International Journal of Earth, Energy and Environmental Sciences
ISSN: 2517-942X
Vol:9, No:9, 2015

A Conceptual Framework of Scheduled Waste Management in Highway Industry

Nurul Nadhirah Anuar, Muhammad Fauzi Abdul Ghani

***Abstract*—**Scheduled waste management is very important in environmental and health aspects. In delivering services, highway industry has been indirectly involved in producing scheduled wastes. This paper aims to define the scheduled waste, to provide a conceptual framework of the scheduled waste management in highway industry, to highlight the effect of improper management of scheduled waste and to encourage future researchers to identify and share the present practice of scheduled waste management in their country. The understanding on effective management of scheduled waste will help the operators of highway industry, the academicians, future researchers, and encourage a friendly environment around the world. The study on scheduled waste management in highway industry is very crucial as highway transverse and run along kilometers crossing the various type of environment, residential and schools. Using Environmental Quality (Scheduled Waste) Regulations 2005 as a guide, this conceptual paper highlight several scheduled wastes produced by highway industry in Malaysia and provide a conceptual framework of scheduled waste management that focused on the highway industry. Understanding on scheduled waste management is vital in order to preserve the environment. Besides that, the waste substances are hazardous to human being. Many diseases have been associated with the improper management of schedule waste such as cancer, throat irritation and respiration problem.

***Keywords*—**Asia Region, Environment, Highway Industry, Scheduled Waste.

I. Introduction

WASTE management is one of the priority issues concerning protection of the environment and conservation of natural resources [1]. Poor management of waste led to contamination of water, soil and atmosphere as well as a major impact on public health [2]. Increasing population levels, demand for better living standard and rapid urbanization have increase the waste generation in a country. Scheduled waste management (SWM) is very important in environmental and health aspect. Scheduled waste is a small percentage of hazardous waste that has been regarded for a long time as intractable, or difficult to safely dispose of, without special technologies and facilities [3]. Scheduled waste is similar with the hazardous waste terminology using in world wide. In Malaysia, the government use terminology of scheduled waste instead of hazardous waste, referring to the only wastes listed in the First Schedule of Environmental Quality (Scheduled Waste) Regulations 2005. Under this schedule, 77 types of scheduled wastes are listed and the wastes are groups into five which are metal and metal-bearing wastes; wastes containing principally inorganic constituents which may contain metals and organic materials; wastes containing principally organic constituents which may contain metals and inorganic materials; wastes which may contain either inorganic or organic constituents; and other waste which is any residues from treatment or recovery of scheduled wastes [4]. Any import and export related to these wastes are subject to the same law and references to the international requirement of Basel Convention.

Despite SWM is very important, the understanding of scheduled waste management especially in highway industry is still lacking. This is very crucial as highway industry in the Asian Region is growing rapidly. To ensure sufficient protection of human health and environment in Malaysia, the government of Malaysia has developed Environmental Quality (Scheduled Waste) Regulations 2005, under the Environmental Quality Act 1974. This regulation is expected to be adhered by all industry in Malaysia including the highway industry. It should be noted that there are many unnoticeable wastes in highway industry that should be manage properly and fall under the categories of scheduled waste. The wastes produce by highway industry are waste of lead acid batteries in whole or crushed form; waste from electrical and electronic assemblies (containing components such as accumulators, mercury-switches, glass from cathode-ray tubes and other activated glass or polychlorinated biphenyl-capacitors, or contaminated with cadmium, mercury, lead, nickel, chromium, copper, lithium, silver, manganese or polychlorinated biphenyl); spent hydraulic oil; and spent mineral oil-water emulsion.

This paper provides a literature review of the SWM in the context of highway industry, conceptual framework on the SWM in highway industry and future research studies.

II. Literature Review

Human activities have always generated waste. This was not a major issue when the human population was relatively small and nomadic, but became a serious problem with urbanization and the growth of large urban area [2]. Increasing population and urbanization caused billion of tons of waste are produced every year. The government holds the responsibility to develop the best practicable and environmentally sustainable waste management strategies. In Malaysia, scheduled wastes are listed under First Schedule of Environmental Quality (Scheduled Waste) Regulations, 2005.

Nurul Nadhirah Anuar is a postgraduate student from the Faculty of Economics and Administration at University of Malaya, Kuala Lumpur, Malaysia (phone: 017-885-7895; e-mail: nurull_nano@ yahoo.com).

Muhammad Fauzi Abdul Ghani is a PhD candidate from the Faculty of Business Management at Universiti Teknologi MARA, Shah Alam, Selangor, Malaysia (e-mail: fauzighani64@yahoo.com).

The wastes in the schedule are groups into five which are metal and metal-bearing wastes; wastes containing principally inorganic constituents which may contain metals and organic materials; wastes containing principally organic constituents which may contain metals and inorganic materials; wastes which may contain either inorganic or organic constituents; and other wastes which includes any residues from treatment or recovery of scheduled wastes [4].

A waste management hierarchy based on the most environmentally sound criteria favors waste prevention/ minimization, waste re-use, recycling, and composting. In many countries, a large percentage of waste cannot presently be re-used, re-cycled or composted and the main disposal methods are landfilling and incineration [2]. Scheduled waste management will also go through these procedures for storage, packaging and labeling. Highway industry produces wastes such as waste of lead acid batteries in whole or crushed form (SW 102); waste from electrical and electronic assemblies (SW110); spent hydraulic oil (SW 306); and spent mineral oil-water emulsion (SW307). The waste under SW110 contain components such as accumulators, mercury-switches, glass from cathode-ray tubes and other activated glass or polychlorinated biphenyl-capacitors, or contaminated with cadmium, mercury, lead, nickel, chromium, copper, lithium, silver, manganese or polychlorinated biphenyl [5].

In production of lead acid battery, huge amount of sulphuric acid (H2SO4) is used. It will lower the pH value of water when mixed up with water which raises the acidic property of water. In addition, in lead acid battery production, huge amount of lead is needed and a portion of that lead is wasted and mixed with the fume [6]. So it causes air pollution and presence of lead in air is very harmful especially for children [6].If lead acid batteries are disposed of in a solid waste landfill or illegally dumped, the lead and sulphuric acid can seep into the soil and sulfuric acid contaminated ground water, potentially affecting the quality of our drinking water supply. If the batteries are disposed of near rivers, streams, lakes or coastal waters, the lead and sulphuric acid can also threaten aquatic life [7]. Besides that, lead causes symptoms ranging from the loss of neurological function to death depending upon the extent and duration of exposure both children and adults can suffer from an illness including effects on central nerve system, kidneys, gastrointestinal tract and blood forming system [6]

Electronic waste or E-waste is relatively a novel addition to the ever-growing hazardous waste stream. It includes discarded electronic and electrical equipment [8]. E-Waste is defined as waste from the assembly of electrical or electronic appliances that consist of components such as accumulators, mercury switches, glass from cathode-ray tube sand other activated glass or polychlorinated biphenyl capacitors, or contaminated with cadmium, mercury, lead, nickel, chromium, copper, lithium, silver, manganese or polychlorinated biphenyl [9]. E-waste also represent component of waste from the appliances that can no longer be used such as air-condition, computer, printer, Photostat machine, video camera recording and fluorescent lamp.

Developing countries like India, today, is burdened with the serious problem of E-waste which is either locally generated or internationally imported, causing serious threat to human health and environment [8]. Often, hazards arise due to the improper recycling and disposal processes. Such offensive practices can have serious aftermath for those staying in proximity to the places where E-waste is recycled or burnt [8]. Electronic wastes that are landfilled produces contaminated leachates which eventually pollute the groundwater. Acids and sludge obtained from melting computer chips, if disposed on the ground causes acidification of soil. For example, in Guiyu, Hong Kong, a flourishing area of illegal E-waste recycling is facing acute water shortages due to the contamination of water resources. This is due to disposal of recycling wastes such as acids, sludge in rivers [8].

Hydraulic oil is not likely to present an inhalation hazard at normal temperatures and pressures. However, when aerosolizing, misting, or heating this product, high concentrations of generated vapor or mist may irritate the respiratory tract (nose, throat, and lungs). It can also cause throat irritation, nausea, vomiting, and diarrhea [10]. Breathing product into the lungs during ingestion or vomiting may cause lung injury and possible death. Individuals with pre-existing respiratory tract (nose, throat, and lungs), eye, and/or skin disorders may have increased susceptibility to the effects of exposure. Hydraulic oil also must keep away from sparks or flame. Where flammable mixtures may be present, equipment safe for such locations should be used. Use clean tools. When transferring large volumes of product, metal containers, including trucks and tank cars, should be grounded and bonded. Keep containers away from flame, sparks, static electricity, or other sources of ignition [10].

Mineral oil-in-water emulsions (OWEs) are used to ensure the corrosion protection of both processed metal parts and operating tools, and to provide assistance in taking away metal scraps and chips from the metal-processing area. During utilization, an OWE undergoes changes under the influence of mechanical, thermal, chemical and biological factors, is no longer safe to be used because of reduced operating functions and emerging health hazards and it must be replaced. Generally, spent OWEs (SOWEs) contain residual mineral oil, tramp oils, greases, biocides, emulsifiers, metal ions, other components of original OWEs and the products of their degradation. When irresponsibly and non-professionally handled, SOWEs appear as environmentally hazardous waste waters [11]. Mineral oil remains the main source of energy and other hydrocarbon based products. Pollution resulting from increasing use of mineral based oil could not be overemphasized. Large quantity of mineral based oil finds their way to the ground. Several millions of tons of oil cause pollution worldwide yearly [12]

Human exposure to substances released at waste management facilities can be acute in case of a serious accident causing short-term exposure to high levels of potentially hazardous substances, ionizing radiation, bioaerosols and dusts. The situation can be chronic when it involves long-term exposure to low concentrations of these

substances or radiation [2]. Scheduled wastes shall be disposed of at prescribed premises only. Every waste generator shall ensure that scheduled wastes generated by him are properly stored, treated on-site, recovered on-site for material or product from such scheduled wastes or delivered to and received at prescribed premises for treatment, disposal or recovery of material or product from scheduled wastes. Every waste generator shall ensure that scheduled wastes that are subjected to movement or transfer is packaged, labeled and transported in accordance with the guidelines prescribed by the director general [4].

Waste management should be understood as a system composed of physical things, human activities, and links between and within physical things and human activities [13]. The regulatory bodies must encourage the prevention or reduction of waste and its harmfulness by encouraging the development of clean technologies, technical product improvements, and disposal techniques [14]. They must prohibit the abandonment, dumping or uncontrolled discharge of waste [14]. The issue of spillages, leakages, corroding container and improper marked labels of scheduled waste must be addressed. To facilitate the proper handling of scheduled wastes, information about the hazards associated with the wastes must be communicated through proper labels and should be used by wastes handlers [15]. To ensure that the wastes are safely handled, suitable containers are also needed to be used by the waste generators. It is the responsibility of the waste generators to ensure that scheduled wastes are packed based on the composition in a manner suitable for handling, storage and transportation [15]. A number of serious and highly publicized pollution incidents associated with incorrect waste management practices, led to public concern about lack of controls, inadequate legislation, environmental and human health impact [2].

Due to its quantity, concentration, physical, chemical or infectious characteristics, scheduled waste may cause to an increase in mortality, or an increase in irreversible or incapacitating illness. Nevertheless, scheduled waste may pose a substantial present or potential hazard to human health or the environment when improperly treated, stored or disposed of, or otherwise mismanaged [16]. Malaysia is targeting to achieve 30% of total solid and scheduled waste recycling in 2020 besides 5% currently [16].

Urbanization has exploded with great speed and scale in recent decades with ‘‘more than half the world’s population now living in urban centers’’, as countries and even individual cities struggle to be competitive in the global marketplace [17]. Good governance requires the participation and collaboration of all relevant parties, including government, non-governmental organizations (NGOs), community groups and the private sector. According to the Asian Development Bank, the four principle elements of good governance are accountability, participation, predictability, and transparency. Good governance allows low-income groups to influence policy and resource allocation, and therefore it is essential for equitable, effective, and efficient SWM [17].

III. Conceptual Framework

Based on the literature review, it is hardly to find a SWM framework especially in the context of highway industry. A conceptual framework that addresses important aspects such as the list of scheduled waste produced by highway industry, the procedure to manage scheduled waste, the hazardous characteristics of scheduled waste, descriptions of the wastes and the effect of improper management of scheduled waste produced by highway industry is proposed in Fig. 1. Fig. 1 is the new conceptual framework of scheduled waste management in highway industry.

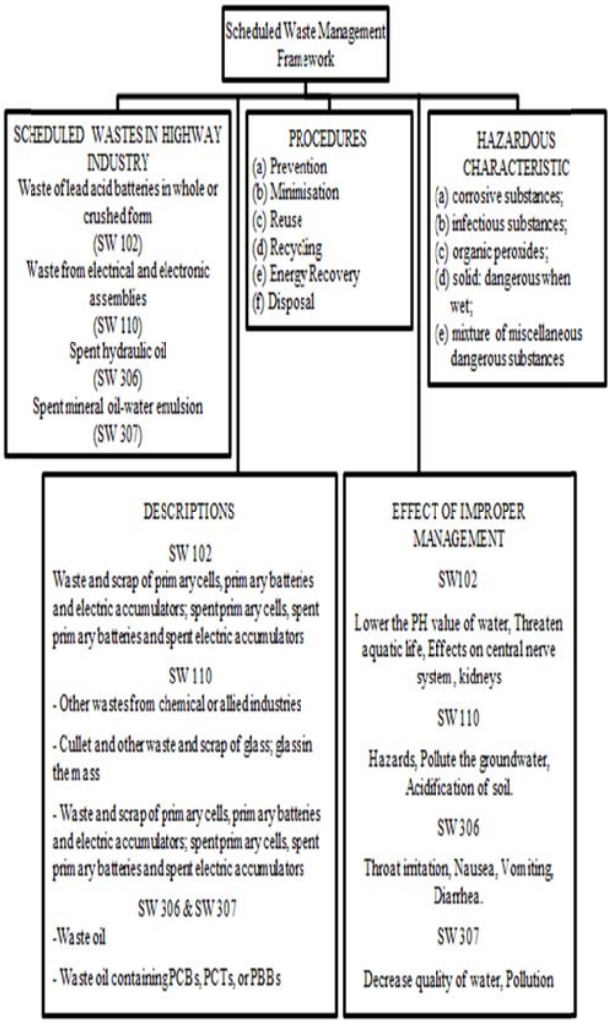

Fig. 1 Scheduled waste management framework for highway industry

This conceptual framework on scheduled waste management focuses on the scheduled wastes from highway industry in Malaysia. There are four categories of scheduled waste produced by the highway industry such as waste of lead acid batteries in whole or crushed form (SW 102); waste from electrical and electronic assemblies (SW110); spent hydraulic oil (SW 306); and spent mineral oil-water emulsion (SW307). The waste under SW110 contain components such as

accumulators, mercury-switches, glass from cathode-ray tubes and other activated glass or polychlorinated biphenyl-capacitors, or contaminated with cadmium, mercury, lead, nickel, chromium, copper, lithium, silver, manganese or polychlorinated biphenyl [5]. The wastes will undergo six procedures which are prevention, minimization, reuse, recycling, energy and lastly, disposal. Scheduled waste has the hazardous characteristics such as corrosive substances, infectious substances, organic peroxides, solid: dangerous when wet, and mixture of miscellaneous dangerous substances.

SW 102 includes waste and scrap of primary cells, primary batteries and electric accumulators; spent primary cells, spent primary batteries and spent electric accumulators. Besides that, SW 110 comprises of wastes from chemical or allied industries; cullet and other waste and scrap of glass; glass in the mass; waste and scrap of primary cells, primary batteries and electric accumulators; spent primary cells, spent primary batteries and spent electric accumulators. SW 306 and SW 307 consist of waste oil containing polychlorinated biphenyls (PCBs), polychlorinated terphenyls (PCTs) or polybrominated biphenyls (PBBs). All the hazardous substances must be handle and labeled correctly as they can lower the pH value of water, threaten aquatic life, decrease the quality of water, effects on central nerve system, pollute the groundwater, cause acidification of soil, throat irritation, nausea, vomiting and diarrhea.

IV. Future Research Studies

The scheduled waste identified in this conceptual paper is based in the context of scheduled waste management in Malaysia. Future researchers should explore on the scheduled waste produced in other country. Despite many research studies on waste management have been published, there is still lack of information regarding SWM especially in the context of highway industry. More research article on SWM should be published to the public.

The conceptual framework will help and guide the future researchers and academician who are interested to study SWM in the future. They can develop more frameworks of SWM for other industry that are also involved in producing scheduled wastes such airlines, retails, furniture and agriculture industry. This will enrich schedule waste knowledge and practice. In addition, this conceptual paper will help the highway industry in other countries to identify new potential scheduled wasted for their highway industry.

Future studies to also look into the techniques that could address the issues relating to SWM in highway industry such as new green technology. Based on the hazardous characteristic of scheduled waste highlighted in this conceptual paper, every organization should identify the scheduled waste generated from their business and take the necessary steps to reduce the hazardous emission of scheduled waste and pollution to the environment and the people.

Besides that, future researchers should create an awareness regarding the SWM and the negative impact of the improper management of scheduled wastes. The study on scheduled waste management in highway industry is very crucial as compared to factories in which the factories are located on specified areas whereas, highway transverse and run along kilometers crossing the various type of environment, residential, forest and schools.

References

[1] Costi, P., Riccardo Minciardi, Michela Robba, Mauro Rovatti, & Roberto Sacile. (2004). An environmentally sustainable decision model for urban solid. *Waste Management*, 277-295

[2] Giusti, L. (2009). A review of waste management practices and their impact on human health. *Waste Management*, 2227-2239.

[3] Australia, C. o. (n.d.). *Scheduled waste management*. Retrieved March 4, 2015, from Australian Government: http://www.environment.gov.au/protection/chemicals/scheduled-waste

[4] Boar, L. R. (2014). *Environmental Quality Act 1974(Act127).* Malaysia: International Law Book Services.

[5] Environment, D. o. (2006). *Guidelines for the Classification of Used.* Putrajaya: Department of Environment.

[6] Uddin, M. J., Mondal, P. K., Rahman, M. A., & Rahman, M. H. (2013). An Approach to Reduce Waste in Lead Acid Battery Industries. *Global Journal of Researches in Engineering*, 16-22.

[7] *Requirements - Hazards and Disposal of Batteries.* (2006, September 6). Retrieved March 4, 2015, from Camden Electronic Ltd: http://www.farnell.com/datasheets/1504234.pdf

[8] Borthakur, A., & Singh, P. (2012). Electronic waste in India: Problems and policies . *International Journal of Environmental Sciences* , 354-362

[9] (2007). *E-Waste Volume I.* United Nations Environment Programme.

[10] Coordinator, P. M. (2008). *J. M. Reynolds Xtreme AW HYDRAULIC OIL ISO 32 & 46.* USA.

[11] Lazarević, V. B., Krstić, I. M., Lazić, M. L., Savić, D. S., Skala, D. U., & Veljković, V. B. (2013). Scaling up the chemical treatment of spent oil-in-water emulsions from. *Hem. ind.*, 59-68.

[12] Lawal, O. Y. (2007). *Transformation of an environmental friendly hydraulic oil in soil using gas chromatography.* The Tema Institute.

[13] Pohjola, V. J., & Pongra´cz, E. (2002). An approach to the formal theory of waste. *Resources, Conservation and Recycling*, 17-29.

[14] *Overview of EU environmental legislation.* (2015, February 16). Retrieved March 4, 2015, from Guide to the Approximation of European Union Environmental Legislation: http://ec.europa.eu/environment/archives/guide/part2c.htm

[15] Environment, D. o. (n.d.). *Guidelines for Packaging, Labelling and Storage of Scheduled Wastes In Malaysia.* Malaysia: Department of Environment.

[16] Hassan, N. (2012, July 19). *Recovery and recycling processes of scheduled waste in Malaysia.* Retrieved March 4, 2015, from Universiti Teknologi Malaysia Institutional Repository: http://eprints.utm.my/12308/

[17] Marshall, R. E., & Farahbakhsh, K. (2013). Systems approaches to integrated solid waste management in developing countries. *Waste Management*, 988-1003.