Factors Affecting the Hazardous Waste Management Practices in Heavy Industries: Evidence from Sri Lanka

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ABSTRACT

Among the different types of waste, hazardous waste poses a serious challenge to the humans and environment if not properly managed. Although many industries generate hazardous waste in various degrees, heavy industries generate the largest volume of hazardous waste. While hazardous waste management (HWM) has been studied well in many industry sectors and countries, it is not so with heavy industries in developing countries. The purpose of this paper was therefore to identify the factors affecting the HWM practices in heavy industries in Sri Lanka. The data was collected from 40 companies in ten different industrial categories of heavy industry. The respondent was the environmental officer of each company. The analysis reveals that technological facilities, public resistance, company policy and economic factors affect the HWM practices in heavy industries in Sri Lanka. This study has several policy level and managerial implications for HWM in heavy industries to contribute towards the achievement of sustainable development.

Keywords: Hazardous Waste, Heavy Industries, Sri Lanka, Sustainable Development, and Hazardous Waste Management.

1. INTRODUCTION

Improper waste management has become a serious issue in relation to the achievement of many sustainable development goals (SDGs). A sound waste management system is therefore essential to make cities safe, resilient and sustainable (SDG 11) and ensure sustainable consumption and production patterns (SDG 12) (UNDP, 2018). Among the different types of waste, hazardous waste poses a serious challenge to humans and the environment. Hazardous waste creates substantial danger to human health or environment when improperly managed (Hu et al., 2009). The institutions which generate the hazardous waste will have to depend on other entities in the waste management supply chain such as collectors, stores (until transport), transporters, recyclers, recoverers and total disposers (Cetin and Yesilnacar, 2005). Hazardous waste can be injurious not only to the health of the entities that generate them, but also to all above supply chain partners who handle it (Fatta et al., 2005). Due to this reason hazardous waste management (HWM) has garnered national as well as international significance (LaGrega et al.,2010).

Hazardous waste can be generated in many industries, particularly heavy industries. Heavy industries are those in which large machines are used to produce raw materials or to make large objects (Collins English Dictionary, n.a). Waste management including hazardous waste has become a serious issue in developing Asian counties due to the rapid economic growth, industrialization and unplanned urbanization (Pariatamby and Fauziah, 2014). This is clearly evident in countries such as Sri Lanka which still lack solid government policies or private sector partnerships in finding long-lasting solutions (Gunarathne et al., 2018; Menikpura et al., 2012). Though these countries have legislations for HWM, there is illegal and improper disposal due to the lack of suitable facilities for waste management (Premachandra, 2003). In addition to legal and infrastructure facilities, evidence suggest that there can be many factors that influence the management of special types of waste such as hazardous waste. This paper therefore investigates the factors influencing the HWM practices in Sri Lanka.

The rest of the paper is organized as follows. Section Two presents the relevant literature that leads to the development of hypotheses in this study. Section Three describes the method followed and the subsequent section outlines the findings and results. The last section provides the discussion and the conclusions of the study.

2. LITERATURE REVIEW

Hazardous waste can physically be a solid, liquid, semi-solid, or gaseous material. It should also be noted that not every industry or not even heavy industry generates this form of waste. Misra and Pande (2005) have identified the most common heavy industries that are potential of HW generation as follows:

Table 1: Types of hazardous waste generated by heavy industry

Industry	Type of HW generated
Plastic product	Organic Chlorine compounds
Pesticides	Organic chlorine compounds, organic phosphate compounds
Medicine	Organic solvents and residue, heavy metals
Paint	Heavy metals, pigments, solvents, organic residues
Oil, gasoline and other petroleum products	Oil, phenols and other organic compounds, heavy metals, ammonia, salts, acids, caustics
Metal	Heavy metals, fluorides, cyanides, acid and alkaline, cleaner solvents, pigments, abrasives plaiting salts, oils, phenols
Oil	Heavy metals, fluorides, cyanides, acid and alkaline, cleaner solvents, pigments, abrasives plaiting salts, oils, phenols
Textile	Heavy metals, dyes, organic chlorine compounds, solvent

Sources: Misra and Pande (2015)

There can be a host of factors that can influence the HWM practices in heavy industries. They include technology, corporate policies, economic factors and public resistance. Many scholars have shown that having proper technologies in HW generating companies is a must for effective management of HW (see Aldrich et al., 2008; Bandara and Hettiarachchi, 2010; Randall and Chattopadhyay, 2004; Duan, 2008; Duke, 1994). Further, corporate policies of the company management can have a major influence over HWM. This view has been supported by many authors such as Aldric et al. (2008), Duan et al. (2008), Duke (1994), Falk and Orloff (2003), Ihlanfeldt (2004) and Misra and Pandey (2005) who suggest that HWM practices depend heavily on various policies of a company. Similarly, the economic factor pertaining to HWM, either a) *environmental economic factors* (i.e. factors lead to a monitory value of a particular environmental damage or environmental gain) and b) financial economic factors (i.e. factors that have a direct bearing towards financial results) have a major influence on the HWM practices (Kirzhner, 2006). In addition, authors such as Bandara and Hettiarachchi (2010), Delgado et al., (2009) and Zubair (2001) have had the same opinion that economic factors directly influence the performance of HWM practices in Sri Lanka. Finally, it has been also suggested that HWM practices are hugely influenced by public resistance (Bandara and Hettiarachchi, 2010; Cetin and Yesilnacar, 2005 and Gerardo and Kikuchi, 2009).

This literature leads us to hypothesize as follows:

H1: Technology availability of a firm has a significant positive influence on the HWM practices in the heavy industries.

H2: Corporate policy has a significant positive influence on the HWM practices in the heavy industries.

H3: Economic factors have a significant positive influence on the HWM practices in the heavy industries.

H4: Public resistance has a significant positive influence on the HWM practices in the heavy industries.

Based on the above hypotheses the conceptual framework of the study can be presented as follows (see Figure 1).

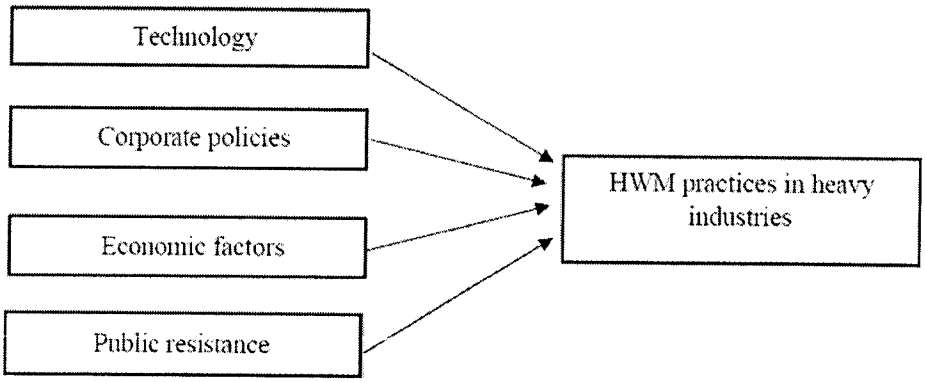

Figure 1: Conceptual framework of the study

3. RESEARCH METHOD

This study was based on primary data. The population of the study is 55 heavy industries in Sri Lanka. The sample consists of 75% of the population, which is 40 heavy industries from different industry categories. A questionnaire was distributed to the Environmental Officer [or to the person who handles the environmental matters of the organization] of each company. The response rate was 82% resulting in 33 complete responses used in the study. The questionnaire consisted of two parts. Section one asked general information such as respondent industry, age and designation. Section two had 25 questions that identified the various factors that influence their HWM practices. The responses were collected on a five-point Likert scale ranging from "strongly disagree" to "strongly agree". The data was analyzed using SPSS 20.

4. FINDING AND RESULTS

Although the majority of the respondents were from the apparel sector, in total they represent diverse industry sectors to allow a reasonable representation of the heavy industries in Sri Lanka (see Table 2).

Table 2: Respondents profiles

Industry	No. of respondents
Hospital	05
Apparels	10
Food processing	03
Farm processing	05
Industrial Zones	04
Chemical	06
Total	**33**

Table 3 shows the descriptive statistics of the variables used in the study.

	Mean	SD	*n*
Technological facilities	3.42	0.560	33
Public resistance	3.46	0.622	32
Company policy	2.41	0.865	33
Economic factors	3.90	0.386	33
HWM practices	4.21	0.246	33

Table 4: shows the correlation between the stated four independent variables and the dependent variable.

Table 4: Correlation analysis

	Technology	Public Resistance	Company Policy	Economic Factors	HWM practices
Technology	1				
Public Resistance	0.423	1			
Company Policy	0.503	0.458	1		
Economic Factors	0.472	0.583	0.477	1	
HWM practices	0.614	0.579	0.493	0.475	1

Table 5: ANOVA analysis

Model 1	Sum of Squares	df	Mean Square	F	Sig.
Regression	2.5693	5	0.5138	2.6504	.000*
Residual	9.0477	28	0.3231		
Total	11.6171	33			

** 5% significant level*

According to Table 5, the results show that the model best fits the data since the F test statistics were significant at 5% significant level. Hence, in Sri Lanka the HWM practices in the heavy industries depend on technological factors, public resistance, company policy and economic factors.

Table 6: Coefficients analysis

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	.461	.180		2.557	*.012
Technology	.135	.049	.159	2.753	*.007
Public resistance	.191	.050	.229	3.800	*.000
Company policy	.386	.046	.486	8.295	*.000
Economic factors	.192	.053	.227	3.661	*.000

** Significant at 5% Significant Level*

Table 6 shows the significant *t-test* statistics and probabilities in relation to each independent variable such as technology, public resistance, company policy and economic factor, the last column of the Table 4.5 shows the significant - *value* where it has been significant at 5% significant level meaning that there is an effect from all independent variables on the dependent variable. Therefore, it can be accepted that there is an effect from all independent variables when considering the individual hypothesis.

5. DISCUSSION AND CONCLUSIONS

Our findings suggest that in the Sri Lankan context, technology, public resistance, company policies and economic factors affect the HWM practices in the heavy industries. These findings are consistent with many of the previous studies such as Aldrich et al. (2008) and Bandara and Hettiarachchi (2010) on the technological factors, Aldrich et al. (2008), Duan et al. (2008), Misra and Pandey (2005) on the corporate policies, Kirzhner, (2006) on the economic factors and finally Bandara (2010) and Cetin and Yesilnacar (2005) on the public resistance.

These findings clearly indicate many managerial and policy level implications. Corporate managers need to invest in advanced technologies to reduce the generation of HW and also to recycle or incinerate the generated HW. Similarly, corporate managers need to devise strong policies and procedures for waste management including hazardous waste. Due to the increased importance of public awareness and resistance, waste management should be a corporate priority. On the other hand, it is the responsibility of the corporate sector to contribute to the sustainable development in the developing countries. Also, the corporate managers need to clearly understand the internal and external economic implications of HWM. This is where they should have accurate information through a better management information system. These findings also suggest that the policy makers should support the industries to invest in advanced technologies by giving tax concessions and other policy level support. Further the policy makers should set up central HWM facilities and infrastructure as individual companies alone are not in a position to make the substantial investments. Without the marriage of corporate as well as policy level initiatives and commitment HWM will continue to be a problem in developing countries, posing a serious threat to the achievement of sustainable development.

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