

# Solid Waste Management Hierarchy: An Empirical Investigation

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## ABSTRACT

The rapid growth in the world's population, together with high urbanization rate, and rising living standards, have all steered the increase in solid waste generation. Solid waste disposal has become a major environmental problem for many countries. Therefore, efficient management of solid waste has now become a concern for government at all levels. Leaning upon the concept of solid waste management hierarchy, this study examines the level of participation of households in waste minimization in Shah Alam city, Malaysia. A total of 150 copies of semi structured questionnaire were purposefully administered to adults in Malaysia, through an online survey. Their responses were coded into the computer and analysed using SPSS version 20. Frequency and Chi-square tests were conducted on the data to examine the level of participation of respondents in waste minimization. Findings from the study revealed that 58%, 48.6% and 45.3% of respondents reuse their old plastic bags, bottles and newspapers respectively. The chi-square results equally showed that significant differences exist in their level of participation in waste minimization ( $p < 0.05$ ). The rate of participation in recycling as revealed by the study is low, most people dispose their old electronics and waste oil instead of taking them to recycle centres. Thus, they do not engage in waste minimization. The successful implementation of solid waste management hierarchy in the study area, depends on the willingness of households to embrace the idea. The study recommends more enlightenment campaigns to let the public know the benefits of waste minimization with respect to reuse, reduce and recycling of household wastes. This will promote sustainable solid management in the city, as less wastes will be taken to the final disposal sites (landfills).

**Keywords:** Solid Waste, Waste Management Hierarchy, Households, Waste Minimisation.

## 1. INTRODUCTION

In cities large amount of resources are consumed, causing environmental pressure and negative impacts (García-Guaita et al., 2018). Bourgeoning human population, economic growth, rapid rate of urbanization, rising incomes and growing demand for goods and services contribute to the increase in solid waste generation (Minghua et al., 2009). Managing solid waste is one of the major challenges facing municipal governments in the 21<sup>st</sup> century. Solid waste management by municipalities dates back to the mid-1900s, when the cause of infectious diseases were for the first time, linked to uncollected waste and poor sanitation (UN HABITAT, 2010).

Sharp increase in human population, economic advancement and urbanization have intensified waste management and generation issues (Iqbal, 2020). According to estimate from World Bank, the annual rate of global municipal waste generation has reached around 2.01 billion tonnes, and is expected to grow to around 3.4 billion tonnes by 2050 (Kaza et al., 2018). Based on UN HABITAT 2010 report, cities around the world spend greater portion (between 20 to 50%) of their recurrent budget on solid waste management. Improper management of municipal solid waste has detrimental effect to both humans and the eco-system. Burning of wastes and open dumping lead to pollution of the environment with harmful gases and soil pollution through leachates (Iqbal, 2020). The continuous promotion for environmental

management and achieving the goals of sustainable development have prompted policymakers and technical experts to adopt appropriate system for managing municipal solid waste and protecting the environment (Patil, and Dilip. 2012). In this regard, the need for reuse and recycling of material wastes has increased over the years due to rapid population increase and urbanization (Umar et.al., 2016). In pursuant of environmental protection and proper management of waste disposal, waste minimization through reduce, reuse and recycling (3Rs) is being advocated by experts and policy makers. There are growing concerns that many landfills are approaching their carrying capacity, with many planned to be shut down over the next couple of years (Nadhir ,2013). In Malaysia, government has made waste separation at source mandatory since 2015 in eight states. This step was taken in order to reduce the quantity of wastes taken to disposal sites, as some have reached their carrying capacity and there are limited space in cities for construction of new ones (Sabariah et al., 2018). Some targets have been set in time past on waste minimization in Malaysia. For example, the Ministry of housing and local government in 2005, set target of 22% for recycling in the solid waste management hierarchy by 2020. The question now is whether the targets have been met or not after 15 years. Looking at the current state of solid waste management in the country, it is obvious that the target of 22% of recycling has not been met. This paper therefore, examines the level of participation of residents in solid waste minimization with respect to reduce, reuse and recycle/compositing.

**1.1 Solid Waste Management Hierarchy**

Sustainable solid waste management nowadays is hinged upon the principles of ‘waste management hierarchy’ (Yakubu & Zhou 2018).The hierarchy is represented in many different ways; however the general principle is to move waste management ‘up the hierarchy’, towards reduction, reuse and recycling (the ‘3Rs’) nearer the ‘top’, diverting waste away from disposal, which is situated at the ‘bottom’. The waste hierarchy refers to the “3Rs”: reduce, reuse and recycle, which classify waste management strategies according to their desirability in terms of waste minimization. The waste hierarchy (Figure 1) remains the cornerstone of the most waste minimization strategies. The aim of the waste hierarchy is to extract the maximum practical benefits from products and to generate the minimum amount of waste (Plesea and Visan, 2014). Waste reduction entails reuse of old materials, going to supermarkets or neighbourhood shops with basket, and so on. Some benefits are derivable from waste reduction including more efficient use of resources, reduction in cost of disposal/treatment, conservation of natural resources, and resolution of environmental problems (Sasikumar and Krishna, 2009).

In the waste management hierarchy in Figure 1, the first and best preferred is waste reduction. The second approach which is waste reuse involves using old items that have value or utility rather than throwing them away (Agamuthu, 2001). William, (2012) noted that one of the ways to reduce quantity of waste generated is for residents to reuse old items that have value or give them to others instead of throwing them away. Households many a times have embarked on reuse process without realizing that. For example, old polythene bags are reused, and old furniture or clothe given to people that need them. Recycling is the next approach in the waste management hierarchy and this is a daily routine for some households. Many components of solid waste generated by households can be recycled for further use. Items that are recycled include: plastic, paper, aluminum, steel and glass. Disposal is the least preferred option in the waste management hierarchy. Disposal can be through open dump sites or sanitary landfill sites. The latter is better and more environmentally friendly. Open dumping of waste leads to environmental pollution, thus experts advocate the use of landfills for final disposal of waste. According to Sasikumar and Krishna (2009) sanitary landfills are designed separately for waste disposal in such a way that applicable water and gas quality standards are adhered to for environmental protection.

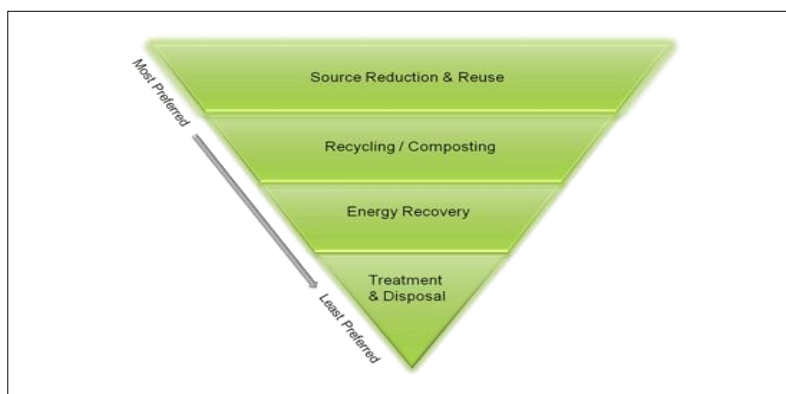


Figure 1. Solid Waste Management Hierarchy. Adopted From EPA 2020

## 2. MATERIALS & METHOD

Due to the Covid 19 pandemic, the study adopted online survey questionnaire administration method. A total of 165 copies of questionnaire were mailed to adults in Shah Alam city, Malaysia. 150 (91%) responded by filling the questionnaire. The data was coded and analysed using SPSS 20 software. Chi-square test was conducted to examine whether or not statistical significant difference exists between the variables of interest in the waste management hierarchy.

## 3. RESULTS & DISCUSSION

The aim of this study is to examine the level of participation of households in Malaysia, on waste minimization using the waste management hierarchy concept. Thus, the eleven questions in Table 1 provides the basis of the analysis. The questions are measured on 3 point Likert scale ranging from 1 Never, 2 Sometimes and 3 Always. The results show that majority (65.3%) of respondents stated that they occasionally buy things in small pack while 27.4% said they do that always. The chi-square results show that respondents significantly differ in their level of participation in waste reduction ( $X= 78.120^a$ ,  $df (2)$ ,  $p<0.05$ ). In terms of reuse of old bottles or containers for storing things at home, results revealed that 48.6% of respondents do that always while 44.7% occasionally and 6.7% never. The chi-square statistics show that there is a significant difference ( $X= 48.360^a$ ,  $p<0.05$ ). What this result suggests in practical terms, is that the level of participation of respondents on waste minimization with respect to reuse of old bottles or containers is high. For the two questions that focused on taking old things (electrics and cloths or furniture) to recycle centre or resale shop a similar pattern was exhibited in the results. About 52% of respondents stated that they never took their old electronics to recycle centre while 42% do that occasionally. Similarly, 34.7% stated that they do not take their old clothes or furniture to resale shop while 54% do that occasionally. What could be inferred from these results is that waste minimization by respondents in terms of sending used items such as cloths or electronics to recycling centre or resale shop is low. Omran *et al.*, (2008) noted waste management minimization techniques needed to be communicated to households and the public in order to increase the rate of recycling.

Most people do not see the need to take their old clothes or electronics to recycling centre or resale shop, since they have the financial capability to replace the old ones. They throw their old clothes or electronics directly into the waste bins. For reuse of old newspapers and plastic bags, results show that 45.3% and 58.0% of respondents respectively always do that while 38% and 33.3% respectively do that occasionally. The chi-square results equally show that a significant difference exists in the level of respondents participation in waste minimization through reuse of old newspapers and plastic bags ( $X = 19.960^a$   $df (2)$ ,  $p<0.05$ ,  $X= 54.760^a$   $df (2)$ ,  $p<0.05$ ). Based on these results, it could be said that respondents while carrying out their daily routine at home engage in waste minimization by using old newspapers to wrap things or reuse of the plastic bags for other purposes. Again, results show that most (56.7%) and (52.0%) of respondents respectively, occasionally refabricate their old container jars into usable flowerpots and visit supermarket or neighbourhood shops with their own leather bags or baskets. However, 32% of respondents stated that they go to supermarket or neighbourhood shops always with their baskets or leather bags. In general based on the breakdown of results in Table 1, about 58%, 48.6%, and 45.3% of respondents reuse old plastic bags, bottles and newspapers respectively.

This result is consistent with the assertion of Arold and Koring (2008), who maintained that reuse may be better than for other aspects of waste minimization strategies as most low and middle income cities, have a thriving reuse sector, built around small businesses who repair household items, and who will buy 'end-of-life' items and repair or remanufacture these, inspect them and resell on the local market. This sector is now being rediscovered, strengthened, and recognized as an important step of the waste hierarchy and as part of an integrated solid waste management system. In general, the level of participation in waste minimization especially reuse of old items, among Malaysians could be adjudged as average.

Table 1: Results of Data Analysis

Waste minimization strategy	Mean	Std. Deviation	Rank
Reuse of old plastic bags	2.49	.653	1st
Reuse of old bottles or containers for storing things at home	2.42	.616	2nd
Reuse of old newspapers, and magazines for wrapping things	2.29	.736	3rd
Likes to buy small packaging	2.20	.556	4th
Go to supermarket or neighbourhood shop with your own basket or leather bags.	2.16	.676	5th
Repair old chairs, furniture through painting and changing of their leather	1.91	.669	6th
Refabricate old container jars or bottles into flower pots	1.89	.651	7th
Food waste as fertilizer in the yard	1.83	.712	8th
Take old clothes or furniture to a resale shop	1.77	.639	9th
Take old electronics to a recycle centre	1.54	.609	10th
Send oil waste to recycling centre	1.42	.648	11th

The level of adoption of each strategy in solid waste hierarchy by households in Malaysia is presented in Figure 1 based on results obtained from data analysis in Table 1. The study has been able to test the hypothetical solid waste hierarchy in Figure 1 through real life data obtained from field survey.

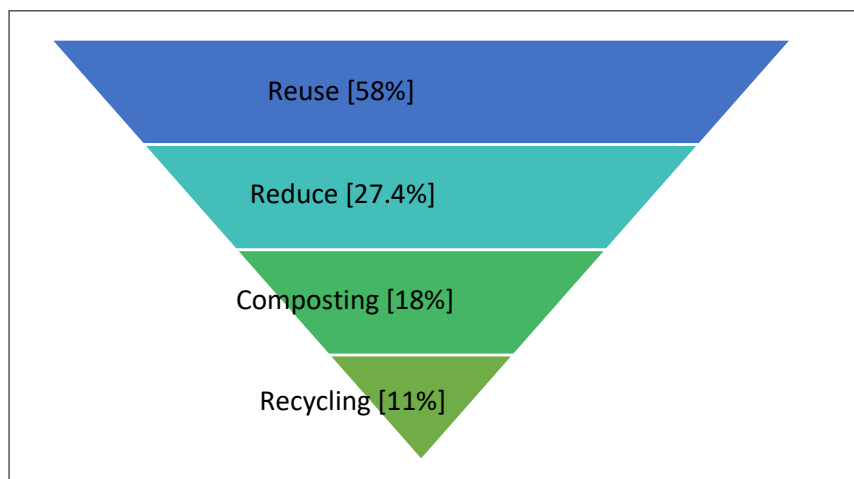


Figure 1. Results on waste management hierarchy

#### 4. CONCLUSION

Waste minimization is an emerging area of inquiry in municipal solid waste management, especially in developing countries where the norm has been to dispose wastes in open dump sites or burning. Environmentalists and other stakeholders in solid waste management, believe that reduction in the quantity of waste going to the dump sites would save cost of managing solid waste and environment. Generating lesser amounts of waste will decrease the pressure on both municipal waste collection services and disposal space. Waste prevention practices, also known as source reduction, typically also save money for the waste generator, whether they are households, businesses or industry (UN HABITAT, 2010).

Solid waste management hierarchy concept forms the basis of achieving waste minimization at household level. Findings from this study show that respondents participated in some of the waste minimization strategies in solid waste management hierarchy, such as reuse, reduce and recycle. Their level of participation in reuse of old newspapers, bottles, cans and plastic bags as shown by results is average. On the contrary, majority of respondents do not send their old electronics or waste oil to recycle centre. Which is an indication that recycling has not gained prominence at household level in Malaysia. One thing that could explain this apathy of not sending old electronics and waste oil to recycle centre among respondents, is low level of awareness on the benefits accruable from sustainable waste management through recycling. Most people feel that once they are financially alright, the token that they may be given at recycle centre for their old electronics or waste oil does not really matter. Government needs to embark on more enlightenment campaigns to let people know the benefit of waste minimization.

Although many people agree that reduction of waste is essential for sustainable environment, there is disconnect between actual participation in waste minimization and their level of awareness.

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