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Determination and Comparison of Solutions Importance and Approaches Contribute to Waste Minimization Among Manufacturing Firms in Shah Alam, Malaysia

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ABSTRACT

Waste minimization plays an important role in sustainable industrial waste management. It is the most effective method in controlling waste arising. There are some common factors contribute in effective practicing of waste minimization in both developing and developed countries. This study examines and compares the most important solutions and approaches in enhancement of practicing waste minimization among 214 manufacturing industries in Shah Alam, Malaysia. Quantitative data were analyzed using both descriptive and inferential statistics. It was revealed that improvement in internal monitoring system has the higher effectiveness in practicing waste minimization among other factors (SI=67.40%). Also respondent's perception toward approaches regarding awareness, encouragement and cooperation were found significantly higher than other approaches ($p<0.05$). The findings of this study highlight the necessity of training programs and technology modification as well as improvement in monitoring systems.

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INTRODUCTION

Industrialization plays an important role in producing goods and survival of human lives and improving their lifestyles. However, the negative consequences of industrial activities on environment and natural resources cannot be neglected [1]. A huge quantity of industrial wastes is generates daily in developing countries that exacerbates the landfill disposal and illegal dumping crisis due to the lack of land and increasing cost associated with landfill disposal [2]. Landfill disposal, which is known as the least desirable option of waste management hierarchy, is the most common method of waste handling in most of developing countries. Also, the management of landfill sites is very poor that can contribute significantly to global warming as well [3]. These disposal sites receive a combination of industrial solid and municipal wastes such as plastic, iron, paper, food wastes, rubber, textile, metal, glass, cardboard, aluminum and miscellaneous. Waste minimization as the most sustainable method for handling the waste arising will continue as one of the challenges and it is necessary to be applied more rigorously [4-6]. Malaysia as one of the developing and Asian country is facing to the serious issues of solid waste management. The increasing trend of solid waste generation in Malaysia due to industrial activities highlights the necessity of changing the current waste management regime into more sustainable strategies [7].

There are few studies that focused on the in– depth at industrial solid waste minimization practices [8]. Also the focus of many studies has been on recycling and less stress has been placed on reduction of wastes at source [9].

One of the aim of this study is to highlight the effective solutions in practicing waste minimization at source (source reduction) as one component of 3Rs and

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as the most suitable option in the waste management hierarchy. Also in this study important approaches contribute to waste minimization practice were categorized and analyzed. Findings of this study can provide useful baseline information on the significant factors for industrial solid waste minimization practice.

Waste minimization and waste management heirachy

In the waste management hierarchy, waste minimization is located at the highest level as shown in figure 1 below. Waste minimization, is considered as the major principle of sustainable development. It is also known as the most efficient method for managing waste arising and essential method for any strategy of waste management. It is followed by reuse, recycling, composting, treatment and disposal [10, 11].

It has been emphasized that in order to move toward sustainable waste management, industries should follow priorities in waste management hierarchy and more priority should be given to reduction and prevention of waste generation than treatment and disposal [12]. At present, small numbers of industrial premises apply the segregation of solid wastes at source for the goal of on–site recycling as one method of waste minimization [13].

Source reduction by manufacturing industries helps to protect natural resources; saving energy and money and reduce any destructive impact on human's life and the environment that is more widely accepted by industries [14, 15].

In Malaysia, the related waste management hierarchy for managing household, construction, commercial and rejected wastes focuses on four option including reduction, re-use, recycle and disposal [16, 17].

Currently in Malaysia, landfill disposal is the most common and main option among other options in waste management hierarchy. Almost 95% of wastes are sent for disposal and about 20% of wastes are burned illegally and just 5% of wastes are recycled. Aside from that some landfill sites are open areas that enhance the environmental concerns. As an example, it was reported that approximately 50 illegal dumping sites existed in Klang Valley with the capacity of almost 100 tons of wastes [4, 18, 19]. Following figures highlights priority of waste minimization in the waste management hierarchy.

Important drivers in practcing waste minimization

Based on the definition provided by the Environmental Agency waste minimization is "the reduction of waste at source by understanding and changing process to reduce and prevent waste" [20]. Waste minimization at source or source reduction defines as any practice for decreasing the amount of any contaminates and substances prior to other options in waste management hierarchy [21]. Babu et.al defined waste minimization as "the continuous application of a systematic approach to reducing the generation of waste at source". This definition contains source reduction and on–site recycling. Techniques of waste minimization practice by industries include source reduction and recycling techniques [13]. Source reduction include equipment or technology modification, process modification, feed stock substitution, housekeeping practice, redesign products and recycling within process [14, 21]. Badgie et al., introduced public education, government policy initiatives and segregation of wastes for recycling purposes as significant factors in waste reduction [22]. Source reduction by manufacturing industries helps to protect natural resources; saving energy and money and reduce any destructive impact on human's life and the environment that is more widely accepted by industries [14, 15].

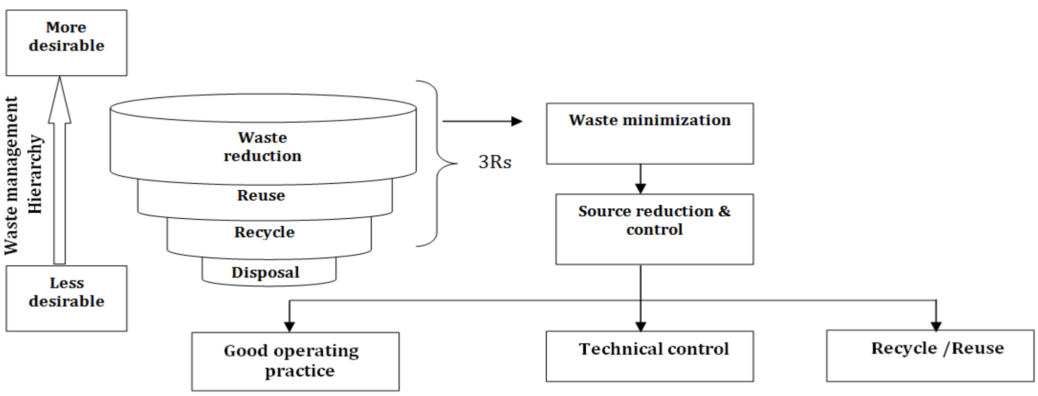

Figure 1.Waste minimization priority and strategies

Based on the report of Pariatamby and Fauziah, Strategies for waste reduction in developing countries are not very effective as well as developed countries such as Singapore and Japan [9]. Also in Malaysia practicing waste minimization by industries are not very common [17].

The following statements are the important solutions and drivers in practicing waste minimization by industries that were reported by pervious study.

Providing data and reliable information resources

Most of the information regarding the solid waste management practices was found to be very general. Because of improper data collection system, the actual figures regarding the worldwide waste generation is not available. However developed countries such as the UK, the US, Japan, Hong Kong and Singapore have more available data due to proper waste management and well– established policies [18, 23].

As stated by Mbuligwe and Kaseva, there are few studies conducted among industries with respect to the solid waste management and highlighted the lack of information and data about industrial solid waste management [8]. In Malaysia the existing figures about daily solid waste generation are related to the municipal solid wastes or mixture of municipal solid wastes and industrial wastes, hence there are limited updated data regarding solid wastes generate by manufacturing industries [4, 24]. It was also reported the data regarding the waste generation not properly documented that hamper Malaysia to establish appropriate waste management system and industrial waste minimization guidelines [25].

Increasing the level of awareness

Environmental awareness is described as the mixture of skill, knowledge and motivation that can be viewed as the knowledge of causes and effects. Perception classified in to categories that entail perception of environmental protection, efforts and knowledge of it and perception of environmental status comprised of the perception of the condition of general and local environment and the environmental problems [5, 26]. Environmental perception is helpful in people's understanding and thinking regarding the environmental principles [27]. On the other hand, lack of environmental awareness and perception toward wastes management and minimization worsen waste related issues [28]. Attitude is defined as a combination of feelings, conditions and beliefs responding to the desirable or undesirable methods [29]. Positive attitudes towards waste management play an important role in protecting the environment [4]. Redmond et al., showed that attitudes and awareness of firm' managers impact on their action with respect to environmental management implementation [30]. As an example, analyzing the results from Chenayah et al., demonstrated that awareness plays an effective role in recycling activities [31]. As stated by Samsudin and Don, there is a perceived conflict between the concept of waste minimization and recycling activities in Malaysia [32]. It was reported many of people considered waste minimization as recycling activities. Also it was also reported that there were some attempts to increase the level of awareness about waste management; however, the results showed insignificant change [17].

Cooperation among stakeholders

The cooperation among firms' employees plays an effective role in order to reduce the negative impacts of industrial activities on the environment [33]. For instance, Zhu et al. and Vachon and Klassen, have found cooperation among manufacturing industries which had significant impact on environmental performance [34, 35].

Also the lack of dynamic cooperation and partnership between industries and local authorities were considered as a hindrance factor for efficient reduction of wastes and sustainable development principles [11]. Tam revealed that the lack of government cooperation in providing financial incentives is the major barrier in practicing waste minimization methods [36]. In Malaysia sustainable waste management cannot be achieved successfully without the cooperation of both governmental and non–governmental organizations [32].

Employing manpower and expertise

Lack of trained staff and expertises that provide the technical knowledge have been realized as one of the important issue in the waste minimization; however, insufficient training of inexperienced employees is another challenge [37-39]. Provision of training to the workforce plays an important role in environmental management and environmentally proactive practices [40]. According to Vanatta, by an effective employee training, approximately 10 to 40 % of wastes can be reduced [41]. It was reported lack of experts in the field of waste management in Malaysia have placed challenges for Local Authorities for implementation of sustainable waste management [37].

Provision of legal instruments

For better implementation of practicng waste minimization, regulatory frameworks and guidelines are required. Without the development of legal instruments and instituational support with the involvment of related stakeholders, proper waste management and minimization by industrial sectors cannot be achieved [17, 42].

Pongracz, introduced regulatory framework as an effective instrument in controlling waste arising [39]. Ineffective enforcement is a hinderance factor in the implementation of 3R strategy for minimizing the wast [9], [28]. In Malaysia, the lack of regulatory framework and absence of suitable policy of 3Rs, hinder controlling the quantity of waste arising from manufactring and effeicient waste management practice [4], [17].

Applying new and modified technologies

Use of technology among industries play important role in waste reduction and 3R activities in both developing and developed countries [23].

Musee et al., showed lack of technology modification to be one of the main problems in wast reduction. He also implied that applying better technology for the purpose of waste reduction required investment [43]. In most of Asian countries lack of technology was recognized as hindrance of waste management [28]. According to Henningsson et al., by changing technologies in industries, considerable saving in manpower, materials, utilities and increase in efficiency can be achieved [44]. In Malaysia, due to outdated technology waste minimization is not very successful. Therefore, for improvement of sustainable waste management technology modification must be provided [7].

Time and money allocation

Fiscal aspects play fundamental role in waste minimiztiation implementation and the absence of financial supporting is a fundamental barrier in wastes management and applying new technologies for waste reduction [4], [23].

As stated by Shekdar, funding plays an effective role in applying technology for the purpose of waste reduction [23]. As revealed by Panos and Danai, financial and legislation incentives play important roles in improvement of waste minimization practicing. Limited time in many companies is considerined as a hindrance factor [45]. Most of the stakeholders implied they do not have time to allocate for waste minimization practicing and monitoring [46]. It is reported in Malaysi the absence of sufficient money and time hamper the local authorities to provide data and information that increases difficulties in wastes management[37].

MATERIAL AND METHODS

In this study the researcher uses survey for data collection as the study involved with collecting and analyzing the data. Data was collected through survey questionnaires that were administered to the respondents (214 respective manufacturing firms) who were chosen randomly to participate in the study. Shah Alam, capital of Selangor in Malaysia was chosen as the study area. Shah Alam was chosen as the study area because it is the major center in Selangor with industrial parks that has infrastructural facilities such as good roads and communication networking, skilled laborers and easy accessibility, which create conducive atmosphere for industrial development. With this advantages, Shah Alam has become one of the top investment centers with the highest number of manufacturing projects, contributing tremendously to the economic development of Selangor and indeed Malaysia [47, 48].

In order to achieve the aim of this study both descriptive statistic (severity index calculation) and inferential statistics (repeated measure ANOVA, factor analysis) were used. The quantitative data was analyzed using IBM-SPSS 20 software. In order to examine the appropriate types of inferential statistics, normality test was used.

Questionnaire design

Questionnaire consists of two sections. In the first section, the respondents were asked to rate the level of effectiveness of each item in improving the waste minimization practiced by manufacturing firms.

Seventeen items were considered for this part as solutions to better practicing of waste minimization and reduction of the waste at source. The value of response for each item was as follows: *0= Very low, 1= Low, 2= Medium, 3= High and 4= Very high*. These questions were modified based on review of the literatures [29, 39, 49, 50].

In the second section, participants were asked to express the level of their agreement to approaches in waste minimization. Four categories of approaches with eleven items were considered as the approaches contributing to waste minimization. The questions of this part were generated and modified from Hopper et al., Phillips et al., Poonprasit et al. and Staniskis and Stasiskiene [11, 39, 51-53].

For assessing the opinion of respondents on approaches to practicing waste minimization, a five–point Likert scale was designed that was similar to the scale used in the studies of Longe et al., Marquez et al., Begum and Pereira and Isa et al. [54-57].

The value of response for each item was as follows: *0=strongly disagree, 1= Disagree, 2= Neutral, 3= Agree and 4= strongly agree.*

Afterwards**,** the content validity of the instruments was used by consulting panel of ten experts/ professionals in the field of waste management.

Severity index (SI) calculation

Severity index is mostly used instead the mean analysis when the data are ordinal [58]. Severity index calculations in this study were used to analyze the frequencies from the responses regarding the respondents' opinion toward waste minimization solutions and approaches where the answers to the questions were demonstrated as the five – point Likert scale. In the SI calculation, there is a classification of rating to show the intensity of the responses toward the issues [54, 57].

The severity index was calculated according to Al-Hammad and Assaf's equation and the rating classification was done according to Majid and McCaffer as below [59, 60]:

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

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 (Very low effectiveness / Strongly disagree)

$0.00 \le SI < 12.5$

a_1: 1 (Low effectiveness / Disagree)

$12.5 \le SI < 37.5$

a_2: 2 (Medium/ Neutral)

$37.5 \le SI < 62.5$

a_3: 3 (High effectiveness / Agree)

$62.5 \le SI < 87.5$

a_4: 4 (Very high effectiveness / Strongly agree)

$87.5 \le SI < 100$

Repeated measures ANOVA

According to Morgan et al. and Pallant, one – way ANOVA is a suitable method for comparing the mean scores of more than two independent and continues variables [61, 62]. Also, it was used in the situations where the sample is normally distributed. Repeated measure ANOVA is a type of one –way ANOVA that compares the mean score of variables in one group under different conditions. In this study repeated measures ANOVA was used to compare different approaches in waste minimization practicing.

Factor analysis

Factor analysis is used for dimension reduction and to condensate a large set of data into smaller variables. Also, it groups variables with related close items [62].

In this research, factor analysis was conducted to group the variables to determine the number of categories with related items to each category.It helps easily to compare the mean score of each category.

RESULTS AND DISCUSSION

Solutions effectiveness in practicing waste minimization

Table 1 shows the findings of the analysis using descriptive statistics (calculated value of severity index) to determine the level of effectiveness of each item in practicing waste minimization.

As indicated in the table, improvement in internal monitoring system (SI= 67.40%) has the higher severity index with the value range of $62.5 \le SI < 87.5$. It is followed by changing the attitude of employee (SI= 66.12%), employ expertise and manpower (SI= 65.53%), receiving policies and waste minimization guidelines (SI= 65.53%), receiving accurate knowledge about waste minimization (SI= 65.42%), process control and equipment modification (SI= 63.78%), government cooperation (SI= 63.66%), workshops about waste minimization and personnel training (SI= 63.55%) and sufficient time for waste minimization practicing (SI= 62.61%), which are in value range from 62 to 67% ($62.5 \le SI < 87.5$). All the above mentioned factors were considered to have high effectiveness value in practicing waste minimization. The severity index value fall within the range of 62.5 and 87.5. This classification for solutions includes:

$0.00 \le SI < 12.5$ (Very low), $12.5 \le SI < 37.5$ (Low), $37.5 \le SI < 62.5$ (Medium), $62.5 \le SI < 87.5$ (High) and $87.5 \le SI < 100$ (Very high)

The remaining seven solutions fall within the moderate category which shows the range of $37.5 \le SI < 62.5$, indicating as the moderate effectiveness. However, only distribution of posters has a low SI among the solutions (SI= 34.46%) which falls in the range of 12.5 and 37.5.

This means that, improvement in monitoring, change the attitude of employees, employ expertise and manpower, policies and guidelines for waste minimization, accurate knowledge about waste minimization, process control and modification, government cooperation, training and workshops and time are the major solutions in the improvement of solid waste minimization by manufacturing firms. This is in line with Olgyaiova et al. and Pongracz who argued that change in attitude of employees is the most contributing factor in improvement of waste reduction, that was followed by receiving knowledge and information and improving the monitoring system [29, 52]. Babakri et al., have found that training is one of the important factors in implementing waste management after identifying and documentation of environmental aspects [49]. According to the study conducted by Wang et al., manpower had significant contribution in improvement of on–site sorting [63].

Legislation was more emphasized in the study of Garcia et al., in chemical industries [64]. Krippendorff , found legislation and financial incentives are the major motivations for waste minimization practice [65].

Respondents' perception toward approaches in practicing waste minimization

As illustrated in Table 2, perception on training, awareness, cooperation and encouraging has three items under which the first item has the highest severity index (81.07%), followed by the second items which has SI = (80.49%) and the last items that has SI = (79.78%). The severity index values obtained range between 79 and 81%, located in the agree range of $62.5 \leq SI < 87.5$ [54]. The second category has two major items with respect to perception on information approaches. Items in this category were found to be within the neutral opinion range ($37.5 \leq SI < 62.5$), with the value of (SI= 49.18%) for the first item, followed by the second item which has the SI value of 46.61%.

Perception on technological aspects in waste minimization has two items; the first item has a highest severity index (SI=73.24%) the second item with the SI value of 71.96%. These value range fall within the agree ranges of $62.5 \leq SI < 87.5$ as argued by Longe et al. and Majid and McCaffer[54], [60].

The last category was allocated to the perception on national policy approaches which has four items. The SI value for the first item were found to be within the neutral opinion range of $37.5 \leq SI < 62.5$ [54], [57], while the severity index value for the other following items were found within the agree range of $62.5 \leq SI < 87.5$ [54].

The exploratory factor analysis was performed to determine the patterns of indices and discover the correlation among indices in each category as the approaches contributing in waste minimization [46]. The KMO test was used to specify the sampling efficiency. According to the KMO test table of the Kaiser–Meyer–Olkin measure is more than 0.5 (0.68) that is acceptable for performing factor analysis [66].The procedure maximum likelihood estimation was applied to extract the factors from the variable data. As expected, based on the Table 3, all 11 items were simplified into 4 extracted factors contribute 56.47% of the total variance (See Appendix A for the table of variance explanation and KMO test).

TABLE 1. Frequency and SI calculation of Solutions Effectiveness for a better practicing of Waste Minimization

Items		VL	L	M	H	VH	SI (%)
SOL1.Employ expertise and manpower	N	1	18	95	47	53	65.53
	P	0.5	8.4	44.4	22	24.8	
SOL2.Change the attitude of employees	N	3	12	67	108	24	66.12
	P	1.4	5.6	31.3	50.5	11.2	
SOL3.Receiving accurate knowledge about waste minimization	N	4	16	70	92	32	65.42
	P	1.9	7.5	32.7	43	15	
SOL4.Receiving legal information	N	8	21	101	82	2	55.72
	P	3.7	9.8	47.2	38.3	0.9	
SOL5.Workshops and personnel training about waste minimization	N	8	22	92	30	62	63.55
	P	3.7	10.3	43	14	29	
SOL6.Mass media (radio, T.V, newspaper)	N	43	50	89	31	1	37.96
	P	20.1	23.4	41.6	14.5	0.5	
SOL7. Distribution of posters, flier etc.	N	56	47	87	22	2	34.46
	P	26.2	22	40	10.3	0.9	
SOL 8.Saving ,separating and choosing suitable materials	N	9	18	110	56	21	57.24
	P	4.2	8.4	51.4	26.2	9.8	
SOL9.Improve packaging and product design	N	6	20	97	82	9	57.94
	P	2.8	9.3	45.3	38.3	4.2	
SOL10. Process control and equipment modification	N	6	17	80	75	36	63.78
	P	2.8	7.9	37.4	35	16.8	
SOL11.Encourage suppliers for using recyclable material	N	7	30	88	84	5	55.84
	P	3.3	14	41.1	39.3	2.3	
SOL12.Compliance to authority requirements and regulations	N	6	20	88	86	14	59.57
	P	2.8	9.3	41.1	40.2	6.5	
SOL13.Receiving financial supports from Government	N	8	46	73	53	34	56.89
	P	3.7	21.5	34.1	24.8	15.9	
SOL14.Government cooperation	N	5	27	67	76	39	63.66
	P	2.3	12.6	31.3	35.5	18.2	
SOL15.Receiving policies and waste minimization guidelines	N	5	15	65	100	29	65.53
	P	2.3	7	30.4	46.7	13.6	
SOL16.Improve Internal monitoring system	N	2	14	69	91	38	67.40
	P	0.9	6.5	32.2	42.5	17.8	
SOL17.Sufficient time for waste minimization practicing	N	4	26	75	76	33	62.61
	P	1.9	12.1	35	35.5	15.4	

N=214

TABLE 2. Frequency and SI of respondents' perception toward Waste Minimization Approaches

Items		Frequency analysis					
		SDA	DA	N	A	SA	SI (%)
Training, Awareness and Encouraging in practicing waste minimization							
Having cooperation and awareness among staff is necessary for practicing waste minimization by industries	N	1	2	13	126	72	81.07
	P	0.5	0.9	6.1	58.9	33.6	
Waste minimization should be encouraged as the most desirable option than treatment and disposal	N	0	3	20	118	73	80.49
	P	0	1.4	8.9	55.1	34.6	
For achieving successful waste minimization training the guidelines and methodologies are necessary.	N	0	1	21	128	64	79.78
	P	0	23.8	9.3	60.3	29.9	
Accessible and enough Information in practicing waste minimization							
Enough information must be provided with regard to the benefits of waste minimization.	N	6	64	82	55	7	49.18
	P	2.8	29.9	38.3	25.7	3.3	
Easy access to the waste minimization information is very helpful in waste minimization practicing	N	10	71	84	36	13	46.61
	P	4.7	33.2	39.3	16.8	6.1	
Practical and modified Technology in practicing waste minimization							
The Industrial waste generation can be reduced by applying available and practical technologies	N	0	4	4	137	33	73.24
	P	0	1.9	18.7	64.0	15.4	
Technology modification gives the greatest result in waste minimization and cost saving.	N	0	3	50	131	30	71.96
	P	0	1.4	23.4	61.2	14.0	
National policy enforcement on practicing waste minimization							
National policy on waste management is not very helpful for industries to minimize the quantity of generating solid wastes at source	N	6	34	82	82	10	56.54
	P	2.8	15.9	38.3	38.3	4.7	
It is necessary for the government to strengthen the policy on industrial solid waste minimization.	N	1	3	45	108	57	75.35
	P	0.5	1.4	21.0	50.5	26.6	
Government must enforce waste minimization program (methodologies and guidelines) for industries.	N	3	17	59	99	36	77.45
	P	1.4	7.9	27.6	46.3	16.8	
Enforcement of the national policy on industrial solid waste minimization improve the waste minimization practicing by industries	N	3	17	59	99	36	67.28
	P	1.4	7.9	27.6	46.3	16.8	

N=214

TABLE 3. Rotate Factor Matrix

Category (dimension)	Component	Factor 1	2	3	4
National policy	Government must enforce waste minimization program (methodologies and guideline) for industries.	0.780			
	It is necessary for the government to strengthen the policy on industrial solid waste minimization.	0.719			
	Enforcement the national policy on industrial solid waste minimization improve the waste minimization practicing by industries	0.675			
	National policy on waste management is not very helpful for industries to minimize the quantity of generating solid wastes at source	0.518			
Information	Enough information must be provided with regard to the benefits of waste minimization.		0.928		
	Easy access to the Wmin information is very helpful in waste minimization practicing		0.767		
Training, awareness and encouraging	Having cooperation and awareness among staff are necessary for practicing waste minimization by industries			0.709	
	Waste minimization should be encouraged as the most desirable option than treatment and disposal			0.638	
	For achieving successful waste minimization training the guidelines and methodologies are necessary.			0.606	
Technology	The Industrial waste generation can be reduced by applying available and practical technologies				0.855
	Technology modification gives the greatest result in waste minimization and cost saving.				0.595

N=214, Extraction Method: Maximum Likelihood, Rotation Method: Varimax with Kaiser Normalization, a. Rotation converged in 5 iterations.

After applying the exploratory factor analysis, the difference between the dimensions was determined using their respective mean scores. As the data met the assumption of normality, one–way repeated measure ANOVA was used. Mauchly's test of Sphericity was significant; therefore, a repeated measure ANOVA with a Greenhouse–Geisser correction determined that the mean of each dimension as a contributing factor different significantly from other dimensions (F (2.425, 516.424) = 183.487, p <.005).

Based on the Table 4 and Figure 1, Post hoc test using the Bonferroni correction revealed that awareness, training and encouraging approaches have the highest mean score (M= 4.218) which is significantly different from other categories (p <0.05), followed by 2= technology approaches (M= 3.90, p <0.05), 3= national policies approaches (M=3.76, p <0.05), and 4= information approaches (M= 2.91, p <0.05), which implied the significant difference among all categories. Based on this result, hence H_{07} is rejected (p <0.05).

TABLE 4. Pairwise comparison of Approaches

(I) factor	(J) factor1	Mean Difference (I-J)	Std. Error	P value
1	4	1.302*	0.066	0.000
1	2	0.314*	0.043	0.000
1	3	0.452*	0.048	0.000
4	2	0.988*	0.065	0.000
4	3	0.850*	0.07	0.000
2	3	0.138*	0.05	0.007

Based on estimated marginal means
* The mean difference is significant at the .05 level.

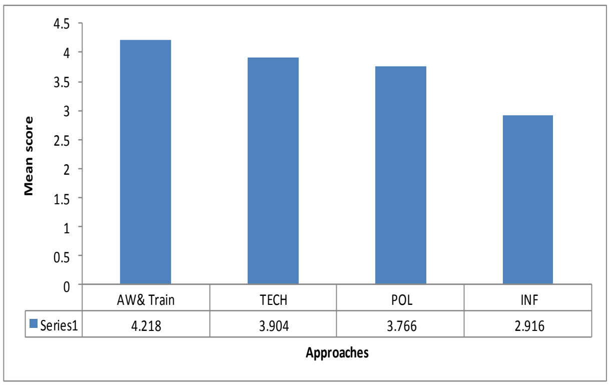

Figure 2. Comparing Approaches contributing to Practicing Waste Minimizatio

Awareness, training and encouraging approaches

Results of repeated measure ANOVA showed that the most important approach is relate to the category of awareness, training and encouraging. Based on the high mean score indicated by its three items (M= 4.21). In line with the finding, it was revealed that about 10 to 40 % of wastes can be reduced by an effective employee training [41].

Redmond et al., showed encouraging as the major factor in waste minimization practice [30]. Also Pongracz suggested awareness factor as the most important factors in waste minimization [39]. However, Tam and Panos found in their researches that staff training and education is the second most important measure in implementing waste minimization [36], [45]. With respect to the importance of cooperation, Zhu et al. and Vachon have found cooperation in manufacturing industries with significant impact on environmental performance [34], [35]. Therefore, Malaysian government and other stakeholders should take a serious action to increase their knowledge in terms of waste generation composition and waste management principles [22].

Technology approaches

Technology approaches were determined as the second important approach based on the high mean value by its two major components (M= 3.9). It can be implied that the applicable and available technology and technology modification are important in enhancing practicing of waste minimization. This finding is in line with Henningsson et al., as they have stated that changing and modifying technology increase efficiency and provide considerable saving in manpower and materials[44]. Also, other researcher argued about the importance of technological aspects in waste reduction [51, 53, [67].

National policy approaches

In terms of national policy approaches in waste minimization, the results revealed that this approach is the third important approach based on the mean score value specified by its four items (M= 3.76).This findings indicated the importance of enforcement of waste minimization programs and necessity of strengthening and enforcement of the national policy on solid waste minimization. Consistent with this finding, a study by Isa et al., shows that the respondents' opinions have higher severity index value regarding the importance of enforcement of source reduction and recycling programs [57].

Information approaches

With respect to the information approach, the results showed that this approach was at the fourth importance level in waste minimization compared to other approaches (M=2.91). However with this mean score the respondents affirmed the requirements of information and its accessibility with respect to the waste minimization practice. This finding is also supported by Simpson and Kautto [68, 69].

CONCLUSION

According to the findings, improve internal monitoring and change the attitude of employees have higher effectiveness as solutions in improvement of practicing waste minimization by firms. The results implied on the importance of monitoring and training program in order to enhance the level of awareness and knowledge of employees. Approaches regarding awareness, cooperation and encouraging are found as more important approaches in practicing waste minimization by firms comparing other approaches. It can be perceived that by increasing the awareness level and encouragement the intention and attitude for practicing waste minimization will also increase among personnel. Furthermore, respondents were implied the technology approaches as the second important approach. Thus by applying available and practical technologies the quantity of generated wastes from industries can be reduced and ensured the applied technologies are clean and practice environmentally friendly approaches. These findings implied on the requirements of research and consultancy program as well as development of technology design and modification. Therefore manufacturing firms should be supported by suitable training programs based on their types and sizes.

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Persian Abstract

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چکیده

به حداقل رساندن ضایعات نقش مهمی را در مدیریت ضایعات صنعتی ایفا می کند و مهمترین روش موثر، در کنترل افزایش ضایعات می باشد. فاکتورهای موثری در جهت کاهش این ضایعات در کشورهای در حال توسعه و توسعه یافته وجود دارد. این مطالعه، راه حل ها و روش های کاهش ضایعات را از میان ۲۱۴ صنایع تولید کننده در شاه الم مالزی بررسی و مقایسه کرده است. داده های کمی با استفاده از آمارهای استنتاجی و توصیفی آنالیز شده است. مشاهدات نشان داده است که بهبود سیستم های کنترل کننده ی داخلی در کاهش ضایعات بسیار موثرتراز سایر فاکتورها می باشد(SI =۶۷/۴۰). البته روش درک مخاطب نسبت به سایر روش های آگاهی، تشویق و همکاری نتیجه بهتری دارد(P<۰/۰۵). نتایج این مطالعه، لزوم برنامه های آموزشی و گسترش تکنولوژی در بهبود سیستم های کنترل را نشان می دهد.