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RESEARCH ARTICLE

STUDY ON WASTE GENERATION AND COMPOSITION IN RAPID RESIDENTIAL DEVELOPMENT OF SUB URBAN AREA IN KUALA SELANGOR DISTRICT, SELANGOR

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ABSTRACT

Municipal solid waste is a growing concern in cities of developing countries and households are the main contributor. Lack of reliable data sources remain one of the major drawbacks for deciding on effective waste management option. However, continued growth in municipal waste if left unattended will only intensify the problem and thus demands proactive action. Therefore, the objective of this study is to analyse waste composition and to evaluate the possible planning for effective management. The study area puncak alam selected because it is one of the rapid development area in Kuala Selangor. Using a stratified sampling method, 200 households selected from residential area. The rate of household waste generation in puncak alam is found to be 1.0 kg/capita/day and estimated each household generate 2.5kg/day. Household waste composition was 60 % organic waste, 24% recyclable waste that comprised of 8% paper and paper products,3% glass, 4% metal, 9% plastic, and 11% other waste. Organic waste has the highest score and if not managed properly, creates serious health and environmental hazards. It could be managed efficiently by composting at household and local government level.

KEYWORDS

Waste composition, local authority, sub urban.

1. INTRODUCTION

Municipal solid waste resulting out of rapid urbanisation has become a thoughtful concern for government departments, as well as for the public in Malaysia. According to Moh and Abd Manaf (2014), the highest waste composition generated in Malaysia is a municipal solid waste (MSW) which consist of 64%, followed by industrial waste (25%), commercial waste (8%) and construction waste (3%). Most of municipal solid waste consists of more than 50% of food waste from the total waste produce daily and disposed about 70% to the landfill sites. Meanwhile, Malaysian municipal solid waste stream contains approximately 40–60% of retrievable materials, including food waste, paper, plastics, glass, ferrous metal, and aluminium [1]. Plastics are undoubtedly the most common recyclable materials being disposed of to the landfills and bring impacts to the environment because it takes time to degrade. It is belief that,the amount of waste generated have similar progress with income levels and development, as income rises and level of development increases, more solid waste per capita produced daily [2].

Currently, there are a few types of technologies applied in the Malaysia for management of solid waste and land filling is the main method used for disposal in Malaysia compared among others (Table 1). Most landfills in this country are in poor condition and run without suitable technique. According to Ismail & Manad (2013), majority of landfills were absence of protective measures, such as leachate treatment, lining systems, and gas collection. Only 8 landfill sites still the standard requirement for sanitary landill Meanwhile, the other landfill sites are contaminating the environment in varying condition such as ground water pollution, air pollution, and sanitary issues [3]. Landfill should manage adequately to avoid the environmental problem in the future. Landfills created various environmental problems such as leachate, water and groundwater contamination, the potential toxic gases and odor emission. A big part of these problems comes from organic waste. Due to hot and heavy rainfall, it is suitable for microbes to degrade all the organic and solid waste and release a lot of leachate and odor. These will lead to nuisance to the public and environment if not accurately control. The odor that produced from degradation might contain a huge amount of volatile organic compounds which nuisance to the environment [4].

Table 1: Method of waste disposal in Malaysia [1]

Treatment	Percentages of waste disposed		
	2002	2004	Target 2020
Recycling	5.0	5.5	22.0
Composting	0.0	1.0	8.0
Incineration	0.0	0.0	16.8
Inert landfill	0.0	3.2	9.1
Sanitary landfill	5.0	30.9	44.1
Others disposal sites	90.00	59.4	0.0
Total	100.0	100	100.0

Disposal of MSW through landfilling is becoming more challenging because current landfill sites are filling up at a very fast rate. At the same time, constructing new landfill sites is becoming more difficult because of lack of land available, increase in land prices and high demands, especially in urban areas due to the increase in population. The government struggled to introduce a new alternative for disposal waste because of limited funding and the available landfill space declines. Because of that, local authority working towards zero waste and trying to reduce the volume of waste entering landfills. The first step in having good waste management is through understand the demand and trend of waste generation in certain area. Waste management approaches should be focus, locally sensitive, critical, creative, and owned by the community of concern; as their particular circumstances may be significantly different [5]. Thus, this study is anticipated to evaluate waste composition in

Puncak Alam and recommendation based on its exclusive characteristics that are expected to contribute in decision-making by the stakeholders, especially at the local municipality level.

2. MATERIALS AND METHODS

2.1 Study area

This study was conducted in Puncak Alam, a township in the Ijok commune of Kuala Selangor constituency in north-western Selangor, Malaysia. It located about 30 kilometres northwest of Kuala Lumpur and 20 km from Shah Alam, the state capital of Selangor. It occupies an area of 60 square kilometres. It has a capacity of accommodating the 350,000 population.

Figure 1: Sampling location

2.2 Sampling Procedure

The study on solid waste generation and composition at four different residential areas consisted of three main stages which are weighing the waste, recording the data and analyzing the data. The data were obtained by direct weighing of the solid waste collected from four resident where it was generated throughout the day. The weighing process was conducted for four weeks, continuously except for weekend (Saturdays and Sundays). Before sample collection, each householder was provided with plastic bags during the period of the sampling. Forty garbage bags for every householder. The solid waste was separated into two main categories (wet waste and dry waste). The wet waste composition contains food waste, and dry waste composition comprises mostly plastic, paper, metal, glass and other materials. In order to have detail data for food waste, it was divided into nine categories (rice, noodles, bread, vegetable, fruit, etc). Then the solid waste is segregated by its type and the weighing using a 50 kg scale. Fig. 2 shows the research methodology framework for this study. The waste generation usually represented by the waste generation rate – the quantity of waste generated per person per day (kg/day/capita). In this study, the waste amount is measured using the average daily waste generated by the family (which is obtained by dividing the total sample of wastes from the individual unit), by the number of days the amount collected by the respondents:

Average daily weight per household (kg) = Total Weight of Wastes /Number of days the wastes collected

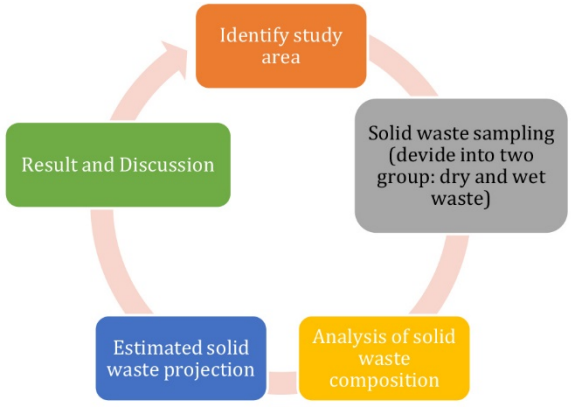

Figure 2: Research methodology flow

3. RESULTS AND DISCUSSION

3.1 Solid waste generation and composition

Throughout the four weeks of waste collection, the wastes were segregated into six main categories; food waste, plastic, paper, glass, metal and others (table 2). Figure 1 provides the household waste composition of Puncak Alam from this study. It found that the main waste generate are organic waste which more than half (65%), this is in line with previous studies conducted within peninsular Malaysia (Samah, 2013). The second higher was other waste which comprised 11%, followed by paper and paper products (9%), glass (8%), metal (4%), and plastic (3%). Other waste mostly consist of baby diapers, old clothes and hazardous waste like batteries and light bulbs.

Hazardous waste such as batteries and light bulbs are prone to catch fire, react or explode under certain circumstances and contains toxic chemical which can pollute environment and pose threat to human health if not disposed properly (United States Environmental Protection Agency (EPA), 2017). At present, all these wastes disposed in municipality designated open dumpsite where some scavengers pick up recyclable waste to sell it for their income. However, there is no data to confirm the recycling rate in this area.

Table 2: Provides list of waste component within each category

CATEGORY	DESCRIPTION
Food waste	kitchen waste (rice, vegetable and fruit peelings and remains, eggshells, food leftovers/stale and tainted food, tea/coffee bag, etc)
Metal	aluminium cans, broken construction steel rods, old utensils
Paper and paper products	books, newspapers, cardboards
Plastic	Polyethylene Terephthalate bottles such as beverage bottles; Low-Density Polyethylene such as trash bags and High-density polyethylene plastics such as bags and sacks, sheets, toiletries containers, condiment containers, water bottles, toys; and food packages
Glass	jars, medicine bottles, broken cup/jug, sauce bottles
Others	Diapers, old clothes, ceramics, medicines, light bulbs, batteries, electronics

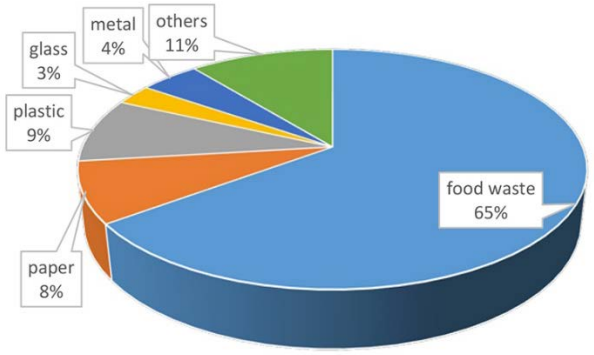

Figure 3: Percentage of waste composition from the study area

3.1.1 Household waste generation

Household waste generation makes up a significant portion of solid waste produced by society. Studies on household wastes are varied, ranging from studies on environmental, behavioral, and socio-economic factors that are linked to household waste generation; to economic incentives and policy related to household waste management [6-8]. In this research, the study on household solid waste (HSW) composition in four selected housing areas in Puncak Alam (Lautan Samudera, Az zahrah, Alam Suria 5A1 and Gugusan Alam) was carried out for a duration of one month and data were collected on a daily basis except for Saturday and Sunday. The purpose of this study is to illustrate the trend of solid waste generation in Puncak Alam; especially in regard to food waste. Figure 4 shows waste generation from day 1 until day 20 for study area. The highest waste generation was at day 20 and least at day 7 which 279.5kg and 252.3 kg respectively.

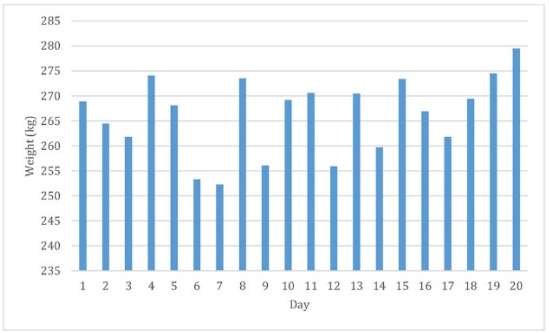

Figure 4: Total waste generation daily

The data from figure 5 showed that Jalan Lautan Samudera has the highest amount of waste composition generated, which is 1394.0 kg/month. However, in Jalan Alam Suria , the total waste generated for a month is only 1262 kg/month and is the lowest among all the housing areas selected in this study. Most of the day of sampling, waste generated not exceed 300kg/day from study area. The average per capita per day for each area was 69.7 (Jalan Lautan Samudera), followed by 68.2 (Jalan Az Zaharah), 65.2 (Jalan Gugusan Alam) and 63.1 (Jalan Alam Suria).

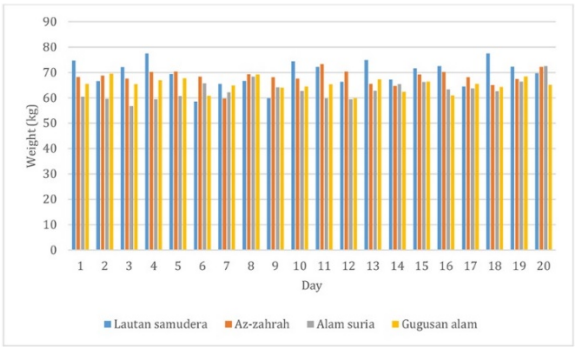

Figure 5: Waste generation at different area of sampling

Figure 2 shows the percentage of solid waste composition generated by a household in Puncak Alam for 1 month. As predicted, organic waste was the highest composition among all solid waste generated in four housing areas. The overall percentages of food waste was between 850-880kg/month and the highest percentage is from Lautan Samudera and the lowest percentage of organic waste belongs to Az-zaharah. The second highest of waste generated is others waste which consist of diapers, old clothes, ceramics, medicines, light bulbs, batteries and electronics (wires). Gugusan Alam has the highest percentage of paper (22%) while the lowest percentage was Alam Suria (19%). For this reason, the assumption for this condition to happen is because the households in Gugusan Alam produced a lot of paper due to their daily routine. As for plastic, the highest percentage is found in Alam Suria followed by Lautan Samudera, Azzaharah and Gugusan Alam which 27.7, 26.1, 23.8 and 22.4 percent respectively. Plastic and paper composition in household waste was the third and fourth highest, which might be due to changes of the household lifestyle, which prefers to buy a variety of ready-made foodstuff in packages and reading materials. Alam Suria was shown to have a highest amount of glass waste due to its highest percentage (32%). A different story goes to Gugusan ALam, which has the lowest glass waste percentage with only 19.7%. For metal, the highest percentage belongs to Lautan Samudera (26.3%) followed by Az zaharah, Alam Suria and gugusan alam (26.8, 24.1 and 23.9% respectively).

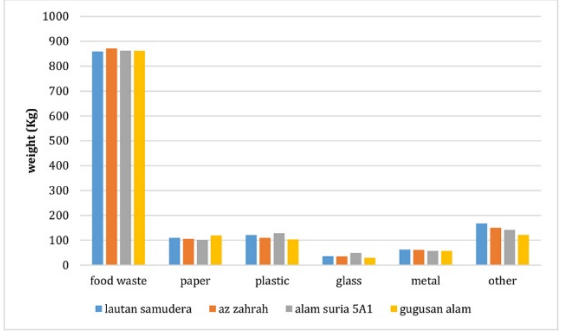

Figure 6: Waste characterization at different area

3.1.2 Food waste

The major constituent of food waste is those associated with cooking activities. Kitchen waste consisted of vegetable peels, spoiled fruits, food remains after consumption, spoiled food, and other eatable items, meat waste, fish waste etc. Vegetable peels, cooked food remains, and spoilt food are the most regularly generated food waste. Most households prepare food two or three times a day; once in the morning, noon and once in the evening. The study on the food waste composition in fourth selected housing areas in Bandar Puncak Alam was carried out for one-month duration and data were collected daily. The data from Figure 5. showed the dominant food products were vegetables (30%) and fresh fruit (17%), followed by rice (13%) and Eggshell contributed to the smallest amount of waste generated, with a value of 89.02 kg and 89.4 kg, respectively. As there are no study on food waste composition in Malaysia, these results are comparable to those found by WRAP (2009), for which fresh vegetables and salads, drink, fresh fruit, bakery, and meals (home-made and pre-prepared) were dominant in the UK.

Observations of the waste collection and segregation process showed that the dietary habits of the residents consist of a high variety of produce, with vegetables such as broccoli, spinach, tomato, mustard, cabbage, as well as fruits such as apple, banana, melon, orange, mango and pear. Consumption of carbohydrates are also varied, as wastes also consist of rice, noodles, bread, potatoes and various types of legumes. Apart from that, protein wastes for example eggs, seafood and remains of meat fat were also amongst the various types of food wastes observed, as are small amounts of eggshells and used tea leaves/bags. These observations, as well as the amount of food wasted, indicates that the residents are not only able to gain access to a variety of nutritional food, but also access to a large quantity of it, thus highlighting a problem of oversupply and wasted resources. Food waste, unfortunately, is a critical indicator of sustainability, as it represents the amount of resources throughout the food production process that are wasted in order to produce uneaten food [9]. Besides that, Food waste also contribute to greenhouse gaseous emission from the decomposition process [10].

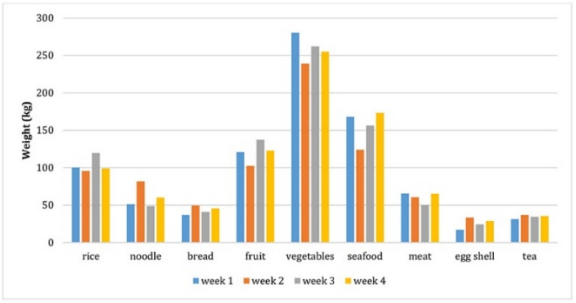

Figure 7: Food waste composition and characterization

3.1.3 Recyclable materials

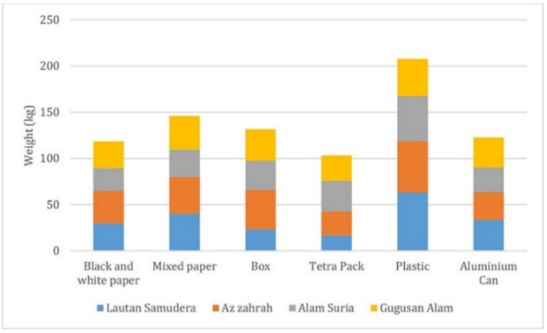

Figure 8: Recyclable, non-recyclable and potential recyclable materials from all areas

Table 3: Total revenue of recyclable materials generated

Recyclable materials	Price (RM/Kg)	Value (RM/Kg)
Black and white paper	0.33	39.24
Mixed paper	0.18	26.28
Box	0.27	35.56
Tetra Pack	0.50	51.6

Plastic	0.40	83.04
Aluminium Can/stainless steel	2.50	306.75
Total		542.47

3.2 Total per capita solid waste generation

The total per capita solid waste generation was estimated to be 0.9 kg/person/day and the annual per capita reached about 292 kg. As there is no previous research in the municipality, the observed result was compared with the finding of other researchers in different cities and states. Study conducted by a researcher found the mean daily per capita solid waste generation rate for the Kuala Lumpur was 0.8-0.9 kg which is similar to this finding [11]. According to a survey conducted on households in low cost apartment in Petaling Jaya the mean daily per capita solid waste generation was 0.34kg which was less than the current assessment [12]. On the other hand, a previous researcher reported that the average amount of municipal solid waste generated in Malaysia was 0.5–0.8 kg/person/day with 1.7 kg/person/day in major cities. Meanwhile, a group of researchers found that the per-capita waste generation is 1.13 kg/person/day in Pasir Gudang Johor [13]. The variation in results may be attributed to change in socio-economic, lifestyle, building types, and geographical. Moreover, the study conducted in rainy season that may probably increase the weights of the daily solid waste generated. This finding was also supported by a study done by a recent scholar where the composition of waste can be influenced by seasonal factors [14].

3.3 Solid Waste Projection from residential area

Calculating the total generation rate of solid waste streams enables us to estimate the total waste that can generated daily, monthly or yearly, which in turn provides a basis for a sound solid waste management plan for a given town/city for a certain period interval. A projection for the total solid waste generation was made by taking into consideration of the expected growth in population and estimated per capita household waste generation for the town. There are three major factors to be consider in making projection of future waste generation which is current population, population growth and per capita waste generation in the area. Assume that population is increasing in arithmetical progression and assumption is made that this pattern will persist into future. In essence, other factors contributing to the generation of urban waste are presumed to remain stable; only the population dynamics are considered critical.

This is reflected in the population growth formula of the form: $Pn = P_0 (1 + r)^n$

where Pn is the population in the intervening (projection) period, Po the base population generating current waste quantities, r the average annual city population growth rate (percent) and n the projection period (in years). Once the future population is computed, multiplication by solid waste per capita affords the projected waste quantity for the envisaged future period. The population of people in Kuala Selangor district will comes to 302,219 from 2015 to 2025 (MDKS, 2019). In average, 20,147 per year. If one uses the per capita of 0.8 kg/per/day obtained in this study, then the waste quantity in Kuala Selangor is probably around 16,117.6 tonnes per annum. The waste generations will continuously rise up every year due to the uncontrollable consumption owing to the increasing population, attitudes toward shopping and eating, and the high living standard.

3.4 Strategic for waste management in Bandar Puncak Alam

3.4.1 Recycling

Majlis Daerah Kuala Selangor (MDKS) should encourage all residents involve in recycling activity through environmental awareness programs and training. According to a study, education on solid waste management especially waste separation at source through numerous broadcasting have helped increase residents' awareness (75%) and their behavior (50%) [15]. But this action should also be maintained with necessary facility as it will influence the decision made by the residents. The poor number of classified containers in residential areas have commanded to poor source-separated collection rate (18%).

From the observation in this study area, the MDKS has provided recycle bins in most residential area and selected business centre. Unfortunately, most of the bins not utilized appropriately where people will mix nonrecyclable materials into recycle bin. Besides that's, there are few recycle bins were poor due to vandalism. There is no official data as how much waste is being diverted by recycling. Most of the recycling activities a were volunteer and an informal basis. Waste separation at source were also not introduce to the resident for the time being where wet and dry waste were disposed together. It is also worth mentioning that if waste from other sources were included such as commercial, industrial or institutional, the actual total waste that generate in each of the categories would be much higher and most probably ends up being uncollected or disposed at the open dumpsite.

3.4.2 Composting

Organic materials continue to be the major portion of solid waste generated in Puncak ALam with 65% from the total waste generated in study area. The high organic waste indicates the necessity for frequent collection and disposal, as well as recycling through composting. Composting is an alternative to reduce the organic waste generation, thus reducing the quantity and the amount of solid waste to be disposed of [16,17]. In addition, this program can offer alternatives to publics to manage organic waste in the form of separation at sources [18]. Improper disposal food waste cause odour (volatile organic compounds) released to the air which significantly environmental concern to the public due to the nuisance and greenhouse gaseous. Therefore, making composting easier is a step can take to keep resident waste out of landfills. Local authority could provide basic information and demonstration on composting technique in order to attract people to join the programme.

3.4.3 Anaerobic Digestion

Organic waste (food waste) might become sources of greenhouse gaseous released to the environment. Hence, diverting food waste from landfills will reduce greenhouse gas emissions. But it also helps to conserve limited landfill space. Anaerobic digestion was recognized as an economic and environmental friendly solution to food waste. In the anaerobic digestion process, organic matter is broken down to form biogas, which consists of methane (50–70% volume), carbon dioxide (25–50% volume) and other small quantities of hydrogen, hydrogen sulphide, ammonia and other trace gases. According to a researcher, anaerobic method has a lot of qualitative benefits such as reducing the amount of municipal solid waste, transportation cost of carrying waste to land fill, emissions and leachate of landfill, increasing life span of landfill and reducing land use [19]. The production of biogas such as biomethane has a great potential to be used as biofuel [20,21].

4. CONCLUSION

There are six principal steps in waste management which is generation, collection, sorting and separation, transfer and transport, and disposal. The study was intended to understand the waste composition and management in these area. The study was done in sub urban residential in the Puncak Alam area of the Kuala Selangor district. Each household generated about 2.5kg of waste per day. Out of that, the biggest constituent was food waste followed by other wastes, plastic and paper. In Food waste, the biggest contributor is vegetables remains during food preparation, followed remain seafood, fruit, rice etc. From the result, there are three suggestion to the local authority for waste management planning, which is strengthen the recycling programme, intensively promote composting and Anaerobic digestion for the organic waste produced. In this area, the efficient planning and management of solid waste is the responsibility of local district (Department of environmental health) including urban cleansing and services. Inefficient management of solid waste has a negative impact when pollution from solid waste occurs. Without systematic management people will be confronted with problems related to the environment, human health, and social issues.

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