

SAFETY AND HEALTH PRACTICE AMONG
WORKERS IN MUNICIPAL SOLID WASTE
MANAGEMENT IN SARAWAK



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SAFETY AND HEALTH PRACTICE AMONG WORKERS IN MUNICIPAL
SOLID WASTE MANAGEMENT IN SARAWAK

IVY DEIRDRE ANAK MANGKAU



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A thesis submitted in
fulfilment of the requirements for the award of the
Doctor of Philosophy in Technology Management

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DECLARATION

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged.

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DEDICATION

I dedicate my dissertation work to my beloved families and friends that support me throughout the process. A special feeling of gratitude to my loving mother (**Madam Pauline John**), my brothers (**Gareth Tembah Mangkau and Frederick Noel Mangkau**) whose words of encouragement and push for tenacity in my ears, my daughter (**Aubrielle Joanna Venedict**) and to my three “anak syurga”.



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ABSTRACT

The current issues of safety and health practice among solid waste management workers to date are less highlighted in our country compare to foreign country. This research is important because it provide important information about occupational problems trends in Malaysia as Concessionaires Company neglected safety and health precaution as in the contract. The push for sustainability solid waste management from the aspect of safety and health thru improvement of contract in between Municipal Council (local authority) and Concessionaires Company hopefully can bring awareness to related parties. The research is conducted to study the issues in safety and health practice among solid waste management workers, and to increase stakeholder and public awareness regarding safety and health issues. This research probed and undertaken to determine occupational problems among municipal solid waste management in the context of physical, health, psychological and social health, analyses the safety and health practice as in the contract and, to develop a framework to achieve sustainable solid waste management in safety and health aspects. The methodology adopted was a hybrid approach (mixed method). Through quantitative approach, a survey instrument constructed for occupational problem among solid waste management workers. Meanwhile, qualitative approach, a semi-structure interview involve two safety officer from Concessionaires Company and one municipal council officer are analyses manually. Five key aspects to improve contract at Local Authority level were formulated namely policy, training, emphasis on PPE, inspection and insurance. Meanwhile, five key categories to improve safety and health at Concessionaires level are formulated namely resources, cultural dimension, working condition and employee safety, communication and training. The novelty gained from this research is to form-up framework to achieve sustainable solid waste management in safety and health aspects which already implemented in two districts. It can serve as a benchmark and guidance in addressing the current safety and health practice in waste industry in our country.



ABSTRAK

Isu keselamatan dan kesihatan dalam kalangan pekerja pengurusan sisa pepejal kurang diketengahkan di Negara kita berbanding dengan Negara asing. Penyelidikan ini penting kerana memberikan maklumat penting mengenai tren masalah pekerjaan di Malaysia kerana Syarikat Konsesi mengabaikan keselamatan dan kesihatan seperti dalam kontrak. Dorongan ke arah pengurusan sisa pepejal yang mampan dari aspek keselamatan dan kesihatan melalui penambahbaikan kontrak diantara Majlis Perbandaran (Pihak Berkuasa Tempatan) dan Syarikat Konsesi diharap dapat memberi kesedaran kepada pihak yang berkaitan. Penyelidikan ini dilakukan untuk mengkaji isu-isu dalam amalan keselamatan dan kesihatan di kalangan pekerja pengurusan sisa pepejal, dan untuk meningkatkan kesedaran dalam kalangan pihak berkepentingan dan masyarakat mengenai masalah keselamatan dan kesihatan. Sehubungan dengan itu, penyelidikan ini meneliti dan melaksanakan bagi menentukan masalah berkaitan pekerjaan dalam kalangan pengurusan sisa pepejal perbandaran dari kontek fizikal, kesihatan, psikologi dan sosial, menganalisis amalan keselamatan dan kesihatan seperti di dalam kontrak, dan untuk merangka rangka kerja bagi mencapai pengurusan sisa pepejal yang mampan dalam aspek keselamatan dan kesihatan. Metodologi yang digunakan adalah pendekatan hybrid (metode campuran). Melalui pendekatan kuantitatif, instrument kajian yang dibina untuk mengetahui masalah berkaitan dengan pekerjaan di kalangan pekerja pengurusan sisa pepejal. Sementara itu, pendekatan kualitatif, temu bual separa struktur melibatkan dua pegawai keselamatan dan seorang pegawai majlis perbandaran telah dianalisis secara manual. Lima aspek utama untuk memperbaiki kontrak di peringkat pihak berkuasa tempatan telah dirumuskan iaitu, polisi, latihan, penekanan penggunaan PPE, pemeriksaan dan insurans. Manakala, lima kategori utama untuk meningkatkan keselamatan dan kesihatan di peringkat konsesi telah dibentuk iaitu, sumber, dimensi budaya, keadaan tempat kerja dan keelamatan pekerja, komunikasi dan latihan. Penemuan baru atau “novelty” dalam kajian ini adalah pembangunan rangka kerja untuk mencapai pengurusan sisa pepejal yang



mampan dalam aspek keselamatan dan kesihatan. Sehingga hari ini, rangka kerja tersebut telah dilaksanakan di dua daerah. Ia boleh dijadikan penanda aras dan panduan dalam menangani masalah amalan keselamatan dan kesihatan dalam industri sisa pepejal di Negara kita.



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LIST OF ABBREVIATIONS

<i>SWM</i>	-	Solid Waste Management
<i>SWMW</i>	-	Solid Waste Management Worker
<i>PPE</i>	-	Personal Protective Equipment
<i>SSS</i>	-	Site Safety Supervisor
<i>MHLG</i>	-	Ministry of Housing and Local Government



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CHAPTER 1

INTRODUCTION

1.1 Introduction

Increase of population, increase of industrial manufacturing, urbanisation, modernisation, increase of demand for goods, technological advancement, and festive season cause increase of waste produce by human. The increased waste volume in the landfill sites, improper waste disposal, dumping of hazardous waste, manual handling of wastes, absence of any engineering controls or inadequate personal protective equipment, poor hygiene education, lack of adequate washing facilities at workplaces, poor personal hygiene practices among staff, lack of awareness about health and sanitation, and inadequate environmental management at landfill sites expose the waste workers to occupational hazards (occupational injuries and occupational disease) (Roopa *et al.*, 2012; Alam & Ahmade, 2013, Elena-Diana *et al.*, 2016; Madaleno, 2018; Bećirović *et al.*, 2015; Triassi *et al.*, 2015; Haseena *et al.*, 2017). As a result, it causes high risk of safety, health, and environmental problem. Wastes, in most cases, are infectious. Studies suggest that 10-25% of waste that produce by the household wastes are hazardous (Soares *et al.*, 2013; Edokpayi *et al.*, 2017; Uchendu, 2016; Klinck & Stuart, 2021).

Since waste industry is very dangerous and prone to get accident and injuries, it is a must for both employer and employee to practice a good safety and health. The low practice of safety and health can lead to two situations: occupational injuries and occupational diseases. Occupational injuries will affect the safety level of the workers and occupational diseases are more to concern with the health and personal problems of the workers. El-Wahab *et al.* (2014) mention in their study that municipal solid



waste workers are exposed to a variety of occupational injuries and occupational diseases.

The most common examples of occupational injuries among solid waste management workers include such as needle prick injuries, cuts, bruises, rapture in body, back pain, dislocation of joint, wrist pain, elbow injury, aches, being struck by refuse collection vehicles, struck by falling objects, trip and low falls, and other physical pains (Bleck & Wettberg, 2012; Fewtrell, 2012; Kim & Arama, 2018; Arquillos *et al.*, 2019; Lacramioara *et al.*, 2017; Jeong, 2016; Jeong *et al.*, 2015; Battaglia *et al.*, 2015). The occupational injuries often occur due to poor personal protective equipment used by the workers. Oviasogie *et al.* (2010) state that after waste is generated, waste workers collect and dispose of such waste along the roadside, around the residential area or in a government-approved dumpsite. During waste collection and disposal most workers in developing countries hardly use protective devices. Since the municipal solid waste workers do not use proper personal protective equipment so it makes them vulnerable to serious safety and health problems.

The occupational diseases often occur due to the poor protective measures taken by the workers even though they know what kind of wastes they are handling. The most common occupational diseases are allergies, symptoms of poisoning, respiratory tract diseases, cancer and cardiovascular diseases. The solid waste management (SWM) industry faces occupational health problems such as cold, cough, chronic cough, bronchitis, bronchial asthma, tuberculosis, respiratory problem, eye irritation, headache, intestinal disorder and skin rashes due to a long-term exposure to waste (Bleck & Wettberg, 2012; Mudalige & Dharmathilake, 2000; Salem *et al.*, 2020; Rabbani *et al.*, 2020; Mihai & Grozavu, 2019; Mensah & Ampofo, 2021).

1.2 Background of the Study

ASEAN country is experiencing an increasing of population and mostly the total population is living in the urban areas. Due to increasing of population, is directly cause increase of volume and composition in waste generation. Constantly increase of waste end up a major problem to final treatment and disposal. Before going for final treatment and disposal, collection of waste is done by the solid waste management

workers; individual that faces first contact with the waste. Majority in ASEAN countries still practice open dumping and open burning of waste due to lack of technology and infrastructure. This problem causes environmental problems and challenges (United Nations Environment Programme, 2017; Dinie & Don, 2013).

Many ASEAN countries have their own policies to tackle the waste problem in their own country. The policies covered many aspects in order to protect the workers that dealing with waste to environment, but the implementation and enforcement of the policies is not good as its pictures. For example, waste management in Cambodia, a weak supervision by the local authority upon the concessionaire's company, extremely limited resources and alternative for waste disposal causing major environmental problem. The Cambodian sub-decree on Solid Waste Management (Article 4) that establish is a guideline for collection, transportation, storage, recycling, minimising and disposal of waste. Meanwhile the Cambodian sub-decree on Solid Waste Management (Article 6) that establish is a guideline for enforce officer to monitor and enforcement the policies and regulation. To achieve sustainable waste management, the Cambodian establishes the 3R policies and regulation in order to reduce the waste production from the beginning (Curea, 2017).

Another example for ASEAN countries is Laos, for the past decades, mostly the waste generation is organic and biodegradable. Due to urbanisation, Lao also face waste management problem due to improper waste management as there is changing of lifestyle and type of waste generate. The Laos government implementing separation of waste at source to reduce the volume and type of waste that going to final disposal site in order to extending lifetimes of landfill and to avoiding soil and water pollution (Curea, 2017).

Next ASEAN country that near to our country is Vietnam, they are implementing 3R policy approach to achieve sustainable waste management in their country. The policy emphasis on waste reduction without ignores the impact upon environment. But clearly, there is lack of awareness among their citizens regarding 3R policy (Curea, 2017).

Our neighbouring country, Singapore, they have very efficient waste management system of waste disposal. The industrial and citizen are actively playing their own role in order to sustain waste management. 100 % of waste produce in



Singapore is going to incinerator to reduce volume of raw waste. The Ministry of Environment and Water Resources of Singapore is focus on policy issues, namely focuses on air and water-related issues and environment issues so it meets the high standard of public health. The National Environment Agency emphasizes on environmental protection to control pollution produce by waste thru prevention, enforcement, monitoring, public education and responsible care in environmental management (Asian Productivity Organization, 2007).

In our country, we are still struggling handling our waste issues which mainly related with environment issues. Not only that, a good safety and health practice in waste industry is not emphasis and enforced accordingly to the Act, Rules and Regulation that set by the government. Solid waste management in Malaysia has a long way to go to become sustainable as in developed country (Hassan *et al.*, 2001; Dinie & Don, 2013). In order to ensure the safe and healthy working environment, Department of Occupational Safety and Health (Malaysia) has enforced the Occupational Safety and Health Act 1994 (Act 514) (Baba, 2007). The purpose of this act is to ensure the safety, health and welfare of workers, to protect people at work (other than those who are employed), to encourage an environment that is appropriate to the physiological and psychological health of the persons who are working and to provide a legal system based on the rule and industry codes of practice in addition to the provisions of the Act. However, Act 514 covers and protects all who work in all economic activities, including the civil service, statutory bodies and the private sector except those working on board commercial and military forces. To ensure the implementation of the Act, the safety and health committee is established which aims to promote the concept of consultation and cooperation to improve the level of safety and health at work, providing a forum or channel two-way communications to deliver comments, views, information and feedback on the issues related to the safety and health, and also to foster interest and motivation of all parties in the field of occupational safety and health. The main function of safety and health committee is to assist in providing security measures and health and safety system of work, conduct inspections, investigate accidents and complaints, review of safety and health policies in the workplace and help organize a program of incentives and education. There are several regulations under OSHA 1994 (Act 514) of Employers' Safety and Health



General Policy Statements Exception Regulations 1995, Control of Industrial Major Accident Hazards Regulations 1996, the Safety and Health Committee Regulations, 1996, Classification, Packaging and Labelling of Hazardous Chemical regulations 1997, the Safety and Health Officer regulations, 1997, the Safety and Health Officer Order 1997, Use and Standards of Exposure of Chemical Hazardous to Health 2000 and the Notification of Accident, Dangerous occurrence, Occupational Poisoning and Occupational Disease regulations, 2004.

1.3 Research Problem

Issues of low safety and health practice are also influenced by low enforcement by the local authorities toward the concessionaire's company. The term and condition of the contract for the refuse collection and disposal work less focused upon solid waste management worker's safety and health from the aspect of using personal protective equipment (PPE), insurance, training, policy, and health inspection. As Term and Conditions of Contract for the Refuse Collection and Disposal Work Contract [Appendix A] subject number 8: Scavenging Truck and Workman, it focused on the well-being of employees. But only sub-subject number 8.4 mention about using PPE.

“During working hours, all the workers shall wear reflective vests/uniform provided by the Contractor, and the Contractor shall ensure that these vest/uniforms are being worn during all working hours”.

In the contract, there is no emphasis on proper personal protective equipment (PPEs), insurance coverage for the foreign workers and regular medical check-up for solid waste management workers. It is based upon employer responsibility either they aware about safety and health of their employee's or not. As found out, only few concessionaires company aware about safety and health of their workers since the company owner has an education background of site safety supervisor (SSS).

Since municipal solid waste in the selected research areas is collected manually, the solid waste management workers are prone to a high risk of injury during the collection process. It is important to study the hazard and risk faced by the solid waste management workers in our country since it has an impact on the environment, safety and human health especially those living near the landfill, and the solid waste

management workers. After studying the hazard and risk that might be faced by our solid waste management workers during working hours, it is important to overcome the problem by tackling it from the root. By eliminating the hazards or the risks, the safety and health of our solid waste management workers will reduce the occurrence of accident or incident.

Issues of low safety and health practice are also influenced by environment problem. To protect the public's health and keep our city and streets clean, the solid waste management workers adopt harmful way of practice. They face hazards during waste collection, waste transportation, waste treatment (composting, incineration and material recycling facilities), and waste disposal. The hazards come through various routes especially during their contact with waste. As the amount of waste tends to increase from year to year, along with the increasing population and rapid pace of urbanization have created several problems leading to the environmental pollution, impact and effect on human health especially to the solid waste management workers. Inability to effectively manage solid waste could lead to environmental deterioration which is harmful to health and life. Sometimes people dump and dispose of waste in open dump especially in the outskirts of the city with no concern to the environmental and public health problems (Alam & Ahmade, 2013; Talyan *et al.*, 2008; Jalil, 2010; Samah *et al.*, 2013; Latif *et al.*, 2012).

The employment situation at the workplace for solid waste management employees is risky due to hazardous chemical and biological materials that are present in the waste stream. Whether they are working in a landfill or who work collecting garbage on the roadside, if the working conditions do not contribute towards ensuring the safety and health of employees, it appeared that the level of safety and health of workers in an institution is not good. Less favourable conditions contribute to the accident, incident, illness, and injuries. Apart from that, low safety and health practice among solid waste management workers also contribute to the accident, incident, illness, and injuries due to work. Statistics show that workers who work in the field of waste management are exposed to a greater danger and often deadly occupation (Wassim *et al.*, 2013). This is supported by Rogoff and Biderman (2015) and Drudi, (1999) who declared the job of solid waste management workers as the most dangerous job including dirty strenuous work due to a higher chance of accidents. Cointreau,



(2006) mention that most causes of death among solid waste management worker(s) were directly related to work such as struck by and falling from the waste vehicle.

1.4 The research questions

This study was carried out to answer the following question:

- i). What are occupational problems among municipal solid waste management in the context of physical, health, psychological and social health?
- ii). What are the safety and health practice as in the Refuse Collection and Disposal Work Contract?
- iii). What is the framework to achieve sustainable solid waste management in safety and health aspect?

1.5 Research objectives

This study, therefore, seeks to achieve the following objectives:

- i). To study occupational problems among municipal solid waste management in the context of physical, health, psychological and social health.
- ii). To analyse the safety and health practice as in the Refuse Collection and Disposal Work Contract
- iii). To form up a framework to achieve sustainable solid waste management in safety and health aspects.

1.6 Research Gap

Research gap have been assessed at contract level and policy enforcement. Mainly the previous researcher studies merely policy enforcement at different level, but nonetheless studies about safety and health practice of waste management worker. These gaps have never been assessed widely in our country due to confidential issues and sensitivity issues. So, this research is conduct with goal to achieve sustainable solid waste management from the aspect of safety and health practice after researcher

determine the occupational problems among municipal solid waste management in the context of physical, health, psychological and social health.

1.7 Scope of the Study

This research is to study the current safety and health practice among municipal solid waste management workers at Sarawak. Specifically, this research wants to consciously know and identify occupationally problems among solid waste management workers in the context of physical, health, psychological, and social health. The respondents of this study are the stakeholders and the solid waste management workers. Stakeholder consists of local authorities and concessionary companies. The state of Sarawak is chosen as scope of study due to its geography. Sarawak is the second largest state in Malaysia. Furthermore, the State of Sarawak has its own Act and Regulation on waste management. Case study or research regarding safety and health of solid waste management workers never been done in Sarawak. After reviewing the Term and Condition of Contract for the Refuse Collection and Disposal Work Contract (Appendix A) and Act, there is a flaw and lack of several information regarding safety and health which directly affect the workers.

1.8 Significance of the Study

This research will give a greater impact to certain individual (municipal solid waste management workers) and stakeholder (Concessionaires Company and local authority). Other stakeholders that gain indirect benefits such as Ministry of Housing and Local Government, National Solid Waste Management Department, Solid Waste and Public Cleansing Management Corporation, collector and manufacturer, non-government organization, private residents association, educational institution, and private waste recycle.



1.8.1 Stakeholder

The concessionaires' company will know the lack of safety equipment and personal protective equipment in their concessionaires' company. The management never overlook upon health supervision that they provided to the employees as currently medical check-up only done for renew working permit, not on regular basic. Base on outcome, concessionaire company need to provide proper safety equipment and PPEs to the workers and keep the level of safety and health as their top priority.

The Municipal Council at Local Government can implement the framework on achieving sustainable solid waste management in safety and health aspects by reconstruct and change the Term and Conditions of Contract for the Refuse Collection and Disposal Work Contract. They also can enforce the use of PPEs among Concessionaires Company by emphasis on use of PPEs in the contract.

1.8.2 Academic aspect

In this study, researcher contribute a framework on how to achieve sustainable management in the solid waste management from the aspect of safety and health after knowing the current practice of safety and health among the municipal solid waste management workers and knowing the occupational health problems in the context of physical, health, psychological and social. The element that related to safety and health practice and the relationship among the element with safety and health practice is used to build a framework for achieving sustainable solid waste management. Finally, this research will contribute to a new side of view which is now relevant as the safety and health among municipal solid waste workers being neglected.

1.9 Organization of thesis

The findings from each stage of research are presented sequentially within the following sections:

Chapter 1 presents the overview and the direction of the study. The background of the study, problem statement, research objectives, the purpose of conducting the study and the significance of the study also has been highlighted in this chapter.

Chapter 2 discusses the relevant theories and literature from past research to strengthen the framework of the study. Most of the topics will cover waste management, health, and safety hazards and environmental hazards. Framework and justification of the variables are also being presented in this chapter.

Chapter 3 discusses the methodology and research design of the study which includes measures, questionnaire design, units of analysis, sampling and pilot testing. The questionnaire design will be presented in detail with relevant reference to the literature.

Chapter 4 describes the results of the quantitative data analysis and its interpretations. Quantitative data gathered through a questionnaire is analysed using SPSS software.

Chapter 5 describes the result of qualitative data analysis and its interpretations. Content analyses are used to analyses the qualitative data gathered through interview and observation.

Chapter 6 describes the form up of a framework to achieve sustainable solid waste management from the aspect of safety and health practice.

Chapter 7 summarizes the main qualitative and quantitative findings of the present research. It also presents some concluding remarks, implications for safety and health practices and suggestion for further study.

1.10 Conclusion

As the waste dramatically increases from year to year, it affects the health of humans and the stability of our planet. As our population increases, so does the waste due to collision of rising standards of living and insufficient technical and financial resources. Unfortunately, the safety and health of solid waste workers are marginalized in our country. It is essential for the authorities to act to overcome the issues.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Chua, (2006) defines the literature review as making references to the documents that content information, ideas, data and method with critical and systematic in order to obtain information related to the topic of research. Chapter 1 explains the background of the study, problem statement, research questions, and objectives of the study and the significance of the study. The discussion in Chapter 1 reflects the importance of safety and health practice among solid waste management workers. In this chapter, it will be discussed more on how to achieve the sustainable solid waste management through the aspect of the element of solid waste. Current practice of safety and health in municipal waste is not prominence in our country, except for the workers that taking care of clinical waste, since it under the management of the Ministry of Health (MOH). Ministry of Housing and Local Government played a big as policies maker and system, but they must tackle the lack of safety and health practice from the root. The enforcement parties such as the local authority officer and district officer must play along to tackle the low safety and health practice in municipal solid waste (Sreenivasan *et al.*, 2012; Razali & Ishak, 2010; Adekunle *et al.*, 2018; Omran *et al.*, 2007).



2.2 Concept and definition of the key terms

2.2.1 Employee

The Occupational Safety and Health Act 1994: Section 3 (1) states (in part) that “employee” means a person who is employed for wages under a contract of service on or in connection with the work of an industry to which this Act applies and -

- i). Who is directly employed by the principal employer on any work of, or incidental or preliminary to or connected with the work of, the industry, whether such work is done by the employee at the place of work or elsewhere;
- ii). Who is employed by or through an immediate employer at the place of work of the industry or under the supervision of the principal employer or his agent on work which is ordinarily part of the work of the industry or which is preliminary to the work carried on in or incidental to the purpose of the industry; or
- iii). Whose service is temporarily lent or let in hire to the principal employer by the person with whom the person whose services are so lent or let on hire has entered into a contract of service”

2.2.2 Employer

The Occupational Safety and Health Act 1994: Section 3 (1) states (in part) that “employer” means the immediate employer or the principal employer or both.

2.2.3 Local Authority

According to the Solid Waste and Public Cleansing Management Act 2007 (ACT 672): Section 2 states (in part) that ‘Local authority’-

- i). Means any local authority established or deemed to have been established under the Local Government Act 1976;

- ii). Includes any person or body of persons appointed or authorized under any written law to exercise and perform the powers and function which are conferred and imposed on a local authority under any written law.

2.2.4 Garbage

Garbage is a “wet” discarded matter that is generally edible by animals. Food remains and yard clippings are examples of garbage (Alters, 2002; Nkwachukwu *et al.*, 2010).

2.2.5 Trash

Trash is a “dry” discarded matter that is generally inedible. Newspapers, bottles, and cans are examples of trash (Alters, 2002; Nkwachukwu *et al.*, 2010).

2.2.6 Refuse

Refuse refers to both garbage and trash, while rubbish is refuse plus construction and demolition debris (Alters, 2002; Nkwachukwu *et al.*, 2010).

2.2.7 Waste

Waste is any substance or solution mixture of articles for which no direct use is envisaged but which is transported for reprocessing, dumping, elimination by incineration or other methods of disposal (Oviasogie *et al.*, 2010). Under the Environmental Quality Act 1974, waste is defined as “includes any matter prescribed to be scheduled waste or any matter whether in a solid, semi-solid or liquid form, or in the form of a gas or vapour, which emitted, discharges or deposited in the environment in such volume, composition or manner as to cause pollution. Waste is also defined as “any substance or object which the holder discards or intends or is required to discard or unwanted materials arising from human activity or industrial processes (Klundert & Anschutz, 2001). Waste is also defined as a “material that is not a prime



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product for which the generator has no further use in terms of his or her own purpose of production, transformation or consumption, and which he/she wants to dispose” (Inglezakis & Zorpas, 2011). According to Al-Khatib *et al.* (2007), waste is the complex mixture of substances discarded by individuals, household or organization which may sometimes be hazardous to health. Meanwhile, Gisborne District Council (2012) defined the waste as; (a) means anything disposed of or discarded; and (b) includes a type of waste that is defined by its composition or source (for example organic waste, electronic waste, or construction and demolition waste); and (c) to avoid doubt, includes any component or element of diverted material, if the component or element is disposed of or discarded.

2.2.8 Hazardous materials

Municipal solid waste landfills are known to receive some hazardous material from households and industry without knowing them. It comprises materials such as personal care products, batteries, chemicals, pesticides, pharmaceuticals, automotive products, household items (paint, thinners, detergents, and adhesives), fluorescent light, mercury-vapor lamps, blades, thermometers, electrical and electronic items (Thanh *et al.*, 2010).

2.2.9 Solid Waste

EPA, South Australia, (2000) defined the solid waste as a solid component of any leftover, surplus or unwanted by-product from any business or domestic activities. Manaf *et al.* (2008) defined the solid waste as unwanted materials or leftover material collected from the residential area. It is also defined as the useless remains, worthless, discarded, and rejected or lack of use (Lindell, 2012). According to the Solid Waste and Public Cleansing Management Act 2007 (ACT 672): Section 2 states (in part) that ‘Solid waste includes

- i). Any scrap material or other unwanted surplus substance or rejected products arising from the application of any process;

- ii). Any substance required to be disposed of as being broken, worn out, contaminated or otherwise spoiled; or
- iii). Any other material that according to this Act or any other written law is required by the authority to be disposed of.

For this study “solid waste” refers to the municipal solid waste from the domestic waste (residential premises) and from other sources namely industrials, commercial and institutional solid waste, community waste, construction waste, and clinical waste.

2.2.10 Municipal Solid Waste (MSW)

Government of Alberta (2010), defined “municipal solid waste” as result from or incidental to municipal, community, commercial, institutional and recreational activities, and include garbage, rubbish, ashes, street cleaning, abandoned automobiles and all other solid wastes except hazardous waste, industrial solid waste, oil field waste and biomedical wastes. As defined by the U.S. Environmental Protection Agency (2001), the municipal solid waste (MSW) includes durable goods (those with a lifespan of more than three years, such as tires, appliances, and furniture), nondurable goods (those with a life span of less than three years, such as paper, certain disposable products, and clothing), containers and packaging, food scraps, yard trimmings, and miscellaneous inorganic refuse from residential, institutional, and industrial sources. MSW does not include construction and demolition wastes, automobile bodies, municipal sludge, combustion ash, and industrial process wastes that generally are discarded in locations other than municipal landfills or incinerators (Alters, 2002). Municipal solid waste (MSW) can be defined as solid waste which includes all domestic refuse and non-hazardous wastes such as commercial and institutional wastes, street sweepings and construction debris collected by municipalities or local authorities (Magutu and Onsongo, 2011; Thitame *et al.*, 2009; Municipal Waste Management Report, 2010; Kadafa *et al.*, 2012; Jacobsen *et al.*, 2013; UNEP^b, 2013). GoI has defined municipal solid waste as “commercial and residential wastes generated in a municipal area in either solid or semi-solid form excluding industrial hazardous wastes but including treated biomedical wastes” (CPHEEO, 2014). Municipal solid waste (MSW) is defined as “waste durable goods, non-durable goods,



containers and packaging, food scraps, yard trimmings, and miscellaneous inorganic waste from residential, commercial, and industrial sources” (Demirbas, 2011; Kadafa *et al.*, 2012). Municipal solid waste (MSW) is a waste collected by or on behalf of a local authority which is mostly household waste (DEFRA^b, 2007).

2.2.11 Accident

Guidelines on Safety and Health (Notification of Accident, Dangerous Occurrence, Occupational Poisoning, and Occupational Disease) Regulations 2004 [NADOPOD] defined accident as “an occurrence arising out of or in the course of work which results in fatal injury or non-fatal injury”. The accident is also defined as an unplanned event that results in harm to people, damaging property or property loss (Industrial Accident Prevention Association, 2007).

2.2.12 Incident

Industrial Accident Prevention Association (2007), defined an incident as an unwanted event.

2.2.13 Hazard

Industrial Accident Prevention Association (2007) defined a hazard as any machinery, equipment, process, material or physical factors that have the potential to cause harm to people or damage to the property or environment.

2.2.14 Occupational Injuries

Guidelines on Safety and Health (Notification of Accident, Dangerous Occurrence, Occupational Poisoning, and Occupational Disease) Regulations 2004 [NADOPOD] defined occupational injury as “any injury such as a cut, fracture, sprain, amputation, etc., resulting from a work accident or from a single instantaneous exposure in the



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work environment. A condition resulting from animal bites, including insect or snake bite and from a one-time exposure to chemicals while working is considered to be injuries”.

2.2.15 Occupational Disease

Guidelines on Safety and Health (Notification of Accident, Dangerous Occurrence, Occupational Poisoning, and Occupational Disease) Regulations 2004 [NADOPOD] defined occupational disease as “a poisoning or a disease arising out of or about work. It includes acute and chronic poisoning or disease which may be caused by inhalation, absorption, ingestion or direct contact.

2.2.16 Work Environment

Guidelines on Safety and Health (Notification of Accident, Dangerous Occurrence, Occupational Poisoning, and Occupational Disease) Regulations 2004 [NADOPOD] defined work environment as “Consists of the employer’s premises and other locations where employees are engaged in work-related activities or are present as a condition of their employment. The work environment includes not only physical locations but also the equipment or materials used by the employee during the course of his work.

2.2.17 Collection

The primary collection of waste in Malaysia is a door to door collection. The waste is transported using three types of vehicles namely compactor, open lorry and RORO (Roll-On-Roll-Out) truck to the transfer station. In the transfer station, the waste will be compressed and compacted into a small cubicle. Based on the observation, the municipal solid waste workers walk and jump in/out from the waste truck to collect the waste (Budhiarta *et al.*, 2012).



2.2.18 Transportation

There are several types of vehicle for waste transportation. Mostly compactor unit is used to transport waste from the residential, commercial, institutional, and industrial areas. The compactor units are usually used for the food or organic waste collection. There is also RORO truck, which is used for recyclables materials, bulky and garden waste collection. This type of vehicle is seldom seen by us, unless during garden waste collection (Budhiarta *et al.*, 2012).

2.2.19 Landfill

A landfill is a solid waste disposal site and a final place where waste is deposit below or above the ground level (UNEP, 2013; Cimino, 1975)

2.2.20 Leachate

A liquid that has percolated through solid waste or another medium and has extracted, dissolved or suspended materials from it (UNEP^b, 2013).

2.2.21 Codes of Practice

Codes of practice are a material that develop as a guideline to employers by the Government to achieve compliance with safety and health legislation (Vrielink & Monthfort, 2010).

2.2.22 Personal Protective Equipment

HSE (2013), define Personal Protective Equipment as “PPE is equipment that will protect the user against health or safety risks at work. It can include items such as safety helmets and hard hats, gloves, eye protection, high-visibility clothing, safety footwear and safety harnesses”



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2.2.23 Municipal Solid Waste Management Worker

Municipal solid waste management worker also known as “refuse collector, garbage collector or trash collector”. California Occupational Guide (2002), define Municipal solid waste management worker as individual that collect and deposit the waste into waste trucks either using automated waste truck or manually lift and dump.

2.3 Waste Management Industry

Waste management practices vary from one place to another: developed and developing nations; urban and rural; residential and industrial. Solid waste management consists of generation, storage, collection, sorting, processing recyclable material, transportation, pre-treatment, and disposal of residue. Solid waste management is defined as the “the application of techniques to ensure an orderly execution of the various functions of collection, transport, processing, treatment and disposal of solid waste” (Demirbas, 2011; Alias *et al.*, 2013; Sreenivasan *et al.*, 2012; Gulis & Mochungong, 2013). It is diverse and complex requiring a lot of data from various sources (Cherian & Jacob, 2012). It also involves high cost and poses greater challenges for the developing countries due to increasing generation and lack of understanding about the diversity of the waste and how to effectively handle the system which aims to improve the public health, aesthetic and environmental conduciveness (Guerrero *et al.*, 2013; Manaf *et al.*, 2008; Al-Khatib *et al.*, 2007).

Since the solid waste management industry has a diverse range of occupational work, so the researcher focuses only upon garbage collection, truck driver, waste pickers/sorters and machine/plant operators as the major respondents (Tooher *et al.*, 2005). Solid Waste Management Workers (SWMW), performed various tasks and jobs. Types of job assigned to the workers depend upon gender and sector or participation in specific survival activities from which they earned their living and simultaneously contributed to the environmental protection. The duties and responsibilities of each occupation are described in Table 2.1. It is also influenced by the physical demand such as the strong, able-bodied workers and younger persons. The younger individuals are more physically fit and indispensable to complete the multiple

tasks, to lift and unload heavy garbage quickly comparing to the older individuals. Below are the examples of the job description of solid waste management workers namely (Noel, 2010) and Table 2.1 shows the duties and responsibilities of each occupational work for the garbage collector, truck driver, waste picker or sorter and machine or plant operator:

- i). Supervising other workers
- ii). Sweeping streets and gathering waste with brooms
- iii). Gathering solid waste with shovels
- iv). Gathering and collecting solid waste with shovels
- v). Cleaning up canals with shovels
- vi). Collecting solid waste
- vii). Transporting solid waste to dump site
- viii). Managing dumpsites
- ix). Controlling and measuring solid waste quantity on dumpsites
- x). Salvaging solid waste

Table 2.1: Duties and responsibilities (Demirbas, 2011; Alias *et al.*, 2013; Sreenivasan *et al.*, 2012; Gulis & Mochungong, 2013)

Occupational	Duties and responsibilities
Garbage collector	<ul style="list-style-type: none"> • Pick up and empty waste material into the waste collection vehicle • Pick up a brush, bulky items, and other debris and place it into the waste collection vehicle • Operate a mechanism for loading the waste bin, compressing waste and dumping waste material • Provide direction to the truck driver in backing up and moving waste collection vehicle in collections operations • Clean and perform minor maintenances on waste collection vehicle as required
Truck Driver	<ul style="list-style-type: none"> • Inspects waste collection vehicle before beginning routes to ensure safe operating conditions • Refuels waste collection vehicles with necessary fluids such as oil and water • Drive waste collection vehicle to designated areas to facilitate collection of waste • Deliver and deposit all collected waste to the waste facilities • Ensure daily maintenance of the truck • Reporting accident and incidents as required • Reporting concerning delays, unsafe sites, unsafe equipment, and maintenance problem as required • Ensuring that all waste bins on the relevant round are emptied
Waste Pickers/ Sorters	<ul style="list-style-type: none"> • Sorting waste for recycling process or other waste treatment

	<ul style="list-style-type: none"> • Ensuring that all the wastes possible for recycling are recycled to reduce waste going to the landfill
Machine/Plant Operators	<ul style="list-style-type: none"> • Operating machine or plant used for waste treatment • Ensure daily maintenance of the machine or plant • Ensure that the hazardous and controlled waste such as medical waste reach the correct facilities.

The solid waste industry work is physically tough and faces various risks of accident which increase the frequency of accidents (Mase *et al.*, 2008). The solid waste management industry is considered occupationally hazardous since they are more prone to injuries that could lead to infections like tetanus, hepatitis B and hepatitis A.

Table 2.2: Summary of Health Risks among Solid Waste Management Workers
(Aminuddin & Rahman, 2015)

Work activity/situation	Hazard	Health effects	Recommended control measures
Heavy vehicles	Physical/ ergonomic	Whole-body vibration, noise, fatigue	Enough rest/take a rest
Congested area (inside the vehicles)	Physical/ biological	Uncomfortable area, bad odour	Housekeeping
Sharp objects	Physical	Hand and leg injury	Use suitable glove
Heavy lifting	Physical/ ergonomic	Hand and leg injury, muscle pain, cramps	Team works
Heavy rain	Physical	Cold stress	Use a raincoat
Muscle contraction (driver)	Physical	Overuse muscle, exhaustion, cramps, fatigue	Take a rest/enough rest
Small road (traffic problem)	Physical, psychosocial	Accident, stress, safety issues	Use of road cone, safety vest
Bad odour	Physical, biological, psychosocial	Sleepiness, discomfort, respiratory problem	Use a suitable mask, face mask
Long way drive	Physical, psychosocial, ergonomic	Exhaust, fatigue, harm-leg cramps	Take a rest/enough rest
Stress management	Physical, psychosocial	Stress, attitude management	Counselling
Repetitive movement	Ergonomic, physical	Impaired or unsafe condition and performance, musculoskeletal disorder	Use a suitable PPE, enough rest
Chemical odour	Chemical, biological	The respiratory problem, irritation in skin and eyes	Use a suitable mask, facemask
Hazardous animal	Biological, physical	Severe wounds, poisoning	Use suitable PPE, beware
Insect-carrying disease	Biological, physical	Dengue, work-related disease	Use suitable PPE, beware
Watery area	Physical	Slippery	Use a safety boot

The main pathway of getting such infections is via puncture wound, needle-stick injuries, other contusion, laceration, through accidents with machinery and splinters (Tooher *et al.*, 2005). There are 3 main routes of health risk exposure namely ingestion of soil, contamination of food chain and dust (Domingo & Nadal, 2009). According to the WIEGO (2014), there is an unpleasant and less rewarding working environment for the waste management workers especially those involved with waste collection such as walking for more than 5 hours a day, up to 10 km a day with loads up to 40 kg, chased and bitten by dog, manually handling waste, harassment and vulnerability to skin, gastro-intestinal and musculoskeletal illnesses. Table 2.2 shows us the risks faced every day by the municipal solid waste management workers. The hazards that are often faced by the workers include physical or ergonomic, biological, chemical, and psychosocial problems.

2.3.1 Informal Workers in Solid Waste Management

The informal workers also known as “waste picker” or “scavengers” or “rag pickers” or “sweepers” usually can be found in the streets, residential area, apartment building, concierges, commercial areas, industrial areas or at the transfer station and also at the landfill collecting recyclable materials. Informal activities of collecting and recycling material are often driven by poverty to improve their standard of living (Gunsilius *et al.*, 2011; Chandrappa & Das, 2012; Mull, 2005). There are several kinds of waste pickers as described below (Sarkar, 2003);

- i). The individual that carries sacks that collect recyclable material on the streets, drains, municipal bins, open dumping, and landfills,
- ii). The individual that carries sack and collects only specific items,
- iii). The individual using tricycle that collects mixed waste and travels a long distance, and
- iv). The individual that works with waste dealers

These informal activities (such as collecting, sorting, trading, grading, and recovery, cleaning, and processing waste materials) are unlicensed and untaxed but are involved in the contribution and provision of income opportunities (Gaikwad, 2011;

WIEGO, 2014; Tan *et al.*, 2013). This is also supported by Medina (2008), who mentions that poverty can be reduced through waste picking. But they usually earn very little despite they have to face risk such as run over by a waste truck and also harassed by the authorities. Also, by these activities, they contribute in protection and conservation of the natural resource and environment.

As a disadvantage of this activity, the informal workers neglect the health aspect during collecting recyclable materials as they exposed to the biological hazard, pathogens, contaminated and toxic wastes including the chemical hazard such as battery cell, nail polish remover, blades, sprays, needles, syringes, saline bottles, iron items or other hospital waste. This leads to the respiratory or skin problems, infections, injury, disability, and other health problems. (Jariwala & Christian, 2011; Devi *et al.*, 2014; WIEGO, 2013; Thirarattanasunthon *et al.*, 2012; Eusof *et al.*, 2011). They are also exposed to ergonomic and musculoskeletal disorders due to heavy lifting, pushing carts, bad body postures, and repetition (WIEGO, 2013). Mostly the informal workers did not use any vehicle during collecting recycle waste, only a few of them using tricycle, pushcarts, donkey carts, horse carts, bicycle or motorcycle. Their working conditions and living environment are usually critical, extremely precarious and unhygienic due to risky activities during collecting recyclable materials or scavenging (Medina, 2010).

2.4 Safety and Health practice with the working environment

Studies and research on the safety and health practice among solid waste management in Malaysia are quite difficult to find and almost none compared to the developed countries. Most of the studies and research are on environmental health, public health, safety, and health of the cleaning workers and among recycling workers. A researcher found out that the issues regarding safety and health of solid waste management workers are apparently general and not in specifically addressed. Mostly in the research, they mention about water pollution, air pollution, land pollution, biodiversity imbalance and weather changes affecting the safety and health of the human being.

2.4.1 The Concept of Environment Health

The World Health Organisation (WHO, 1991) defined the health as “a state of physical, social and mental wellbeing and not a mere absence of disease or infirmity”. In order to have a healthy population, there is a need for the environment to be in a healthy and ideal condition, this includes the physical, mental and social environment. Environmental health is defined as the provision and control of all those factors in people’s physical surrounding which can affect their health (Dung-Gwom & Magaji, 2007). Waste manager must consider the following when managing waste: air emission and health effects; dust and odour; flies, vermin, and birds; noise; litter; water resources (DEFRA^b, 2007). Compared to the inadequate waste management system, the increasing quantity of waste is the major global environmental issue. This mismatch posed a greater challenge to the world. Problems associated with waste management include insufficient and inadequate disposal of solid waste; lack of liners and collection system for leachate and landfill gas; and uncontrolled discharge of leachate (Tinmaz & Demir, 2006). Improper waste management activities can increase the disease transmission or otherwise threaten the public health, contaminate ground and surface water, create greenhouse gas emissions and other air pollutants, damage ecosystems, injure people and property, and discourages tourism and other businesses (The Cadmus Group Inc, 2009).

2.4.2 Environmental Problem Related to Safety and Health

The poor management of solid waste led to the contamination of water, soil, and atmosphere. Lack of concern for the environment led to a serious problem from the aspect of safety and health. Not only the poor management of solid waste led to the contamination but, the current landfill that overload with serious leachate spilling also plays a role in the environmental and health problems (Ferronato & Torretta, 2019; Giusti, 2009; Masirin *et al.*, 2008). Figure 2.1 shows how the waste leads to environmental problems, namely air pollution, groundwater pollution, and surface water pollution.

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