

Municipal Solid Waste Management in Malaysia - Possibility of improvement?

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ABSTRACT Municipal Solid Waste (MSW) in Malaysia involves the disposal of approximately 98% of the total waste to landfills. Current disposal method of landfilling needs improvements to prolong the landfill life and to minimize the problem of land scarcity. Rapid developments and industrialization in Malaysia necessitate a better and more efficient waste management strategy. The mushrooming of urban areas and rural-urban migration has increased the per capita income due to changes in the consumption patterns that led to increased waste generation. The study involved the compilation of data from relevant municipalities on waste generation in Malaysia. The study also includes waste composition analysis according to income level, to determine the trends of composition produced. The local authorities and waste management consortia have to handle approximately 17,000 tonnes of MSW everyday throughout the country. MSW generation depends on the size of township and level of economical standard, that as low as 45 tonnes of MSW are generated in Kluang (a small town in the southern part of Peninsular Malaysia) to as high as 3000 tonnes in Kuala Lumpur (Malaysia's capital). The largest sources are household waste followed by industrial and commercial waste. In Selangor state, the highest percentage of MSW consisted of putrescible waste of approximately 46%, followed by plastic and paper at 15% and 14%, respectively. The study indicated that composting can be incorporated in all the landfills in the country together with an integrated system of recycling. The integrated system would allow optimization of waste reduction and reuse programs, which is actually a realistic possibility to improve the MSW management in the country.

ABSTRAK Sisa pepejal munisipal di Malaysia melibatkan pelupusan hampir 98% daripada jumlah sampah ke tapak pelupusan. Kaedah pelupusan yang diamalkan sekarang memerlukan perubahan positif untuk memanjangkan tempoh hayat tapak-tapak pelupusan dan meminimalkan masalah kekurangan tanah. Pembangunan dan perindustrian yang pesat di Malaysia amat memerlukan strategi pengurusan sisa yang lebih baik dan efisien. Pertumbuhan kawasan Bandar dan migrasi dari luar-bandar ke bandar telah meningkatkan pendapatan per kapita akibat daripada perubahan dalam corak perbelanjaan pengguna yang telah meningkatkan penghasilan sisa. Kajian melibatkan pengumpulan data-data daripada pihak perbandaran yang terbabit di negeri-negeri di Malaysia. Kajian juga melibatkan analisis komposisi sisa berdasarkan tahap pendapatan untuk menentukan corak komposisi sisa yang dijana. Pihak kerajaan tempatan dan konsortium pengurusan sisa terpaksa mengendalikan kira-kira 17,000 tan sampah setiap hari di seluruh negara. Penghasilan sisa pepejal munisipal bergantung kepada keluasan kawasan perbandaran dan tahap ekonomi, di mana sekurang-kurangnya 45 tan sisa dikeluarkan di Kluang, sebuah pekan kecil di Johor sehingga 3000 tan di Kuala Lumpur sebagai ibunegara Malaysia. Sumber terbesar adalah sisa rumah diikuti dengan sisa industri dan komersil. Di Selangor, peratusan terbesar sisa pepejal munisipal terdiri daripada 46% sisa dapur, diikuti dengan plastik dan kertas, masing-masing sebanyak 15% dan 14%. Pengkomposan boleh digabungkan di semua tapak pelupusan di Malaysia bersama-sama dengan sistem integrasi kitar-semula. Sistem integrasi akan mengoptimalkan program pengurangan dan penggunaan-semula sisa, yang sebenarnya adalah satu kemungkinan yang realistik untuk memperbaiki pengurusan sisa pepejal munisipal di negara ini.

(waste management, landfills, waste composition, MSW)

INTRODUCTION

Human activities have always been associated with some form of waste generation. The rate of pollution load, including solid waste disposal has exceeded the carrying capacity of the earth by 30% resulting in severe environmental degradation. MSW is mainly household waste and other organic and inorganic wastes from commercial activities, industries and institutions. MSW generation has increased at a rapid rate (2-3%) in almost every country. Most developed countries have managed to tackle this problem through proper waste management involving various techniques. High environmental consciousness among the population in developed nations with stringent regulation and enforcement, and committed participation have enabled the improvement of waste management. However, this scenario hardly exists in developing nations like Malaysia, where the daily production of 17,000 tonnes of MSW [1] is of concern. Most of the countries in Asia have an increasing rate of MSW generation at 3 – 7% annually [2]. Malaysia has an increment rate of 2-3% per year [2]. Some reasons associated are growing population, changes in consumption patterns and the expansion of trade and industry in urban centres. Developing countries striving to become industrial nations are generating MSW at an alarming rate. Facilities for waste treatment are also not appropriately available to match the requirement for proper waste management [2, 3].

Lack of public participation and indifferent attitude, as well as, lack of environmental awareness among the developing nations had caused many waste management strategies to fail. Malaysia also faced similar problems [3, 4] and solid waste is considered as one of the three major environmental problems faced by most municipalities besides water and air pollutions [5]. Development of solid waste management programmes in Malaysia began in the 1970s with just street cleaning and hauling of household wastes to municipal disposal sites. In the early 1980s, the government initiated national programs to manage municipal and industrial wastes, which led to the establishment of a comprehensive hazardous waste management centre in the region, as well as, enforcing Refuse Collection & Disposal By-Laws (1983) concerning waste disposal regulations [6]. By mid 1990s, proper management of municipal and industrial solid wastes had become such a high

priority due to higher environmental awareness among the government and the NGOs that more financial resources were allocated to the sector, particularly in creating recycling awareness. MSW management operations absorb large portions of municipalities' operating budgets, totaling to more than 60% for collection and transfer of wastes for disposal [7]. In some municipalities more than 70% of the total income is required for MSW management cost. There is much debate at present on sustainable development through an integrated method of waste management, which incorporates waste minimization and optimizing recycling and reuse of wastes. Throughout the region, cities have been implementing source separation and recycling program formally and informally. Malaysian government had been implementing various strategies in solid waste management system to encourage public to participate in 3R (reduce, reuse and recycle) programs but the results have been disappointing. The government had targeted to increase the rate of recycling over the year to 22% by the year 2020, to achieve higher recycling percentage and lesser waste to be sent to landfills for disposal.

Each Malaysian was reported to generate approximately 0.8- 1.2 kg of MSW everyday [2]. Approximately 76% of the total MSW generated in the country is collected, where 2.0% is recycled while the remaining MSW are sent to the 144 disposal sites throughout the country [1]. Even with the difficulty in searching for suitable sites for landfills, it still remains as the main waste disposal option due to the lower cost of operation at only RM35/tonne, as compared to RM500/tonne for incineration and RM216/tonne for composting [2]. The annual increase of MSW was 2-3% [2], that a fast and long term solution must be implemented immediately to prevent more detrimental effects to the environment. The study was conducted mainly to compile data on MSW management in major cities in Malaysia and to determine the trend in waste generation among residents of different income levels.

METHODOLOGY

Data were compiled from relevant municipalities on waste generation and others using questionnaires as proposed by Jankowicz [7]. Waste composition studies were conducted at nine landfills (4 rural, 3 sub-urban and 2 urban landfills) where wastes from randomly selected

lorries received by the landfill were separated and sorted into different categories (putrescible, paper, plastics, metal, glass, wood, rubber, textile and others). Each category of the wastes were weighted and the volume was determined. The study was focused in Selangor state to compare the waste composition and waste generation rates from areas with different levels of income. Data on the fresh weight of the waste generated were computed for analysis.

RESULTS AND DISCUSSION

Per Capita Generation

Results of the questionnaires distributed among the municipalities of relevant cities in Malaysia showed considerable differences in the per capita generation rate among local authorities which ranged from 0.25 kg/capita/day in Kluang to 2.0 kg/capita/day in Kuala Lumpur. The average waste generation rate for the local authorities in Sabah and Sarawak was 0.70 kg/capita/day and 0.97 kg/capita/day, respectively, while the rate was 0.71 kg/capita/day in the eastern states of Kelantan, Terengganu and Pahang. The southern states of Johor and Melaka, produced 1.12 kg/capita/day. In the central states of Selangor and Negeri Sembilan, the generation was at 1.07 kg/capita/day, while it was 2.0 kg/capita/day in Kuala Lumpur. Trend observed was that states with higher urbanization level tend to generate higher quantities of MSW. This possibly resulted from changes in consumption patterns related to changes in income level and the expansion of trade and industry in the respective states.

The main waste source was from the household which ranged from 31% (wt) in Johor Bharu to as high as 80% (wt) in Kuala Terengganu. The next largest waste types were industrial and construction wastes, followed by commercial waste. The composition of solid waste from industries differed substantially between different areas and municipalities. In some area, such as Kuantan, the percentage of industrial wastes was higher than the household wastes.

Waste characteristics and compositions were observed to vary with the degree of affluence and urbanization of the area served by specific

landfills. The waste received by the landfills in Malaysia was highly mixed, which made extraction of recyclables impracticable.

Figure 1 indicates the average Malaysian waste composition derived from the study. Approximately 40% of the total waste received daily was recyclable with paper at 14%, plastics at 15%, metal at 3.0%, and glass at 3%, while approximately 47% consisted of putrescible, which could be composted.

The figures indicated a high potential for recycling and composting. More packaging materials, in the form of plastics and paper were generated with greater consumerism. Figure 2a indicates the waste composition in percentages which were received by Panchang Bedena landfill, Kampung Hang Tuah landfill and Hulu Yam Bharu landfill in Selangor. These landfills are the rural landfills which receive approximately 50-70 tonnes of MSW everyday. Composition of the organic waste was the highest in all these three landfill ranged from 36% to 58%, followed by plastic (16% to 18%) and paper (11%-17%).

Figure 2b indicates the waste composition in percentages which were received by Ampar Tenang landfill, Bukit Beruntung landfill and Kerling landfill. The highest portion in Ampar Tenang landfill and Bukit Beruntung landfill was the organic waste ranging from 45% to 49%, followed by paper waste which ranged from 19% to 23%. In Kerling landfill the highest portion consisted of wood waste which accounted up to 37% of the total waste received, followed by 30% of organic waste and 12% of plastic.

Figure 2c shows the percentages of waste composition received by Sungai Kembong landfill, Kundang landfill and Sungai Sedu landfill. Kundang and Sungai Kembong landfills are the urban landfill while Sungai Sedu landfill is a sub-urban landfill. The organic waste contributed the highest percentages in all the three landfills, which ranged from 41% to 58%. This is followed by plastic and paper which accounted 14% to 24% and 10% to 16%, respectively.

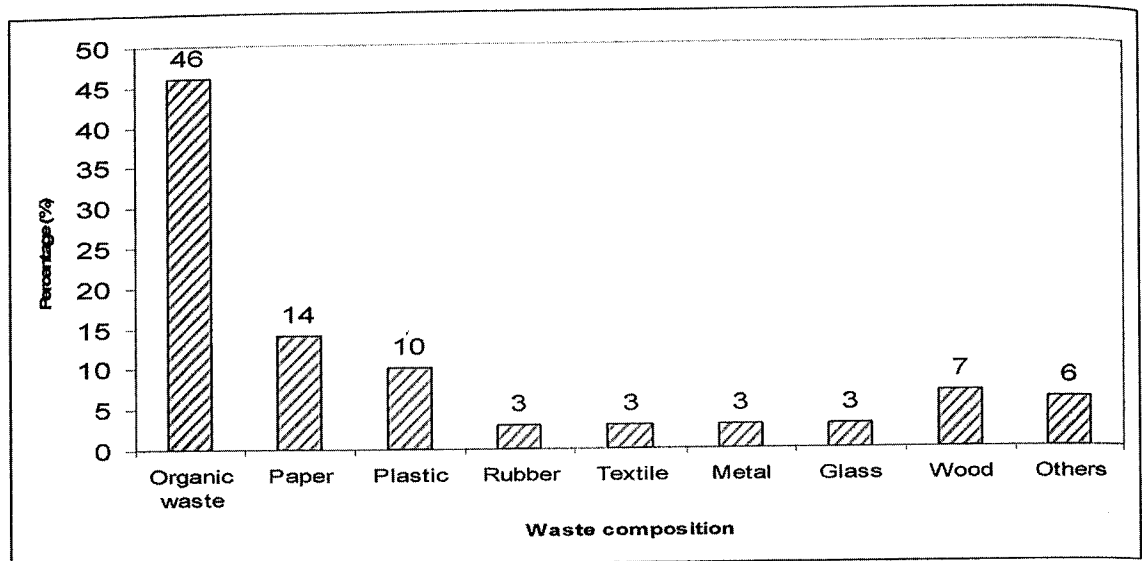


Figure 1. The composition of MSW in Malaysia

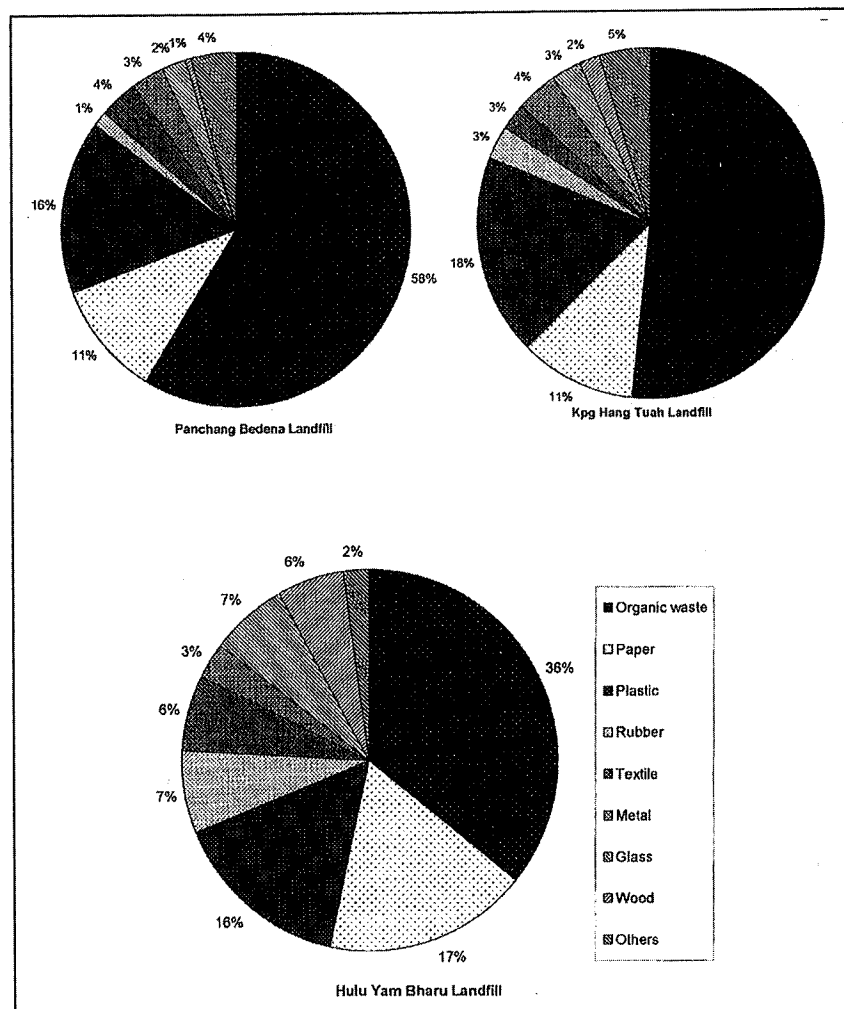


Figure 2a. Composition of MSW in rural landfills in Selangor State

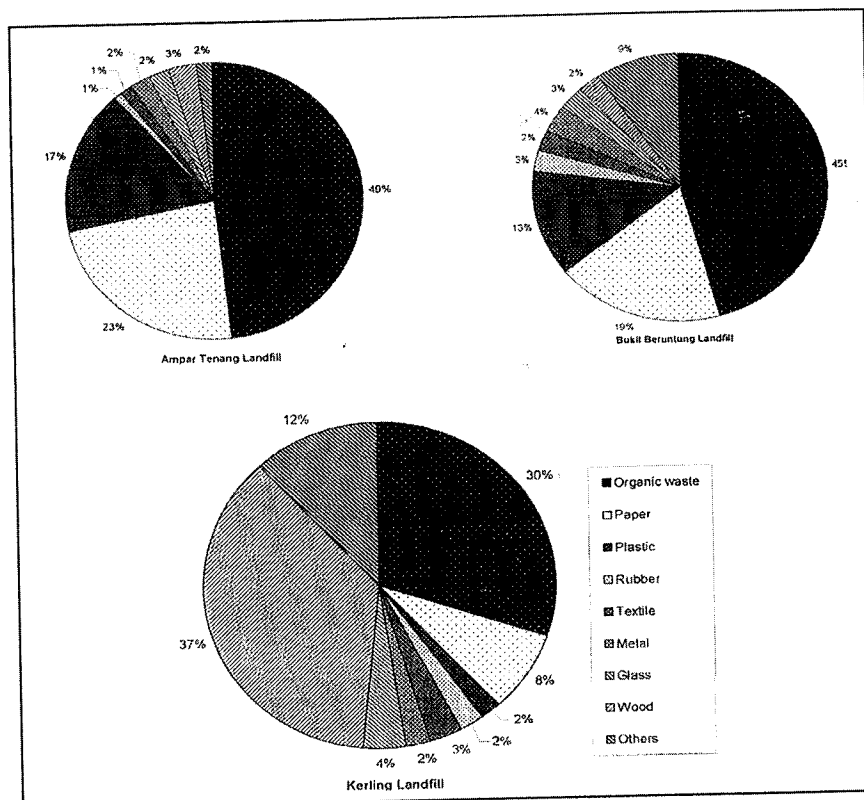


Figure 2b. Composition of MSW in sub-urban landfills in Selangor State

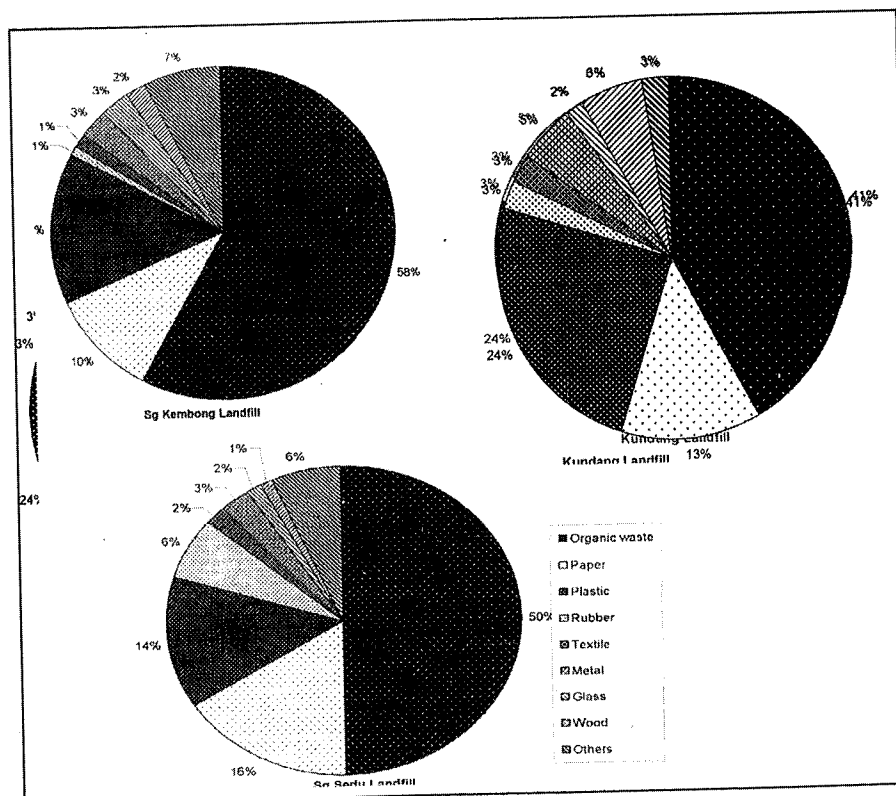


Figure 2c. Composition of MSW in landfills in Selangor State

The urban landfills i.e. Kundang landfill and Sungai Kembong received approximately 300 tonnes and 500 tonnes daily, respectively, while Sungai Sedu received as much as 200 tonnes of MSW daily. The highest portion in most landfills is putrescible waste with an average of 46.7 % followed by plastics and paper at 14% and 15%, respectively.

Results indicated that residents with high income tend to generate more waste compared to the middle and low income groups (Table 1). This was probably due to the higher consumption ability of this group as compared to the others. Table 1 indicates the daily waste generation per capita according to the income groups.

An interesting observation from this study was that the middle income group was found to generate the lowest amount of waste. High income group was found to generate 112% more waste than that generated by the low income group and nearly 140% more than the middle income group. The detailed waste composition of all three income groups consisted of high percentage of organic wastes ranging from 37 % to as high as 49 % of the total waste stream and Figure 3 details out the percentage of each component in organic waste stream generated by different income groups.

Food waste was one of the major portions in organic component [3, 9]. Low income group generated approximately 49% of food waste from the total waste stream, which was found to be 32% higher than that generated by the high

income group. The middle income group generated approximately 6% lower amount of food waste than that disposed by the low income group. The possibility would be that the low income group tends to process more fresh food that the wastes from preparing meals were higher, while middle income group tends to consume more processed food causing the disposed waste to be reduced significantly. The low income group generated the lowest amount of un-consumed food (0.32%) than that disposed by middle income group and high income group at approximately 1.6% and 1.9%, respectively. Un-consumed food is the food waste disposed without being consumed including expired food and spoil fruits or vegetables. Besides food waste, paper and plastic wastes were also generated in considerable amounts. Other waste included the textile waste, metal and other inorganic wastes.

Recovery

The generation of paper wastes were found to be generally high in the waste stream in Malaysia, which accounted up to 13%, including mixed paper, white paper, newsprint, corrugated paper, phonebook and magazines as indicated in Figure 4.

The studies also indicated that different income groups generated significantly different percentage of paper waste as indicated in Figure 5.

Table 1. Daily waste generation per capita according to different income groups (fresh weight basis).

Per Capita Generation (Family Income Per Month)	Minimum Generation (Kg)	Maximum Generation (Kg)	Average Generation (Kg)
High income (>RM 3000)	1.30	2.10	1.7
Middle income (RM 1500- RM 2999)	0.39	1.03	0.71
Low income (<RM1500)	0.29	1.29	0.80

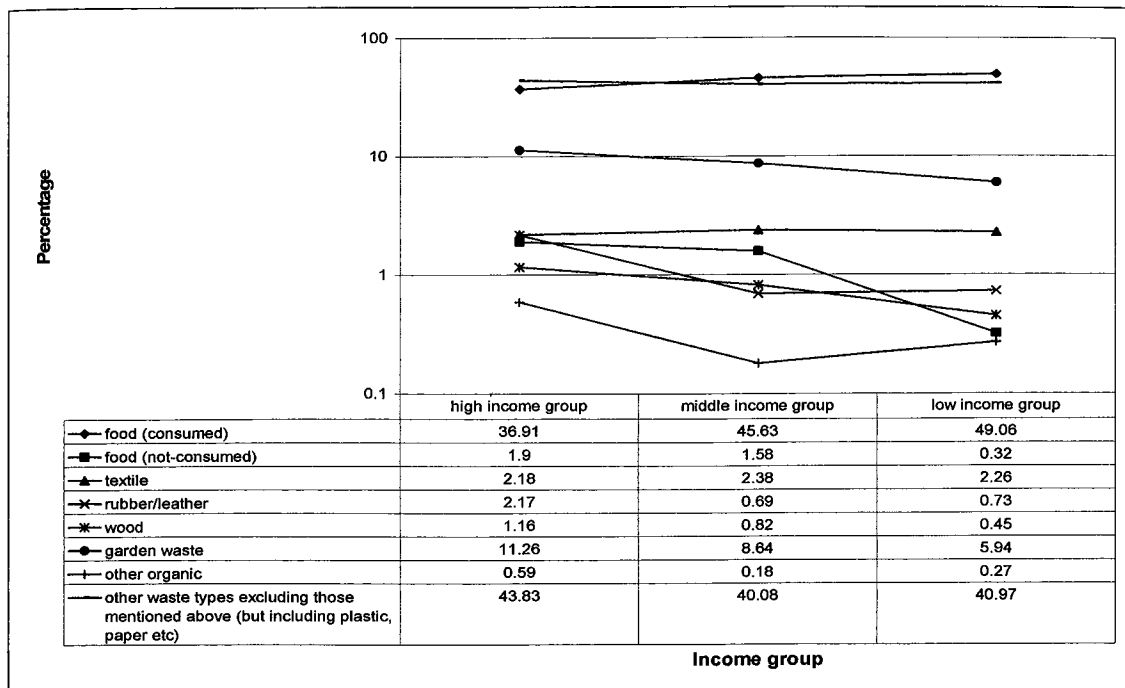


Figure 3. Trends (%) in organic waste generation by different income groups

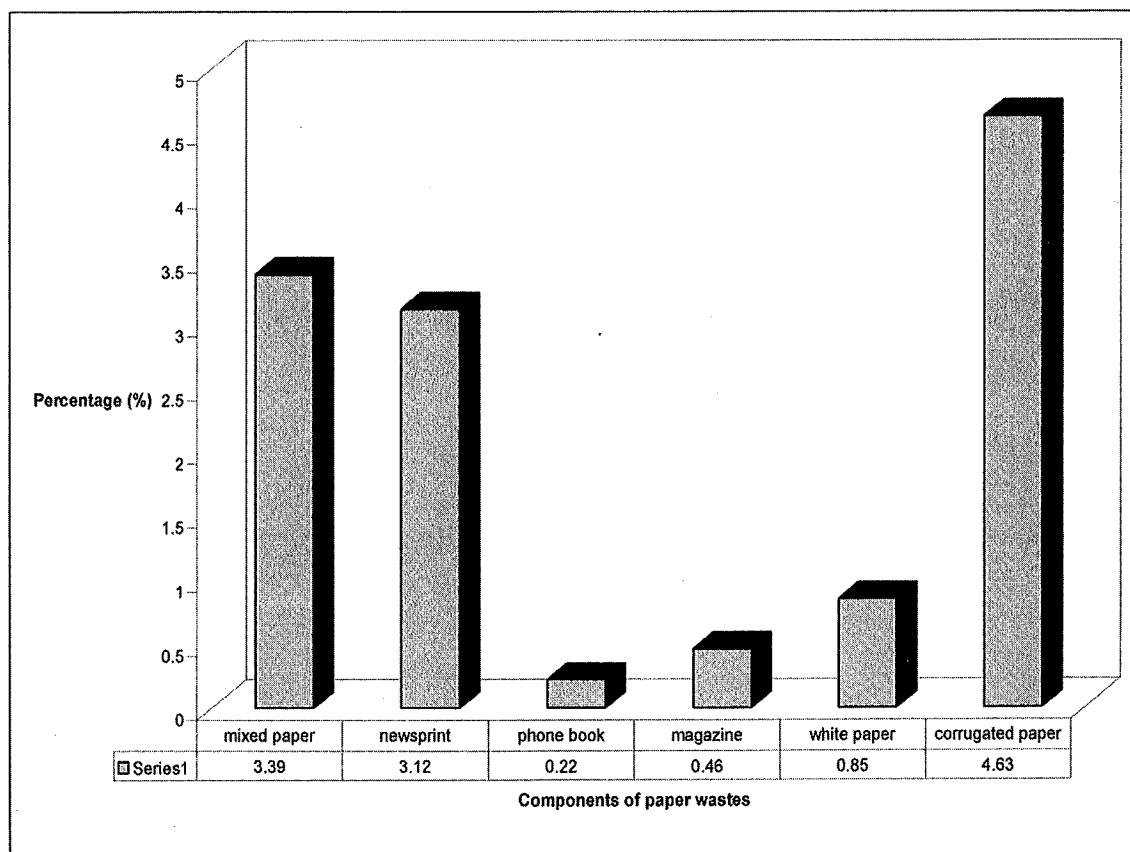


Figure 4. Percentage of paper waste disposed to landfills according to types

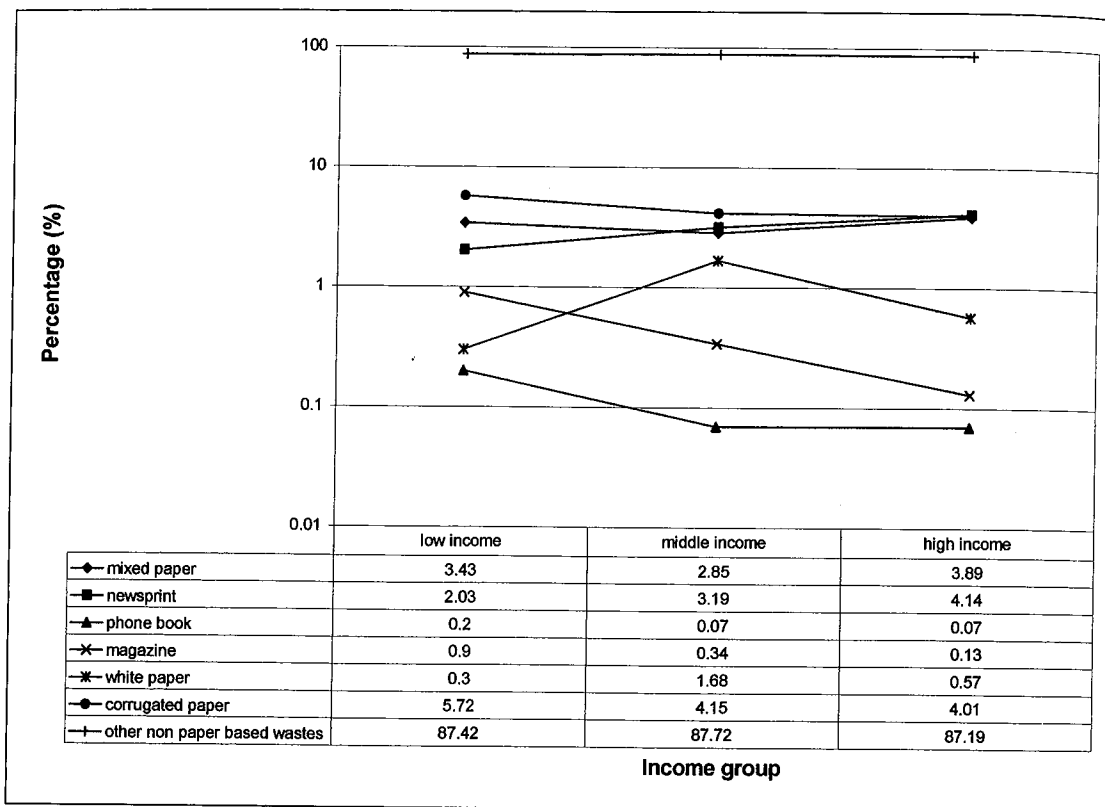


Figure 5. Trends (%) in paper wastes generated by different income groups.

The trends in generation of paper wastes vary with the types of paper waste. Generation of newspapers indicated trend of increasing percentages from the low income group (2.03%) to middle income (3.19%) and high income (4.14%) groups. However, the trend for corrugated paper generations were found to decrease from the low income group (5.7%) to the middle and high income groups (4%), while the generations in mixed paper and white paper showed no clear trends.

The recovery yield from the 17,000 tonnes of MSW generated by Malaysians, can amount to approximately RM50.00 (US\$ 13) per tonne daily [10]. The amount included RM 14.8 (US\$ 3.90) of plastics, RM 5.10 (US\$ 1.30) of paper, RM 28.60 (US\$ 7.50) of metals and RM 1.35 (US\$ 0.36) of glass, generating RM 850 000 or US\$ 223 700. The recovery would reduce the annual waste managing cost from RM 400 million to RM 90 million.

As the putrescible component of the MSW in Malaysia ranged from 38% to 58%, with an average of 47%, composting system would be

another effective method to reduce the quantity of waste sent to landfills [9]. This could be conducted with various suitable additives in enhancing the composting process and to give the ideal carbon to nitrogen (C/N) ratios to the compost. With up to 50% recovery, compost production from MSW composting would reach 5600 metric tons per day or 2 million metric tons annually [10]. Compost at approximately 4 000 tonnes/day can be sold conservatively at RM2.00 per kg to generate RM 8 million. With the cost of composting at RM330.00 per tonne, the net profit from the process would be approximately RM 5.4 million (US\$ 1.4 million) daily or RM 1971 million (US\$ 511 million) per year.

Recycling, which is an important approach to conserve landfill space and natural resources, is only carried out by a small number of participants. Recycling campaigns launched by certain local governments previously in 1990s failed due to poor public response, lack of collection centers and recycling facilities. However, with the increasing awareness among general public concerning environmental issues, a convenient system that readily integrates into

an existing infrastructures are high on demand. Currently, with the co-operation between the Governments, Alam Flora Sdn. Bhd. i.e. a private waste management company, the non-governmental organizations (NGOs) and public participation, recycling has reached 3% [11]. As the country moves towards the status of industrial country as stated in Vision 2020, the government planned to achieve a rate of 22% recycling by 2020, 15% of intermediate processing while only 63% of the total MSW would be sent to landfill [1]. Therefore, effective and efficient integrated waste management need to be implemented in order to fulfill the objectives in realizing an improved environment. Besides composting or recycling, another option would be thermal treatment with the recovery of energy through the production of refuse derived fuel materials (RDF). RDF utilizes the combustible portion of the MSW to be converted into free burning pellets and it can reduce as much as 30% of the MSW combustible component. The implementation of RDF technology will save RM 153,000 (US\$40,000) daily and generate income at approximately RM255,000 from the RDF production [10].

The possibility to improve towards a proper MSW management is obvious that some local authorities have started to investigate this option. However, the challenge to overcome would be to increase awareness among the public to participate in the programmes planned, and induce source separation.

CONCLUSION

The waste received by the landfills in Malaysia was found to be highly mixed with 47% organic waste. With appropriate biological treatment methods the portion can be drastically decreased which can reduce the tonnage of waste sent for disposal in landfills. The other significant portions of the waste i.e. paper and plastic which can be recycled or used for refuse-derived fuel plants would also reduce the volume of waste sent to landfill as much as 29%. In order to achieve an efficient waste management in a developing country like Malaysia, alternative options including material recovery, composting and thermal treatment could be implemented. Besides the improvement in the environmental quality, the implementation of an integrated waste management would also contribute to economic perspective. However, a specific

improvement tool involving public participation is necessary in order to ensure that an appropriate MSW management system can be implemented. This is to create awareness among public to get involved in composting and recycling activities as the recyclables present were very high (48% of food waste and 13% of paper).

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