottle (various size according to sample)	Equipment to put the waste
Distilled water	To clean the apparatus after used
Thermometer	To check and control the temperature of the sample
pH paper / litmus paper	To check and control the pH of the sample
Glass rod	To equalize the sample
Seal	To seal sample after sampling procedure
Preservatives	Acids that preserve the sample
Designated plastic	Used to keep scheduled waste sample
Scoop or coliwasa	Used to sample scheduled waste

Figure 4.3 and 4.4 shows example of a sampling kit and preservation in the kit from one of DOE officer.

Figure 4.3: Example of sampling kit

Figure 4.4: Example of preservation in the sampling kit

4.2.2 Second Stage

In terms of performing sampling, it was observed that the officers were exposed to multiple threats, depending on the location. At the sampling sites, it was observed that the officers unloaded the sampling kits and cool box and used a trolley to carry tools towards the sampling area. Some of the cool boxes were equipped with wheels and were conveniently portable. It was also observed that the wastes being taken were in the form of solid and liquid. Generally, the solid waste is a scheduled waste and the liquid waste is an industrial effluent.

Procedure to sample scheduled waste is simpler than industrial effluent. It is either a grab sample or a composite sample. Sampling scheduled waste starts with identifying what kind of scheduled waste to be sampled. Each waste has a different way of storage. For example, sampling used lubricant oil (SW306) requires a glass bottle, while sampling contaminated gloves (SW409) stipulates a designated plastic. Here, the experience of the officer is crucial to decide which method is suitable. Sampling scheduled waste will be a little bit tricky when sampling 'unknown' scheduled waste due to illegal dumping. Sampling 'unknown' scheduled waste thus puts a higher risk of exposure to the officers because of limited information regarding the physical and chemical characteristics. Figure 4.5 and 4.6 are the example of scheduled waste sampling for SW306 and SW409.

The sampling site for scheduled waste was usually done at the scheduled waste storage and sometimes at the production area. After sampling, the bottles or plastics were sealed and labelled accordingly. The wastes had to be kept under room temperature to avoid any changes in their composition.

Figure 4.5: Sampling SW306 by DOE officer

Figure 4.6: Sampling SW409 by DOE officer

Sampling industrial effluent was more technical. First, the DOE officer had to obtain a blank sample in which no preservation was added. The pH of the effluent was tested on the blank sample to estimate how much preservative was needed to add into the actual sample. Preservative was added in the sampling bottle according to the blank sample estimation before putting in the actual waste sample. Note that different parameter required different chemical as preservation and that only one apparatus was used for each chemical. However, in some rare cases where the apparatus was broken or inadequately provided, the DOE officer needed to clean the available apparatus with distilled water first before using it on another chemical. Then, effluent sampling could be commenced accordingly. Usually there were four sample bottles for each parameter as shown in Table 4.2. Although at times the samples taken will be more as to cater other parameters such as sulphide, cyanide, formaldehyde, boron and free chlorine. After each of the samples had been taken, the pH was tested to confirm the value below 2. All the sample bottles were sealed and labelled accordingly. All the effluent samples were kept between 2℃ to 6℃ in the cool box.

Table 4.2: Common sampling parameter for industrial effluent in food industry

Sample	Preservation	Parameters
Bottle A - Plastic	No preservation (use as blank sample)	BOD, SS, Flouride, Color, Chromium
Bottle B - Plastic	H_2SO_4 50% concentration	COD, AN, Phenol
Bottle C - Plastic	Rinse with HNO_3 before sampling, HNO_3 also used as preservation	Heavy metals
Bottle D – Glass	HCl	O&G

Sampling of industrial effluent is usually done at the final discharge point. Sometimes, depending on the case, location of sampling will be at the bypass piping scattered at the premise. From observation, the locations of sampling of each participating premise of this study were different. As seen in Figure 4.7, the sampling location for the first food industry was at a public drain outside the premise with high flowrate effluent. In Figure 4.8, the sampling location for the second industry was at a confined space. Figure 4.9 showed that sampling was at a public drain outside the premise of the third industry involving slippery area. Also, note the difference in flowrate which gave different risk of exposure.

Figure 4.7: Sampling location for first industry

Figure 4.8: Sampling location for second industry

Figure 4.9: Sampling location for third industry

4.2.3 Final Stage

After sampling, the wastes were transported to the Department of Chemistry within 24 hours and it was highlighted that this was a compulsory time range. Upon arrival, the samples were analyzed by the chemists.

4.3 Survey's Output

In total, there were 293 respondents involved in this research, of those among the DOE officers in Putrajaya, Kuala Lumpur and Selangor. Results of the survey were divided into four sections comprising the respondent's profile, safety knowledge, hazard identification, and risk control that had been implemented. Excluding the first section, all other sections were rated as scores to indicate the weight of each section.

4.3.1 Respondent's Profile

In Table 4.3, 65.5% of respondents were male and 34.5% were female. This is quite unexpected because 73% of the staff in DOE is actually female officers (DOE, 2018). Although, the reason can be that male officers usually go into field works and technical areas while female officers work behind the desk. Therefore, the survey of this study would be reliable enough to ponder. It was found that 52.9% of respondents were between 30 to 39 years old, 34.5% were those aged between 40 to 49 and 10.9% were 50 to 60 years of age. Those aged between 20 to 29 made 1.7% of the total respondents. It was also interesting to find that 53.6% of the respondents had 11 to 20 years of experience in DOE, 22.2% of the respondents had 5 to 10 years of experience in DOE, and the remaining 15.7% of respondents had 21 to 30 years of experience in DOE. Respondents with less than 5 years of experience made up 5.5% of the total and those with more than 30 years of experience were 3.1%.

Most of the respondents were from the support group which contributed 80.5% of the respondents and the remaining was from the management and professional area. The support group does the field works including the sampling activity while the management and professionals are the decision-makers. Each body in the DOE is highly correlated to one another in ensuring proper practice of pollution control by industrial players.

In terms of educational background, 69.8% of the respondents were diploma holders, 25.1% of the respondents had a degree certificate, while 5.2% of the respondents hold a master's degree. None of the respondents were a doctorate. From the educational background, 76.5% of the respondents were in engineering field, and 22.9% of the respondents were from the science stream. These two courses contributed to the background of DOE officers. One respondent was from the technology and marketing background.

Table 4.3: Respondent's profile

Variables	Frequency (n= 293)	Percentage (%)
Gender		
Male	192	65.5
Female	101	34.5
Age		
20 – 29 years	5	1.7
30 – 39 years	155	52.9
40 – 49 years	101	34.5
50 – 60 years	32	10.9
Group of service		
Support group	236	80.5
Management and professional	57	19.5
Service experience		
Less than 5 years	16	5.5
5 – 10 years	65	22.2
11 – 20 years	157	53.6

21 – 30 years More than 30 years	46 9	15.7 3.1
Education level Diploma Degree Master PhD	 203 73 15 0	 69.8 25.1 5.2 0
Education background Engineering Science Technology Marketing	 224 67 1 1	 76.5 22.9 0.3 0.3

There are three main sections in DOE which are enforcement, development and education. Usually there will be rotation every four to five years to widen their experience in all sections. From Figure 4.10, it could be seen that 175 respondents were from the enforcement section, 24 respondents from development section and three respondents from the education section. There were 39 respondents with experience from both enforcement and development in their whole career in DOE. Respondents experienced in both enforcement and education sections were nine people, while four respondents had experienced both development and education sections.

Ultimately, those with the highest understanding of the common practice of DOE were the other 39 respondents that had experienced all sections in DOE.

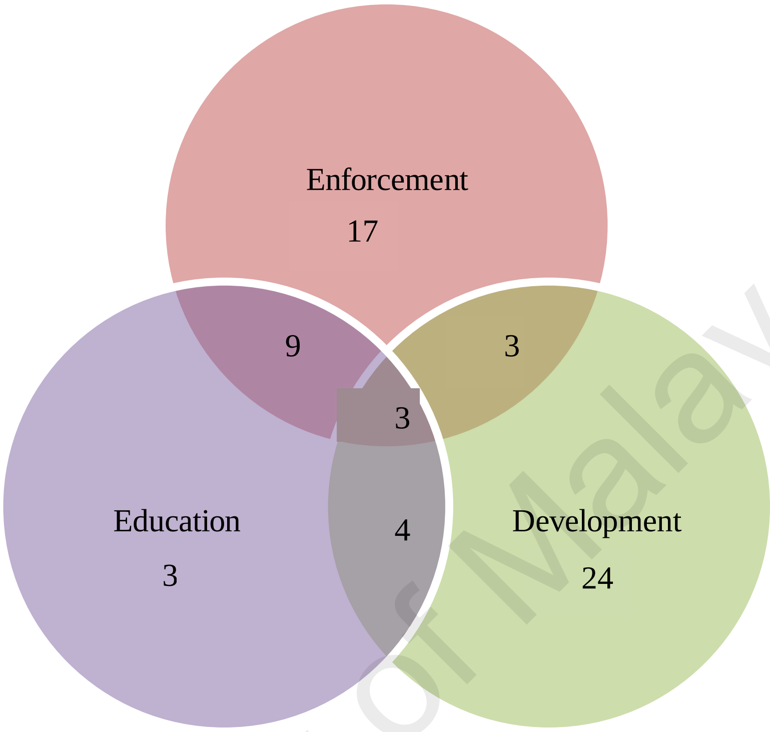

Figure 4.10: Section experience in DOE

4.3.2 Safety Knowledge Section

The rating score of safety knowledge will be based on Table 4.4. Higher score indicates better awareness on the safety culture in DOE. Table 4.5 is the questions in safety knowledge section while Table 4.6 summarizes the overall safety knowledge section from the survey.

Table 4.4: Score and rating for safety knowledge evaluation

Score	Rating
1.00 – 2.00	Very poor
2.01 – 3.50	Poor
3.51 – 4.00	Good
4.01 – 5.00	Excellent

Table 4.5: Question in safety knowledge section

Question No.	Question
Q1	My employer has established safety and occupational health policy and the policy has been explained to me
Q2	My employer provides Standard Operation Procedure (SOP) for waste sampling activity
Q3	The SOP provided by my employer emphasize safety aspect
Q4	My employer provide training for waste sampling activity
Q5	The training provided by my employer emphasize safety aspect
Q6	My employer provides appropriate Personal Protection Equipment (PPE) for waste sampling activity

Table 4.6: Summary of safety knowledge section

Question	Strongly Disagree (1) (%)	Disagree (2) (%)	Neutral (3) (%)	Agree (4) (%)	Strongly Agree (5) (%)	Score
Q1	4.8	10.7	35.7	33	15.8	3.44
Q2	0.0	2.7	11.6	49.5	36.2	4.19
Q3	3.1	11.0	25.4	38.5	22.0	3.65
Q4	1.0	4.8	19.6	46.4	28.2	3.96
Q5	3.4	10.6	30.5	36.0	19.5	3.58
Q6	7.5	15.4	32.8	31.1	13.3	3.28

It could be inferred from Table 4.6 that majority of the DOE officers appreciated the current SOP and showed the credibility of procuring the right safety aspects. This was proven from the excellent score of SOP for waste sampling activity (4.19) which indicated that the DOE officers had high awareness of the SOP and used it as guideline. Furthermore, the finding also indicated that the DOE officers were satisfied with the safety aspects of the current SOP (score 3.65).

Majority of the officers also agreed that training for sampling activities were prominent and beneficial (score regarding training for sampling activity was 3.96). Regardless, the safety aspect was not clearly emphasized during training which was depicted from the moderate score (3.58). As the training was more about technical procedures for sampling, the safety aspect such as PPE required for training, hazards in sampling activity and risk control to reduce the hazards were often disregarded. It could be insinuated that most DOE officers approved to incorporate more about safety measures during the training of sampling as an improvement towards the current program.

It was important to highlight here that findings from the survey showed poor score on the safety policy and explanation of the policy (score was 3.44), by which 48.8% of DOE staff agreed and strongly agreed with the statement. This was rather an unexpected finding because despite that there was a policy; it was possible that the higher officials did not clarify it lucidly to their staff. Also, some of the officers were on the opinion that the PPE provided might not be appropriated enough for the sampling activity (score was 3.28). Of the total number of respondents, 22.9% agreed to this opinion which might be because of the PPE provided for sampling activity did not qualify to the standard SOP. The current PPE is different than that illustrated in the SOP as shown in Figure 4.11. The usual PPE provided are surgical or N95 mask, gloves, safety helmet and safety boots. It was remarkable to learn that these officers had a good understanding of safety upon themselves as workers in the field, and aware of the safety initiative by the employer especially regarding the SOP and training for waste sampling. This reflects their utter commitment for dedicating their lives by putting the welfare of our environment before their own well-being, which is respectable

Figure 4.11: PPE recommended in the SOP for sampling activity

4.3.3 Hazard Identification Section

The rating score for hazard identification will be based on the likelihood of occurrence of chemical, physical, biological and/or ergonomically hazards towards DOE officer as shown in Table 4.7. The summary of hazard identification from respondents is shown in Table 4.8 and 4.9.

Table 4.7: Score and rating for hazard identification section

Score	Rating
1.00 – 2.00	Remote, unlikely but possible to occur
2.01 – 3.00	Occasional, likely to occur sometimes
3.01 – 4.00	Probable, will occur several times and not something unusual

Table 4.8: Question in hazard identification section

Hazard Category	Question No.	Question
Chemical	Q1	Chemical spill or splash during sample preservation
	Q2	Inhalation of chemical during sample preservation
	Q3	Sampling of unknown waste that can cause harm
Biological	Q1	Potential to expose with venomous animal during sampling at bush are
	Q2	Deal with foreign workers with unknown health condition
Physical	Q1	Sampling at height
	Q2	Sampling at slippery area
	Q3	Sampling at noisy area
	Q4	Sampling at confined space
	Q5	Exposed to electrical hazard
Ergonomic	Q1	Sampling activity involved awkward position (eg: bending, squatting, bent neck)
	Q2	Sampling at extreme temperature (hot or cold)
	Q3	Heavy lifting of sampling equipment

Table 4.9: Summary for hazard identification section

Hazards	Never (1) (%)	Rarely (2) (%)	Sometimes (3) (%)	Always (4) (%)	Score
Chemical					
Q1	8.5	23.2	37.9	30.4	2.90
Q2	8.2	20.1	35.8	35.8	2.99
Q3	5.5	15.4	38.2	39.9	3.11
Biological					
Q1	6.8	17.7	41.6	33.8	3.02
Q2	5.1	14.7	35.8	44.4	3.19
Physical					
Q1	7.5	21.5	46.8	24.2	2.88
Q2	3.1	13.0	50.5	32.8	3.12
Q3	4.4	25.3	47.4	22.2	2.86
Q4	10.6	29.4	42.7	17.1	2.66
Q5	14.7	32.8	33.4	19.1	2.57
Ergonomic					
Q1	2.4	10.9	25.6	60.8	3.44
Q2	5.5	13.7	32.8	47.8	3.22
A3	4.1	13.0	34.1	48.8	3.28

It seemed that there was a probability of chemical hazards occurring from time to time, where DOE officers experienced chemical spillage (2.90) and inhalation of chemical (2.99) during sampling activity, especially when transferring samples and chemical preservatives. It was more likely to happen for a less skillful staff or an individual new to the activity. The most important issue to mention here was that the respondents also pointed out that the chemical storage was not properly designed, which was without ventilation. Furthermore, a serious threat to the officers were also sampling unknown waste that usually occurred when dealing with illegal dumping cases, of which was rated high by the respondents. Supposedly, Regulation 13 of Scheduled Waste Regulation 2005 mentions that all waste needs to be provided with a waste card where the information for chemical and physical properties are stated including the risk.

In terms of biological hazards, the results were probable for both risk of venomous animal (3.02) and dealing with foreign workers with unknown health condition (3.19) which became a concern for the DOE officers; reflected from the high score given by the respondents. Foreign workers are general workers in Malaysia and usually work for the small and medium enterprise (SME), including to handle waste from processes. Other than that, some of the respondents stated that they have been exposed to wild animals such as dogs and even crocodiles while sampling in isolated areas like the riverbank.

Apart from that, Table 4.9 also showed that 83.3% officers had experienced slippery conditions while doing sampling, thereby indicating the likeliness of accidents to occur. The main reason is the location of most final discharge points of premises are at a rear end of a drain or a riverbank. Sampling at a certain height (2.88) and sampling at noisy area (2.86) were also given moderate score rating of likeliness to occur. On the other hand, sampling at confined spaces (2.66) and exposure to electrical hazards (2.57) were also moderately scored, suggesting that sometimes, the officers had also been exposed to such hazards. These results indicated that the officers felt the need of a more comprehensive risk control to be incorporated as an improvement. Other physical hazards such as using heavy sampling tools, exposed to lightning due sampling while raining and inadequate lighting when sampling at night were mentioned as well.

On the flipside, ergonomic hazards had become a major issue for the officers. Table 4.9 concluded that all ergonomic hazards listed in the questionnaires had already occurred several times and were not unusual to the respondents. For example, 60.8% of the respondents agreed that they were always in an awkward position while sampling wastes. Plus, 80.6% of the respondents were always exposed to extreme temperature and hot weather because most of the sampling areas were open spaces and the sampling time was usually done at noon. Given the weight and size of the sampling kit and cool boxes, heavy lifting was given a high score of 3.28. This stipulates the need of a control action to eliminate or reduce the risk and avoid future accidents in the future.

4.3.4 Risk Control Section

Table 4.10 reflects the effectiveness of the current risk control measures implemented in DOE. The summary for risk control section is listed in Table 4.11 and Table 4.12.

Table 4.10: Score and rating for risk control section

Score	Rating
1.00 – 2.00	Not efficient
2.01 – 3.00	Less efficient
3.01 – 4.00	Efficient
4.01 – 5.00	Very efficient

Table 4.11: Question in hazard identification section

Question No.	Question
Q1	Existing PPE provided by employer is sufficient to carry out sampling activity
Q2	There is existing engineering control for sampling activity
Q3	Risk control can eliminate occupational accident

Table 4.12: Summary for risk control section

Question	Strongly Disagree (1) (%)	Disagree (2) (%)	Neutral (3) (%)	Agree (4) (%)	Strongly Agree (5) (%)	Score
Q1	10.5	28.0	37.4	19.6	4.5	2.80
Q2	7.6	26.6	45.9	16.9	2.8	2.80
Q3	1.0	9.6	26.8	37.1	25.4	3.76

The most apparent information to extract from Table 4.12 is related to the PPE provided and engineering control. Results for both questions showed that the existing risk control was less efficient with a score of 2.80. From the open questions regarding risk control, some respondents were concerned with the low supply of PPE since using only latex glove for chemical handling was not enough. Sometimes, the PPE had already expired. A suggestion stated by the respondents was to add body harness and safety jacket along with the PPE, especially for sampling at slippery areas such as the riverbank. Since the sampling activities had many possible situations, a few respondents suggested additional adjustable sampling tools to avoid accidents from sampling in confined spaces. A total of 62.5% respondents were consistent with eliminating occupational accidents by implementing risk control measures. This indicates that DOE officers are well aware of the importance of risk control for their safety.

4.4 Qualitative Risk Assessment

After the on-the-job training and survey, a qualitative risk assessment was performed for each stages of the sampling activity to assess the possible hazards that might occur and what would have been the consequences of the incident. Then, the risk was evaluated based on the probability of occurrence and severity of the risk. The risk level was calculated based on the multiplication of probability and severity score. Recommendations were given for each of the risks in order to reduce occurrence probability and risk severity. The result of the qualitative risk assessment is recorded in Table 4.13.

Table 4.13: Qualitative risk analysis for waste sampling activity

Likelihood \ Severity	Negligible (1)	Minor (2)	Serious (3)	Fatal (4)	Catastrophic (5)
Frequent (5)	**5**	**10**	**15**	**20**	**25**
Probable (4)	**4**	**8**	**12**	**16**	**20**
Occasional (3)	**3**	**6**	**9**	**12**	**15**
Remote (2)	**2**	**4**	**6**	**8**	**10**
Improbable (1)	**1**	**2**	**3**	**4**	**5**
Low risk		Medium risk		High risk	

Department:	Department of Environment				Prepared by:	Nurul Syazreen Razali		
Process:	Chemical and sampling kit preparation for sampling activity				Date:	1 March 2020		
Checked by:	Prof. Che Rosmani				Revision date:			
Hazard Identification				Risk Analysis				Risk Control
No.	Job Step	Hazard	Effects	Existing Risk Control	Probability	Severity	Risk	Recommended Control
1	Dilute chemical to required concentration	**1.1 Chemical**						
		Chemical spill or splash	Burn or irritates body parts such as hands or eyes	PPE: Surgical mask and latex glove	2	3	6	Eliminate: Purchase chemical with required concentration Substitution: Chemical dilution

								done by EiMAS since they have lab facility Engineering: Provide designated room for chemical preparation and storage Administration: Provide training and SOP regarding chemical preparation PPE: Goggle, apron, organic vapor

								(OV) mask and nitrile glove
		1.2 Physical						
		Glass bottle or apparatus drop and broke	Body parts injury	PPE: Safety boots	3	2	6	Administration: Provide training and signage at job area
		Slippery condition due to chemical spillage	Body parts injury	None	3	2	6	Administration: Provide spillage kit and signage at job area
		Inadequate lighting	Eye injury	Room lighting	1	2	2	Administration: Provide adequate lighting and ensure lighting is not obstructed

		1.3 Ergonomic						
		Improper body position	Body aches and muscle cramps, muscular skeletal disease (MSD)	None	3	1	3	Administration: Provide training for proper body position in working
2	Repackaging chemical to sampling kit bottle	**2.1 Chemical**						
		Chemical spill or splash	Burn or irritates body parts such as	PPE: Surgical mask and latex glove	2	3	6	Engineering: Provide designated room for chemical

			hands or eyes					preparation and storage PPE: Goggle, apron, OV mask and nitrile glove
		2.2 Physical						
		Glass bottle or apparatus drop and broke	Body parts injury	PPE: Safety boots	3	2	6	Administration: Provide training and signage at job area
		Slippery condition due to chemical spillage	Body parts injury	None	3	2	6	Administration: Provide spillage kit and signage at job area
		Inadequate lighting	Eye injury	Administration: Room lighting	1	2	2	Administration: Provide adequate

								lighting and ensure lighting is not obstructed
		2.3 Ergonomic						
		Improper body position	Body aches and muscle cramps, MSD	None	3	1	3	Administration: Provide training for proper body position in working

Department:	Department of Environment				Prepared by:		Nurul Syazreen Razali	
Process:	Travel to and from the sampling area (Department car)				Date:		1 March 2020	
Checked by:	Prof. Che Rosmani				Revision date:			
Hazard Identification				Risk Analysis				Risk Control
No.	Job Step	Hazard	Effects	Existing Risk Control	Probability	Severity	Risk	Recommended Control
1	Driving a car	**1.1 Physical**						
		Brake failure	Lose control/ car accident/ injury/ death	Administration: Scheduled maintenance, Driving SOP, Training for driver	3	4	12	Administration: Training for driver, monitoring of scheduled maintenance

		Vehicle tire puncture or bald	Lose control/ car accident/ injury/ death	Administration: Scheduled maintenance, Driving SOP, Training for driver	3	4	12	Administration: Training for driver, monitoring of scheduled maintenance
		Slippery road	Lose control/ car accident/ injury/ death	Administration: Follow speed limit	3	4	12	Administration: Prudent driving instructions
		1.2 Ergonomic						
		Improper position	Back ache and neck tension, MSD	Engineering: Adjustable seat	3	1	3	Administration: Stop for rest when muscle feels tense

Department:	Department of Environment	Prepared by:	Nurul Syazreen Razali
Process:	Sampling activity at sampling area	Date:	1 March 2020
Checked by:	Prof. Che Rosmani	Revision date:	

Hazard Identification				Risk Analysis				Risk Control
No.	Job Step	Hazard	Effects	Existing Risk Control	Probability	Severity	Risk	Recommended Control
1	Loading and unloading sampling kit and cool box	**1.1 Physical**						
		Fall of sampling kit or cool box	Injury, property damage	None	3	2	6	Administration: Manual handling training
		1.2 Ergonomic						
		Improper body position	Back and hip ache, MSD	None	4	2	8	Administration: Training of manual handling

		Lifting material more than individual ability	Back and hip ache	Engineering control: Using trolley to handle heavy material	4	2	8	Engineering: Use cool box with wheels Administration: Training of manual handling
2	Insert preservatives into sample bottle using pipette	**2.1 Chemical**						
		Chemical spill or splash	Burn or irritatation of body parts such as hands or eyes	Administration: Waste sampling training, Waste sampling SOP PPE: Latex gloves, safety boot	4	1	4	PPE: Goggle, OV mask, apron and nitrile glove

		Inhalation from toxic chemical from preservative	Respiratory problem	Administration: Waste sampling training, Waste sampling SOP PPE: Surgical or N95 mask	3	3	9	PPE: OV mask
		2.2 Physical						
		Apparatus fall and break	Body parts injury, property damage	Administration: Waste sampling training, Waste sampling SOP PPE: Safety boots	4	1	4	Administration: Manual handling training

		2.3 Ergonomic						
		Improper body position	Back and hip ache, MSD	None	5	1	5	Administration: Manual handling training
3	Sampling waste at sampling area	**3.1 Chemical**						
		Inhalation of toxic gases release from waste	Respiratory problem	Administration: Waste sampling training, Waste sampling SOP PPE: Surgical or N95 mask	3	2	6	PPE: OV mask

		Spill or splash of waste due to high flowrate	Inflammation	PPE: Latex glove and surgical or N95 mask	4	2	8	Engineering: Use adjustable bottle handle or tools to sample waste PPE: OV mask
		3.1 Physical						
		Noise from waste treatment system	Hearing impairment	None	2	3	6	Administration: Training for sampling at dangerous sites PPE: Earmuff or ear plug (premise responsibility)

		Falling due to sampling at slippery area	Injury/ Death	PPE: Safety shoes, safety helmet	4	4	16	Elimination: Premise housekeeping, premise constructs proper sampling platform Administration: Training for sampling at dangerous sites
		Falling from open edges (drain or riverbank	Injury/ Death	PPE: Safety shoes, safety helmet	4	4	16	Elimination: Premise housekeeping, premise constructs

		more than 1-meter deep)						proper sampling platform Administration: Training for sampling at dangerous sites PPE: Harness with robust lifeline (anchorage)
		Inadequate lighting due to sampling at night	Fault trip and fall, injury	PPE: Safety shoes and safety helmet	3	3	9	Eliminate: Premise provides adequate lighting Engineering control: Provide

								spotlight for sampling at night Administration: Training for sampling at dangerous sites
		Fall from height	Injury/ Death	PPE: Safety shoes and safety helmet	4	4	16	Elimination: Premise housekeeping, premise construct proper sampling platform Administration: Training for

								sampling at dangerous sites PPE: Harness with robust lifeline (anchorage)
		Sample in inadequate air for breathing (confined space)	Suffocation/ Death	None	3	3	9	Engineering: Using adjustable bottle handle or tools to sample waste Administration: Training for sampling at dangerous sites

								PPE: Breathing apparatus
		Heat stroke (hot weather)	Black out and fainted	None	4	3	12	Administration: Keep hydration
		3.3 Ergonomic						
		Improper body position	Body and hip ache, neck tension, MSD	None	5	1	5	Administration: Manual handling training
		3.4 Biological						
		Expose to venomous animal (bush area)	Injury/ Death	None	3	3	9	Eliminate: Premise does housekeeping to keep any dangerous animals nearby

		Expose to wild animal such as dog and crocodile (remote area)	Injury/ Death	None	3	3	9	Eliminate: Premise does housekeeping to keep any dangerous animals nearby
		Expose to bacteria/ virus/ parasite	Infection	Administration: Provide Hepatitis B injection for exposed workers PPE: Surgical or N95 mask	2	4	8	Administration: Occupational health training, good hygiene practice/ procedure
4	Test sample for	**4.1 Chemical**						

	pH and temperature	Chemical spill or splash	Burns or irritates body parts such as hands or eyes	Administration: Waste sampling training, Waste sampling SOP PPE: Latex gloves, safety boot	4	1	4	PPE: Goggle, OV mask, apron and nitrile glove
		Inhalation of toxic chemical from preservative	Respiratory problem	Administration: Waste sampling training, Waste sampling SOP PPE: Surgical or N95 mask	3	3	9	PPE: OV mask
		4.2 Physical						

		Apparatus falls and break	Body parts injury, property damage	Administration: Waste sampling training, Waste sampling SOP PPE: Safety boots	4	1	4	
		Mercury type thermometer falls and break	Expose to mercury poisoning	None	4	3	12	Substitution: Using alcohol type or digital thermometer
		4.3 Ergonomic						
		Improper body position	Back and hip ache, MSD	None	5	1	5	Administration: Manual handling training

5	Prepare sample bottle for delivery to Chemistry Department	**5.1 Physical**						
		Sample bottle falls and break	Body parts injury, property damage	Administration: Waste sampling training, Waste sampling SOP PPE: Safety boots	3	1	3	Administration: Manual handling training
		Heat stroke (hot weather)	Blacked out and fainted	None	4	3	12	Administration: Keep hydration
		5.2 Ergonomic						
		Improper body position	Back and hip ache, MSD	None	5	1	5	Administration: Manual handling training

Table 4.14: Summary of risk rating in qualitative risk assessment

Risk rating	**Total**
Low risk	10
Medium risk	29
High Risk	3

As summarized in Table 4.14, a total of 42 hazards were found to possibly risk human lives and property damage during the sampling activity. Out of the total, 3 hazards were highlighted as high risk and immediate action was necessary to avoid accidents in the near future. From the analysis of risk, it could be inferred that all high risk was attributed with the sampling area itself. First, it is suggested here in order to eliminate or control the 3 major risk hazards, the premises are urged to upgrade their waste area into a proper platform for sampling. In Regulation 29, IER 2009, it is stated that premises need to offer reasonable assistance and facility available for the purpose of inspection. In the same regulation, from the Eleventh Schedule, the location of discharge point must be easily accessible and does not pose any safety hazards to any personnel for sampling purposes.

Then, in terms of staff training, the DOE has to support refreshment trainings to increase the technical proficiency of DOE officers, mainly for those working at dangerous sites such as sampling in confined spaces. For instance, sampling in a manhole for sewage requires certain techniques as well as wearing the proper PPE and breathing apparatus. It is also proposed that training for sampling at slippery edges or at a certain height by wearing harnesses is also crucial for the DOE officers. This is to prepare themselves for sites like the riverbank or high bridge. It is well understood that these officers have gone through training for sampling; however it is also important to upgrade the current skills especially for those constantly exposed to dangers in the field.

Despite all that, chemical risks were entirely rated as medium risk and the advantage of this was the existing control measures were appropriately applicable. However, it is advisable that for improvement, the chemical storage room needs proper ventilation system and equally suitable PPE for chemical handling. The reason for acquiring and matching the suitable PPE that meets the standard SOP is crucial especially when waste sampling activity involves irritable chemicals and unknown waste samples. It is recommended that organic volatile (OV) mask and nitrile gloves are used to handle chemicals.

Ergonomic hazards were also rated as medium risk with high probability of occurrence but low severity. Improper body position tends to happen during sampling activity due to repeating movement of squatting, bending, twisting and heavy lifting. A proper manual handling training will reduce the risk for ergonomic risks and boosts awareness of the staff regarding proper position for posture.

Biological hazards in waste sampling activity were rated as medium risk. Hazards from venomous and wild animals can be reduced if the premises perform proper housekeeping. It is a good initiative from DOE to provide injection for Hepatitis B, especially when the officers are possibly exposed to viruses while sampling in the sewage. From Table 4.14, 10 hazards were rated as low risk. Generally, these risks do not need further action, but calls attention for extra awareness from the officers. For an example, apparatus falls and breaks can be avoided with extra caution. Safety culture such as frequent safety briefings and reminders in the toolboxes can be implemented to ensure consciousness to avoid accidents.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

Waste sampling activity is one of the main job descriptions in DOE. There is still no documentation regarding risk assessment for waste sampling activity and the activity sometimes considered as low risk. Risk assessment for waste sampling activity was analyzed in this study. The hazards were identified by observation, on-job training and survey. Risk assessment was developed, and risk control was suggested from the identified hazards.

5.2 Conclusions

Hazards were the circumstances of working in the field, but the chances of hazards to cause harm towards the health and well-being could be avoided regardless. Findings from the on-the-job training at the selected food industries and outcome from the survey were convincing enough for this research to come up with a systematic risk assessment as a countermeasure for the DOE, particularly in the sampling activity.

Dangers vary from physical hazards such as dangerous postures, slippery riverbanks, or tight manholes, and biological hazards like venomous and wild animals, as well as chemical hazards like sampling unknown wastes without really knowing the properties of the samples. Generally, sampling scheduled waste was found to be simpler than wastewater discharge because of no involvement of chemicals but sampling unknown scheduled waste gave a certain level of uncertainty that needed precautionary safety measures. In addition to this, outcome from the survey further corroborates the understanding of the experiences of the DOE officers on the job in detail.

The survey was participated by 293 cooperative members of the DOE; with most of the respondents had major experience in enforcing waste sampling. The survey confirms the possibility for chemical, physical, ergonomic and biological hazards while performing the waste sampling. Ergonomic hazards were given the highest rating by the respondents, indicating that officers were very concerned about the awkward postures they had to endure while performing sampling. Thus, the respondents agreed that risk control could eliminate these hazards. Although they seemed to be aware of the availability of the current risk control measures, the survey however showed that it was inadequate in several ways.

Generally, 43 hazards were identified from the qualitative risk assessment for waste sampling activity. Of the 43 hazards, 3 were categorized as high-risk hazards that required immediate action to reduce the risk. Although waste sampling activity can be underestimated as low risk job, without proper and adequate risk control, one might lose their life, gotten injured, or causes damage to property.

5.3 Recommendations

Other perspective of assessment can be applied for risk assessment to give a different approach and details out major hazards. Health effects are not discussed in this study; thus it is recommended that Chemical Health Risk Assessment (CHRA) to be conducted regarding the use, handling and storage of chemicals that are hazardous to health. CHRA will be assessed by an assessor registered with DOSH according to Occupational Safety and Health (Use and Standard of Exposure of Chemicals Hazardous to Health) Regulation 2000.

Behavior based study can also be included to broaden the perspective. Attitudes are related to unsafe act and combination of unsafe act and unsafe condition leads to accidents. Example of poor attitude is not wearing PPE although it has been provided by the employer. There is a possibility that employees wear the PPE because fear of enforcement and to avoid any fines. This attitude should be changed from fear over being fined into feeling of contributing towards the safety of the organization (Health and Safety Authority, 2013).

It is also encouraged that ergonomic risk assessment (ERA) to be included in further works. Since ergonomic is rated as the highest risk in this study, it is fairly logical to obtain an in-depth evaluation from a trained person as per recommended in the guideline of DOSH. Based on the guidelines, ergonomic hazards do not only affect the physical but also physiological work demands (DOSH, 2017).

REFERENCES

Annual Report 2018, Department of Environment

Annual Report 2019, Department of Environment

AuYong, H. N., & Chin, Y. H. (2019, June). Cleaner production and sustainability: stakeholder pressure and the adoption of pollution prevention measures of industrial hazardous waste in Malaysia. In *IOP Conference Series: Earth and Environmental Science* (Vol. 268, No. 1, p. 012027). IOP Publishing.

Environmental Quality Act. (1974). Act 127 and subsidiary legislations.

Fox, M. A., Spicer, K., Chosewood, L. C., Susi, P., Johns, D. O., & Dotson, G. S. (2018). Implications of applying cumulative risk assessment to the workplace. *Environment international*, *115*, 230-238.

Gul, M., & Ak, M. F. (2018). A comparative outline for quantifying risk ratings in occupational health and safety risk assessment. *Journal of cleaner production*, *196*, 653-664.

Hamka, M. A. (2017). Safety risks assessment on container terminal using hazard identification and risk assessment and fault tree analysis methods. *Procedia engineering*, *194*, 307-314.

Jamin, N. C., & Mahmood, N. Z. (2015). Scheduled Waste Management in Malaysia: An Overview. *Advanced Materials Research*, *1113*.

Jacxsens, L., Uyttendaele, M., & De Meulenaer, B. (2016). Challenges in risk assessment: quantitative risk assessment. In *International conference of Sabaragamuwa*

University of Sri Lanka 2015 (ICSUSL 2015): Challenges beyond food security(Vol. 6, pp. 23-30). Elsevier Science.

Jusoh, Z., Shattar, N. A., Majid, H. A. M. A., & Adenan, N. D. (2016). Determination of Hazard in Captive Hotel Laundry Using Semi Quantitative Risk Assessment Matrix. *Procedia-Social and Behavioral Sciences*, *222*, 915-922.

Kshash, A. H. (2019). A storage cabinet design for research chemicals for developing nations. *Journal of* Chemical *Health & Safety*, *26*(4-5), 29-32.

Landberg, H. E., Westberg, H., & Tinnerberg, H. (2018). Evaluation of risk assessment approaches of occupational chemical exposures based on models in comparison with measurements. *Safety science, 109*, 412-420.

Lien, C. C., Shen, Y. C., & Ting, C. H. (2014). Ohmic heating for tofu making—A pilot study. *Journal of Agricultural Chemistry and Environment*, *3*(02), 7-13.

Malaysian Investment Development Authority (2020). Malaysia's Industrial Growth Complements Global Supply Chain. https://www.mida.gov.my/home/malaysia/posts/

Metcalf, L., Eddy, H. P., & Tchobanoglous, G. (1979). *Wastewater engineering: treatment, disposal, and reuse*. New York: McGraw-Hill.

Noh, M. F. & dan Suhaini, N. A. (2019, June). Pencemaran udara: 16 sekolah, 69 tadika, 1 IPT ditutup. Berita Harian. https://www.bharian.com.my/berita/nasional/2019/06/577266/pencemaran-udara-16-sekolah-69-tadika-1-ipt-ditutup

Occupational Safety and Health Act. (1994). Act 514 and subsidiary legislations.

Pasman, H., & Rogers, W. (2018). How trustworthy are risk assessment results, and what can be done about the uncertainties they are plagued with?. *Journal of loss prevention in the process industries*, *55*, 162-177.

Pasman, H. J., Rogers, W. J., & Mannan, M. S. (2018). How can we improve process hazard identification? What can accident investigation methods contribute and what other recent developments? A brief historical survey and a sketch of how to advance. *Journal of loss prevention in the process industries*, *55*, 80-106.

Persampelan Buangan Terjadual Di Bawah Seksyen 48AB, Akta Kualiti Alam Sekeliling, 1974 (2013)

Petrovic, M., Sremacki, M., Radonic, J., Mihajlovic, I., Obrovski, B., & Miloradov, M. V. (2018). Health risk assessment of PAHs, PCBs and OCPs in atmospheric air of municipal solid waste landfill in Novi Sad, Serbia. *Science of The Total Environment*, *644*, 1201-1206.

Protokol Persampelan, Pengawetan dan Pengendalian Sampel Untuk Tujuan Penguatkuasaan (2015)

Sinar Harian (2019, March). Penolong Jurutera JAS Pengsan Lepas Terhidu Bahan Kimia. https://www.sinarharian.com.my/article/19453/EDISI/Johor/Penolong-jurutera-JAS-Johor-pengsan-lepas-terhidu-bahan-kimia

The Star (2019, March). Teams Deployed to Monitor Sungai Kim Kim for Contamination. https://www.thestar.com.my/news/nation/2019/03/16/river-under-constant-watch

Valis, D., & Koucky, M. (2009). Selected overview of risk assessment techniques. *Problemy* eksploatacji, 19-32.

Zio, E. (2018). The future of risk assessment. *Reliability Engineering & System Safety*, *177*, 176-190.