

Barriers to Practice of Non-Hazardous Solid Waste Minimization by Industries in Malaysia

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Abstract

The Practice of waste minimization plays a significant role in sustainable development as the most acceptable method in the waste management hierarchy. This paper is a case study research on industrial non-hazardous wastes generated from different industrial activities in one of the major Malaysian industrial areas. This study is aimed at identifying the barriers of waste minimization practices in Malaysian industries. The combination of quantitative and qualitative methods were applied in the study through the use of a structured questionnaire prepared on Likert scale and semi-structured interviews with respondents across thirty (30) factories. Data collected through the questionnaire was analyzed using software and severity index tool. Findings reveal the barriers faced in practicing waste minimization by industries include the lack of time for separation of waste, absence of guidelines, regulations and limited accurate knowledge with severity index range of $62.5 \leq SI < 87.5$, which were considered to be serious issues. Through the application of suitable educational and awareness programs for industrial stakeholders, an effective waste minimization practice can be achieved.

Keywords: industrial solid wastes, waste minimization, barriers, severity index

1. Introduction

Population growth stimulates demand for a better standard of living, thereby encouraging industrial activities for the production of goods and services to match the growing demand for development. This development needs to comply with sustainable development standards. This challenge has equally faced developed countries (Smith & Ball, 2012). Development without sustainability increases the deterioration of the environment in many aspects. For instance, waste generation could defeat the objectives of sustainable development where the required standards are not followed (Bavani & Phon, 2009). Practicing the techniques of waste minimization from generation at source is inevitable in industrial sectors. This can be achieved through the process of re-use of waste generation for other productive processes (Bates & Phillips, 1999). Non implementation of waste minimization methods has resulted in many environmental crises; such as illegal dumping sites and open burning, thereby causing littering and air pollution (Agamuthu & Fauziah, 2011; Desa et al., 2011).

In the UK, nearly 26 million tons of wastes are generated by industrial activity annually. It was reported, landfill disposal was the main method of waste disposal accounting for 85% of solid wastes disposal (Pratt & Phillips, 2000). Apart from the UK as a developed country, Taiwan and Thailand generate 18 million tons of industrial waste annually, and hazardous wastes generated by industries in Taiwan are estimated at about 1.5 million metric tons (Phechpakdee, 2009; Wei & Huang, 2001).

In Malaysia, solid wastes were recognized as the principal environmental crises challenges in 1992, due to the increasing trend of solid wastes generation as a result of Malaysian industrialization (Desa et al., 2011). This is evident in documents revealing the volume of generation of industrial schedule wastes, which has an increasing trend from nearly 415 metric tons in 1994 to 1,880,000 metric tons in 2010 (DOE, 2010; Hassan et al., 2005). In 1998, Industrial wastes consist of 30% of total solid, which increased by 4% every year (Fariz, 2008). Recently, solid waste generation from both industrial and household sectors in the capital has risen by 3,500 metric tons daily (Jalil, 2010). However the Ministry of Housing and Local Government in 2013 describe a dearth of

information in generation quantities from specific industries, thus making planning and efficient industrial solid waste management difficult (MHLG, 2013).

The study therefore, attempted to assess the barriers and seriousness of issues in practicing waste minimization by industrial sectors in order to support sustainable industrial activity. Recognizing those factors may also be effective in motivating industries to solve obstacle relate to improving waste minimization practice.

1.1 Regulations and Instruments for Promoting Waste Minimization

In an attempt to deal with the increasing trend in solid waste generation, rising costs of proper waste management and illegal dumping sites, waste minimization strategy was identified by the Malaysian Government, as one of the policy goals of the 8th Malaysian Development Plan (2001–2005). It was further emphasized in the 9th Malaysian Development Plan (2006–2010). This solidified regulatory provisions by means of the Solid Waste Management Act 2007 (MHLG, 2006).

1.1.1 Solid Waste Management Act (Act 2007)

The Act 2007, provides a detailed regulatory framework for minimizing the amount of generated solid waste. The Ministry of Housing and Local Government (MHLG) enforced this Act using the 'reduce, reuse and recycle (3Rs) approach strategy as introduced and mandated Local Government compliance. In addition the Act encourages business and public participation in waste minimization practice. This is expected to enhance solid waste management at the local level where compliance seems difficult with little enforcement mechanisms in place (Agamuthu & Fauziah, 2011; Jalil, 2010; MHLG, 2006). Other legislation contains related provisions geared toward ensuring solid waste minimization practices; this includes the Act 127 primarily enacted for prevention and control of pollution as well as other relevant Acts. Worthy of note is the Act's recognition of 3R as a strategy to achieving its primary objective even though there are no regulations for the control, reduction, reuse and recycling except in the case of Environmental Impact Assessment (EIA) for new developments (EQA, 1974; MHLG, 2013). The significant provision relating to solid wastes is included in this Act. For instance, Act 171 provides legislative guidance for the Local Government, waste recyclers, generators and operators of the industrial waste disposal sites (Fariz, 2009; MHLG, 2013).

1.2 Barriers in Waste Minimization Practices by Industries

It is emphasized for industries to move toward a waste management hierarchy which gives more priority to the reduction and prevention of waste than treatment and disposal for effectiveness in sustainable development (Phillips et al., 1999; Pratt & Phillips, 2000). Solid waste minimization in industrial applications will continue as one of the significant issues and should be applied more rigorously (Bai & Sutanto, 2002). Presently, small numbers of industrial sectors apply the segregation of solid wastes at source for the goal of on-site recycling as one of the method for waste minimization (Babu et al., 2009). Certain barriers in waste management and waste minimization such as; lack of expertise and manpower, lack of belief and awareness for waste reduction and applying the sources inefficiently, are known to hamper the efficient management of solid waste (Isa et al., 2005).

According to Bai & Sutanto (2002), one of the issues of solid waste management in Singapore is the regulatory factors, which limit systematic management for industrial solid wastes (Bai & Sutanto, 2002). Pongrácz (2009) in his study on barriers of waste minimization in Finland stated that, poor personnel attitudes, technology deficiency, lack of trained personnel and knowledge provision by the authorities were realized as obstacles in food and drink industries due to the high demand of packaging resulting in a considerable amount of wastes generated (Pongrácz, 2009). The weakness in packaging of products might affect the waste minimization practices such as using non-recyclable material and inefficient managing of packaging (Henningsson et al., 2004; Poonprasit et al., 2005). Melanen (2001) in his analyses of waste minimization in small and medium enterprises reveals that technology is an efficient tool and offers a great opportunity in waste minimization (Ilomäki & Melanen, 2001). Furthermore, research results also noted technology as a barrier in waste management in Asian countries (Agamuthu et al., 2007; Babu et al., 2009; Phillips et al., 1999). In Malaysia, lack of policies to enhance waste minimization activities, lack of awareness, lack of information and essential data on waste generations among other factors have been major challenges experienced (MHLG, 2006). Also, it was reported the lack of time is a hindrance factor in implementing the regulations effectively (Goh, 1990), and insufficient financial support are fundamental barriers in waste management (Agamuthu & Fauziah, 2011).

2. Methodology

2.1 Survey Design and Data Analysis

Survey, on-site observation and semi-structured interview methods were conducted to cover the objective of this research. Structured questionnaire with 5 point Likert scale; Not very serious, Not serious, Moderate, Serious and Very serious were used to assess the respondent on the barriers faced by their companies (Grover & Vriens, 2006). Thirty (30) industries were selected from all the principal types of industrial activities in Malaysia. The respondents who were from the Health, Safety and Environment (HSE) and ISO department of the industrial sector, as well as those with related environmental affairs within the company.

2.2 Severity Index and Frequency Analysis

The data collected from the respondent were analyzed using frequency analysis and severity index estimation according to the Al-Hammad and Assaf 's equation (Al-Hammad & Assaf, 1996) and the rating classification was done based on Majid and McCaffer (Majid & McCaffer, 1997). The severity index classification is as follows:

Not very serious $0.00 \leq SI < 12.5$

Not serious $12.5 \leq SI < 37.5$

Moderate $37.5 \leq SI < 62.5$

Serious $62.5 \leq SI < 87.5$

Very serious $87.5 \leq SI < 100$

The Severity Index (SI) as defined by Al-Hammed and Assaf is mathematically stated as follow:

$$\text{Severity Index (SI)} = \frac{\sum_{i=0}^4 (a_i x_i)}{4 \sum_{i=0}^4 x_i} * 100$$

Where:

a_i = Index of a class; constant expressing to the weight given to class

x_i = Frequency of responses

$i = 0, 1, 2, 3, 4$ and is represented as: x_0, x_1, x_2, x_3, x_4 are the frequencies response respectively as follow:

a_0 : 0 (Not very serious)

a_1 : 1 (Not serious)

a_2 : 2 (Moderate)

a_3 : 3 (Serious)

a_4 : 4 (Very serious)

3. Results

3.1 Type of Generated Waste

Assessing the type of generated waste by the companies, the results show that the industries generate common types of solid wastes. Rubber based industries have the highest mean of waste generated (78.0), basic metal (67.0), food and beverages (63.13), wood-base (67.0), textile and apparels (18.68), electrical and electronic (16.40), machinery and equipment (9.6), and chemical (5.3). Table 1 shows the distribution of the respondent's by industrial type, mean and type of waste generated.

Table 1. The quantity and types of wastes generations

Industrial type	No	Mean of generation (T/Y)	Waste	Type of generated waste
Food & Beverage	4	63.13		Paper & cardboard, Plastic, Food waste, scrapped Aluminum
Textile & apparel	3	18.68		Paper & cardboard, Wood, Fiber, Scrapped Glass, Plastic, Scrapped Metal, scrapped Aluminum
Wood-based	3	43.20		Paper & cardboard, Wood, Plastic, Scrapped Metal, scrapped Aluminum
Rubber-based	5	78.00		Paper & cardboard, Rubber, Plastic, Food waste
Machinery & Equipment	2	9.6		Scrapped Metal, scrapped Aluminum
Chemical	3	5.30		Paper & cardboard, Wood, Scrapped Glass, Plastic, Scrapped Metal, Food waste
Basic metal	5	67.00		Paper & cardboard, Wood, Scrapped Glass, Plastic, Scrapped Metal, Food waste, Scrapped Aluminum
Electrical& Electronic	5	16.40		Paper & cardboard, Wood, Rubber, Scrapped Glass, Plastic, Scrapped Metal, scrapped Aluminum, Wires
Total	30			

3.2 Awareness and Human Capability

Awareness drives waste management through dispersal of salient information, ensuring human capability. Education will have a stronger and lasting effect as it encourages participation. Also, education promotes creative responses to any shortcomings. An analysis result reveals an average in lack of awareness among employee, belief, partnership, trained staff and expertise and manpower to run the program in the industrial categories. The Severity Index shows a value range between $37.5 \leq SI < 62.5$ implying a moderate rate of awareness and human capability with the lack of expertise and the manpower among other issue have a higher severity index of 59.16% (Table 2).

Table 2. Frequencies of respondent's awareness and human capability in waste minimization

Awareness& human capability	Frequency analysis						SI (%)
	N	V	S	M	NS	VS	
Lack of awareness among employee	N	9	7	12	2	0	53.33
	P	30	23.30	40	6.7		
Lack of belief	N	2	6	8	11	3	55.83
	P	6.7	20	26	36.7	10	
Lack of partnership	N	2	8	9	10	1	50.16
	P	6.7	26.7	30	33.3	3.3	
Lack of trained staff	N	2	4	11	11	2	55.83
	P	6.7	13.3	36.7	36.7	6.7	
Lack of expertise and manpower to run the program	N	0	5	10	14	1	59.16
	P		16.7	23.30	23.30	3.35	

3.3 Information

Lack of environmental ethics and awareness contribute to the failure of solid waste management plans. Therefore, instilling information on waste issues will go a long way. Figure 1 shows the company issues regarding information and data about waste minimization practices. This includes basic information about solid waste minimization, legal information, technical information and accurate knowledge about waste minimization. The analysis result has shown that the lack of accurate knowledge about waste minimization activity has the highest severity index in this category with 64.1% within the 'serious' range ($62.5 \leq SI < 87.5$), this is followed by the lack of technical information 58.33 %, lack of legal information with 52.5% and the lack of basic data on solid waste minimization with 49.17%.

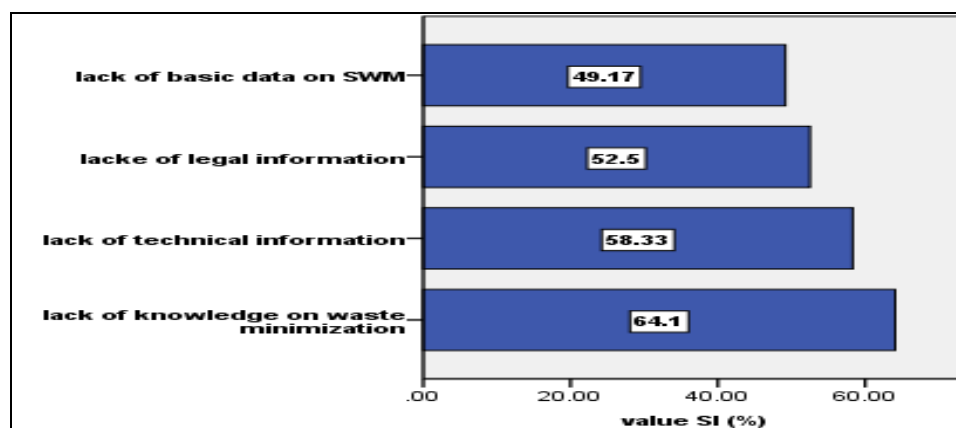


Figure 1. Severity index of information on waste minimization

3.4 Waste Packaging

Regarding to investigate the possible barriers in packaging activities may affect the solid waste minimization practice, three issues were examined. Slow and insufficient change in packaging, use of non-recyclable material and lack of proper management for packaging. The Severity Index assessment for packaging have shown the use of non-recyclable material constitutes a major barrier in this category with a 50.0% severity index, followed by lack of proper management for packaging with 45%, while slow and insufficient changing in packaging is the least in the category with 42.5% of SI value. More data are needed to determine the precise extent of this barrier to waste management practice.

Table 3. Frequencies of respondent's opinion on waste packaging

Packaging	Frequency analysis						SI (%)
	N	V	S	M	NS	VS	
Slow and insufficient change in packaging	N	0	7	21	2	0	42.50
	P		23.30	70.0	0.70		
Using non- recyclable material	N	2	7	13	5	3	50
	P	6.7	23.30	43.30	16.70	10.0	
Lack of proper management for packaging	N	2	10	15	1	2	45
	P	6.7	33.30	50.0	3.30	6.70	

3.5 Technology

It has been frequently commented upon that scientific policy or technological advancements in one industry or country may not be suitable in another, despite geographical or cultural proximity. This must be kept in mind when exporting waste disposal technology or incorporating waste management policies. Local capacity development is a more sustainable alternative to technological or policy adaptation. With the right talent, a country can develop a sustainable capacity for waste management, unique to their economic situation and waste composition.

Technology assessment of the company has been evaluated to an extent to show the severity index. The results show that all items considered in this category have the severity index range of $37.5 \leq SI < 62.5$, within the moderate range. This implies that the technology factors are not as such a hindrance to the waste minimization practice by the company.

Table 4. Frequencies of respondents on technology in company for waste minimization practice

Technology	Frequency analysis					SI (%)
	NVS	NS	M	S	VS	
Old production process	N 2	12	11	4	1	41.67
	P 6.7	40	36.7	13.3	3.3	
Lack of process control and modification	N 4	5	10	9	2	50.00
	P 13.3	16.7	33.3	30.0	6.7	
Lack of proper inventory management	N 2	10	8	9	1	47.50
	P 6.7	33.3	26.7	30.0	3.30	
Lack of equipment modification	N 3	8	10	7	2	47.50
	P 10	26.7	33.3	23.3	6.7	
Lack of material modification	N 0	10	10	8	2	51.67
	P	33.3	33.3	26.7	6.7	
Lack of product modification	N 2	9	9	6	4	50.83
	P 6.7	30.0	30.0	20.0	13.3	

3.6 Other Issues

The category of other factors include Lack of specific waste minimization guidelines for industrial activity, time, policy and regulations for practicing waste minimization, cost of implementing waste minimization activities, and government cooperation. The result shows high severity index value range of $62.5 \leq SI < 87.5$. This range indicates that other factors lead to the serious barriers in waste minimization practices in the industrial sectors. The Lack of specific guidelines and time constitute 63.3%, policy and regulations for practicing waste minimization (62.5%), cost of implementing waste minimization activities (57.5%), and government cooperation constitute 52.5% of severity value in waste minimization practices (Figure 2).

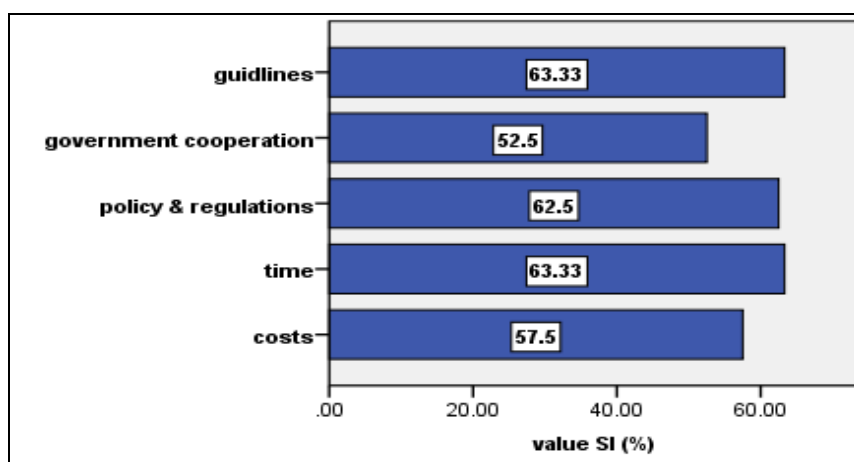


Figure 2 . Severity index others issue as barrier to waste minimization practices

4. Discussion

Findings reveal that the lack of expertise and manpower to run the program is one of the major barriers in waste minimization practice by industries (Table 2). The lack of accurate knowledge in practicing waste minimization (Figure 1) and the low level of recycling rate (Table 2) as part of minimizing activity (Hopper et al., 1993), lack of material modification (Table 4) creat serious barriers. Due to lack of basic guidelines (Figure 2) as the most critical issues ,most managers of the industries don't have estimation about the expenditures of materials, wastes disposal and the real costs of wastes that generates core issues in the company (Raouf & Jafarzadeh, 2005).

In Malaysia, study have shown that the 3Rs approach is very weak due to inadequate awareness (Agamuthu & Fauziah, 2011). Though, the severity index on the awareness and human capability (Figure 1) reveals a range within the moderate ($37.5 \leq SI < 62.5$) based on the respondent's opinions. However, time factor is known as the most serious issue revealed (Figure 2) to hinder the implementation of waste minimization despite the existence

of acceptable awareness level among employee. For instance time play an important role in better understanding of the regulation's concepts before implementations. Sometimes despite all facilities for waste minimization implementation, staffs are busy to spend time on practicing waste minimization principals. In terms of legislations relating to industrial waste minimization, most of the waste strategies and regulations have major focus on hazardous industrial wastes and municipal and household wastes, while there are few statutes, which are responsible for encouraging the business entities for practicing waste minimization. Institutional factors such as policies, regulations and guidelines were considered as serious issues in waste minimization practicing (Figure 2). Despite the existence of some policies regarding waste minimization practicing, the industrial sectors do not follow them because it is not mandatory. Also some of these policies are not clear and do not mention directly on waste minimization practice for industrial solid and non-hazardous wastes as well as regulatory frameworks. For instance segregation, recycling, collection, storage, transportation, treatment and disposal activities are enforced under the Acts of solid waste management activities (EA, 2009), realizing there are not any regulation for industrial waste minimization under the Act, apart from the government's support by preparing and improving policies of private waste management companies (Manaf et al., 2009).

Malaysia has no specific guidelines and methodologies for practicing industrial solid waste minimization while in Singapore, UK and Thailand there are guidelines and methodologies that are suited for industries. Most of the industries in Malaysia have their own policies and guideline obtained from other countries that is implemented under the supervision of the expert person in the company, but this is not efficient enough considering the results from the analysis, which reveal the seriousness of the issues. To accomplish the goal of solid waste reduction by practicing waste minimization, it is necessary to formulate waste minimization guideline under the Act and make it mandatory to enforce the industries to practice waste minimization rather than disposal and treatment. Provision of information and accurate data on the amount of waste generation before and after practicing waste minimization is required to monitor the implementation for sustainability. Also, emphasis on packing as barriers should be given great consideration despite the study result show that technology and packaging have less serious severity index (Table 3&4). From the technology point of view, Malaysia imported some relative technologies from Japan and European region to share the technology (Manaf et al., 2009).

5. Conclusion

Increased waste generation coupled with lack of effective waste management practices has resulted in difficulty in achieving sustainable waste management. Several factors are responsible for the current condition and also are likely to affect future directions. Transfer of relevant technologies; broadly raised awareness and knowledge at industry and workforce level, together with regulatory factors are essential in bringing about successful waste minimization practices provided they are tailored to the local conditions. There is a need for a pro-active waste management approach in Malaysia. In achieving 2020 target of national development priorities in sustainable waste management there are the identified barriers which form stumbling block, by focusing on barriers that prevent industries from practicing waste minimization. This could be done by educating and instilling awareness of changes in technology, environment, waste practices to the industrial workers who are part of the implementer of regulations and guidelines from enforcement agencies to achieve sustainable waste management through effective waste minimization practices.

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