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Photo courtesy of Samniang Saenram

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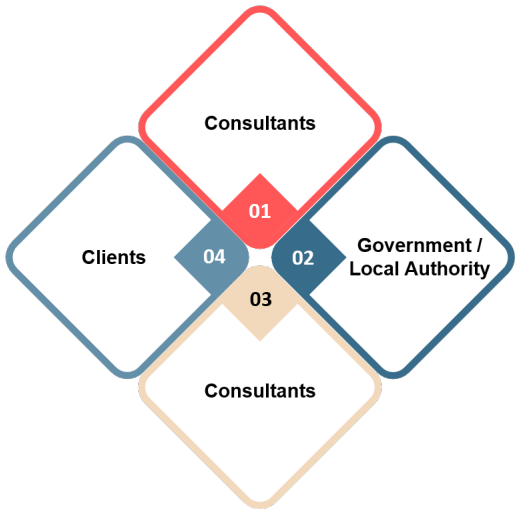

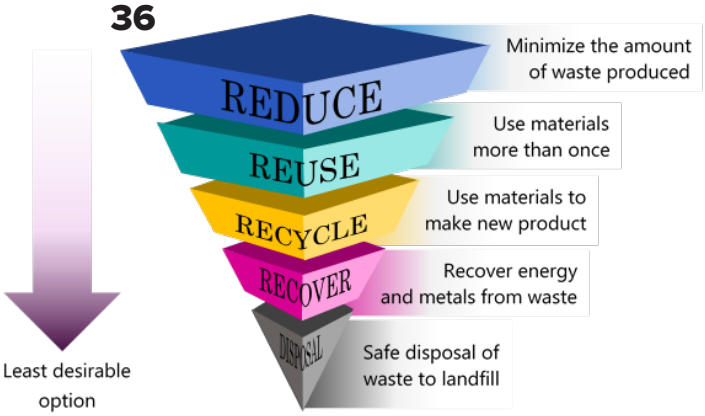

Plastic Waste Management in Malaysia: Current Status, Key Challenges and Opportunities

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Nowadays, plastics are considered an essential material in our daily lives. The expansion of its consumption in Malaysia and globally has provided certain societal benefits. These include safe food storage and consumer products, improvements in the health sector, growth of clean energy, building and construction and in transportation. Since 1950, global production of plastic materials has progressively increased. Currently, the world is producing more than 340 million tonnes of plastics a year [1]. Many common plastics such as polyethylene, polypropylene and polystyrene are made from hydrocarbon monomers. These plastics are made by linking many monomers together into long chains to form a polymer backbone. Although the basic makeup of many plastics are carbon and hydrogen, other elements can also be involved which include oxygen, chlorine, fluorine and nitrogen. To cite some examples, polyester and polycarbonates contain oxygen, polyvinyl chloride (PVC) contains chlorine, nylon contains nitrogen while teflon contains fluorine [2]. Generally, it takes from 15 to 10,000 years to degrade these plastic materials. If mismanaged, this plastic waste will end up in landfills, beaches, rivers and oceans, contributing to devastating environmental problems. Plastics represent one of the waste fractions with the smallest recycling rate. Globally, only 9% of plastic waste is recycled, 12% is burned and the remaining 79% ends up in the landfill or the natural environment [3].

OVERVIEW OF CURRENT SITUATION

In Malaysia, plastic consumption per capita increased to over 35kg per year with the demand growing 6% annually [4]. Demand continues to increase as the population grew, with Malaysia's population growing at a rate of 1.30% as of 2020 [5]. Nonetheless, what makes plastics so convenient in our daily lives is because it is cheap, making it ubiquitous, resulting in one of the planet's greatest environmental challenges.

The management of solid waste in Malaysia is placed under the Solid Waste And Public Cleansing Management Corporation (SWCorp), an agency under the Ministry of Housing and Local Government (KPKT), which is a federal statutory body incorporated through the Solid Waste and Public Cleansing Management Corporation Act, 2007 (Act 673). This Act provides the establishment of SWCorp with powers to administer and enforce the solid waste and public cleansing management laws and related

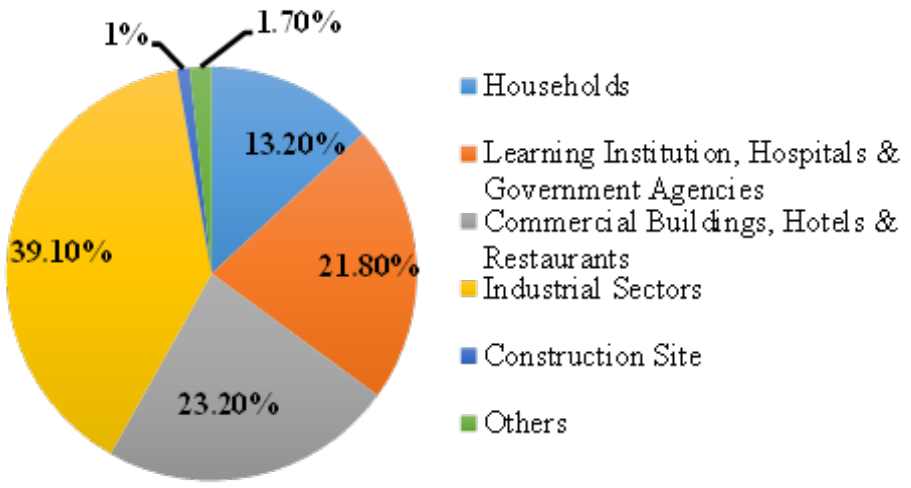

Figure 1: Percentage Composition of Plastic Waste Generated Based on Different Sectors in Malaysia, Survey on Solid Waste Composition, Characteristics and Existing Practice of Solid Waste Recycling in Malaysia, Final Report by JPSPN, 2013

matters. Since September 1, 2011, SWCorp has been responsible for enforcing the Solid Waste and Public Cleansing Management Act, 2007 (Act 672) and regulations relating to solid waste management services and public cleansing in states that have adopted the Act. SWCorp's role is to ensure management services of solid waste and public cleaning are more efficient and integrated while providing optimal satisfaction to the community in terms of solid waste management and public cleaning services [6].

Plastic waste is categorised under controlled solid residue and subject to the hierarchy of solid waste management which includes proper disposal, treatment, recycle, reuse and reduce. To ensure the best practices of plastic waste management being adopted, we need to be clear on the value chain of plastic waste within the country. Based on the report, Survey on Solid Waste Composition, Characteristics and Existing Practice of Solid Waste Recycling in Malaysia (*JPSPN, 2013*), the majority of the plastic wastes generated is from the industrial sector, which makes up 39.1% from the total waste as shown in Figure 1. This is followed by the commercial sector, which includes commercial buildings, hotels and restaurants with 23.2% and 21.8% respectively and 13.2% from the households. The lowest contributor is from the construction site at only 1%. To date, Malaysia is still using the data obtained in this 2013 report as a reference to determine the composition of the institutional, commercial and industrial plastic residues because of the difficulty of obtaining annual input from relevant parties.

In light of the increasing plastic waste generated within several sectors, the Government has started to implement active measures, including promoting recycling activities. Figure 2 shows the national recycling rate for solid waste, including plastics from 2005-2018. In 2005, the recycling rate was only 5% and increased to 10.5% in 2013. The recycling rate has shown a steady increase throughout the years. However, this improvement is slower compared to other developing countries. KPKT has set a target recycling rate for 2020 at 30% with at least an increment of 3% per annum.

The Separation at Source (SAS) Programme is one of the Government's initiatives to reduce the number of recyclable materials sent to the landfill. This constructive effort, introduced in September 2015, demonstrated positive impact

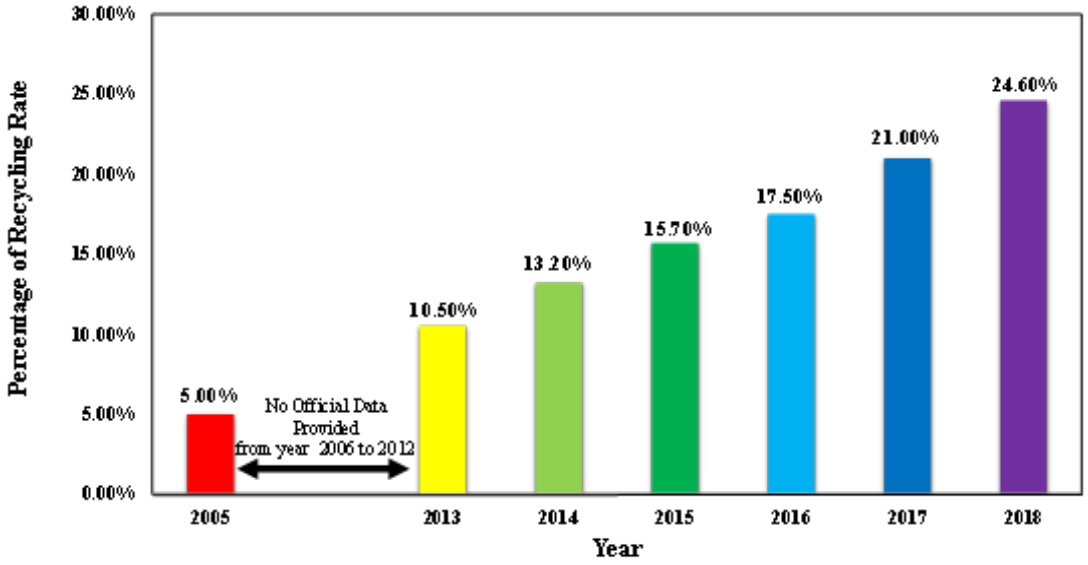

Figure 2: National Recycling Rate 2005-2018, Solid Waste Management Malaysia Compendium 2019, SWCorp

in reducing Government spending to manage solid waste disposal, minimising reliance on site disposal and at the same time helped cut down the production of carbon footprint. Outstandingly, as seen in Figure 3, in 2018 the percentage of plastics waste recycled recorded the second-highest (30.79%) after waste paper (40.80%) as compared to other solid waste materials. On top of that, a comprehensive Communication, Education and Public Awareness Plan on active promotion of the Reduce-Reuse-Recycle (3Rs) principle with participation from the public, private, and community stakeholders has been developed and continuously deployed by KPKT.

On the other hand, in 2018, the Ministry of Energy, Science, Technology, Environment and Climate Change (MESTECC) unveiled a roadmap to reduce the usage of single-use plastic in Malaysia to zero by 2030 [7]. For 2019, the Ministry enforced a pollution charge on single-use plastic. Effective March 15, 2019, a 20 cent pollution charge was imposed on customers for each plastic bag purchased within the Federal Territories. Similar efforts were introduced in selected states such as Selangor and Penang. The move was initially implemented on selected days and gradually increased to every single day in a year. The roadmap also targeted business premises to only provide plastic straws upon request. Although the total plastic straw ban would be in place for several years, an initial effort should be carried out now.

Apart from managing local plastic waste, there are emerging issues currently under the spotlight of two Ministries; KPKT and MESTECC. The importation of plastic waste saw a significant increase from RM241.7 million in 2015 to RM739.8 million in 2018. This is fuelled by Beijing's ban of plastic waste imports into China, which came into effect in 2018 and opened up a gap in the market. Between January and July 2018, Malaysia imported more than 450 thousand tonnes of plastic waste, 40% more than for the whole of 2017 [8]. It is an international issue and one of the key challenges for this country waste management system. Not all plastic waste that ends up here can be recycled. Thus, Malaysia is now stuck with tonnes of plastic waste that will end up in landfill, a huge financial and environmental cost to bear with.

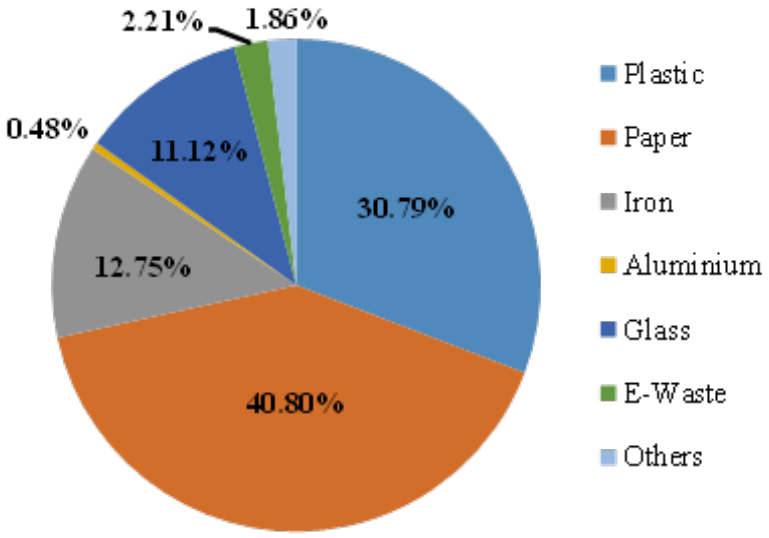

Figure 3: Percentage Waste Materials Recycled under SAS Programme in 2018 (Total waste materials recycled: 2,012.52 tonnes), Solid Waste Management Malaysia Compendium 2019, SWCorp

KEY CHALLENGES IN PLASTICS WASTE RECYCLING

In general, plastics are a material which can be easily melted and remoulded into a new product. However, given the context of the scenario in Malaysia and characteristics of plastic products available today, recycling of plastics remains a challenging task considering several issues as follows:

1) Cross-linked molecular structure of thermoset plastics

As a monolithic material, recycling of plastics particularly the thermoplastic seems very straightforward. Theoretically, thermoplastics can be melted and remoulded [9]. However, usage of plastics' inactive applications usually involves thermoset resins such as epoxy and unsaturated polyester. For instance, an aeroplane structural composite is mainly made of carbon fibre reinforced epoxy. Recycling of cured thermoplastic waste is far more complicated. Thermoset resin has a three-dimensional cross-linked molecular structure, which prevents the cured plastic to be melted and remoulded [10]. Thermoset-based composite product requires attentive process such as pyrolysis or chemical recycling to decompose the resin and recover the fibre or reinforcement.

2) Material complexity of the plastic products

Plastic products usually consist of several materials. The plastic component of a product may be bonded to a metal part or composite sandwich structure. For instance, food packaging usually contains aluminium coated plastic laminates. Separation of plastics from these foreign materials is an arduous and time-consuming process [11]. Such a complex product has different individual material properties that affect the colour, shape, structure and melting point. The products require sorting technology. The mixture between plastics would be more complicated as a chemical approach may be required to separate the individual components. The involvement of additional process for the separation needs to be assessed from a life cycle perspective. The requirement of such processes would increase energy consumption [12]. Besides, the cost of separation could be high. Some processes may have by-products which could further adversely impact the environment. The disassembly or separating of co-materials is not economically viable for business entities.

Since the plastics have low value, the uses of machinery for sorting are rarely considered in industries where recycling is not a core competency.

Material mixing in a product is closely related to its recyclability. The recycling rate for a product with less material complexity is usually higher [11]. This is on account of less or no separation step needed apart from the reduced possibility of having contaminated recycled material. In Malaysia, the challenge can be understood by considering the characteristics of plastic waste collected via recycling centres and bins. The public may not separate the plastic waste according to its type, thereby increasing the waste complexity. The sorting needs to be done locally and the process is expensive.

3) The low value of recycled plastics

According to Malaysia's Roadmap towards Zero Single-Use Plastics 2018-2030, the plastic recycling industry in Malaysia only focuses on materials with high value to ensure its commercial viability [7]. Virgin plastics are sometimes cheaper. Therefore, it is a must for having another dimension of added value for the recycled counterpart. The value of the embodied energy could be low or enhanced mechanical properties. Although recycling of plastics could consume less energy than producing plastics from new raw materials, this is not the priority for the profit-driven entities. Public perception of recycled plastics may also be the hindrance for its usage in a new application, given that the user has no information on where and what the material has been used in its previous life stage.

4) Illegal plastic waste trade

As mentioned earlier, Malaysia is facing the problem of illegal plastic waste trade with the developed countries [8]. This illegally imported waste is mixed with contaminated waste and low-grade value plastics, which cannot be recycled or is not cost-effective to recycle. Unethically, such residual wastes are dumped mostly by illegal factories in landfills and some have started burning them. Waste were brought into the country illegally in containers under false declaration and other offences which violates our environmental laws.

The Government authorities are managing this issue seriously, thus shipping 60 containers filled with around 3,300 tonnes of plastic waste back to the exporting countries such as the United States, United Kingdom, Canada, Australia, China, Saudi Arabia and even Bangladesh [13].

5) Lack of publicly available data and information

Variation in quantity and quality of supply for plastic waste may be a major hindrance for plastic recycling business to operate. In ensuring the commercial viability of recycled plastic, the availability of data regarding the supply of plastic waste is vital. It may also be possible to introduce the concept of material passport, where each material has its record, showing its composition, properties and usage in previous life stages.

6) Lack of enforcement on take-back policy

The central discipline for end-of-life waste management is the concept of product take-back [14]. Under this scheme, user-discarded products are collected preferably for recycling or at least for environmentally safe disposal. Two types of take-back approach are in place: (1) customer-pays, and (2) manufacturer-pays [15]. Both approaches have a significant influence on end-of-life product collection. Examples of take-back in developed countries are the bottle bank scheme, container deposit legislation, pay-as-you-throw, product stewardship and extended producer responsibility [14]. Several approaches are carried out in Malaysia but more voluntarily rather than following Federal policies. The take-back schemes of ink cartridges, collection of old electronic devices by the manufacturer and the implementation of Recycle for Life membership are some examples. With these schemes, the users will be given tokens either in cash or discounted price for buying a new product.

7) Social behaviour towards plastic waste

The issue of rising plastic waste is worsened when considering unsustainable consumer behaviour. Not everyone is taking their waste seriously by separating waste and disposing of them through the designated bins or a collection centre. On the other hand, the bin and recycling centre may not be available in every neighbourhood, hence causing difficulty for the consumer to practise sustainable habits.

Discarded plastic wares

OPPORTUNITIES FOR IMPROVING PLASTIC WASTE RECYCLING

Undoubtedly, the challenges in plastic waste recycling initiatives are inevitable. Discussed here are several key points to morph challenges into opportunities for improvement.

1) Promoting cleaner productions and usage of recycled plastics

Recycling of plastic wastes into new products can contribute to less landfilled wastes. Plastics also contain high energy content that can be converted to electricity, synthetic gas, fuels as well as other products of chemistry. The strategies are to design and implement effective recycling programme by identifying goals, characterising recyclable the quantity, composition as well as the accessibility of plastic wastes locally, assess and generate political support, assess markets and market development strategies for recyclable plastics, assess and select the best technology for collection and processing, addressing legal issues, and finally implementing the programme.

2) Creating more jobs opportunities

The production of more sustainable plastic products with greater incentives by the Government can generate new businesses that contribute to more job opportunities for locals and thus contribute economically. By putting in place stronger incentives such as tax incentives, rebates, grants and loans for local companies and organisations will increase their commitment in producing more sustainable products and create more job opportunities.

> Recycling of a wider range of post-consumer plastic packaging, together with plastic waste from consumer goods is an opportunity to enable improvement in the recovery rates of plastic waste and diversion from landfills.

3) Economic growth

Increase in the export of plastic products from recycled plastics contributes to Malaysia's economic growth. Our plastic products under the chemicals category have contributed around RM50 billion annually as reported by the Malaysia External Trade Development Corporation's (MATRADE) Major Export Products Report 2019. The strategies are to offer export incentives, to get involved in trade fairs and export acceleration missions as well as international sourcing programmes supported by the Government for local companies, including small and medium enterprises (SMEs) [16].

4) Business development

The increase and development of high demand markets for recyclable plastics will lead to developing an established recycling industry assisting local entrepreneurs with the start-up of small-scale manufacturing businesses, encourage existing local manufacturers to increase their use of recyclables, as well as the adoption of a more eco-efficient approach in every part of their business by the local companies. The examples include environmental management systems, design for environment, industrial ecology, eco-labelling, as well as green purchasing and supply chain management [17].

5) Increase education and expertise

Education is one of the most vital components to help foster the development of producing sustainable plastics from plastic wastes. Both the Government and companies could work hand in hand with local universities in research and development on how to tackle plastic waste problems and convert the waste into wealth in the most sustainable ways. This will produce more expertise in related fields.

For example, genetically tailored bacteria are being created which possess the necessary enzymes to degrade the synthetic wastes. Some strains of existing bacteria and fungi have also been identified, which can degrade some of the complex organic chemicals. Also, there are efforts to create 'biodegradable plastics' using starch as the raw material, which can be degraded in a few weeks [18].

6) Technology development and innovations

Another opportunity from plastic waste is the development of the innovative design of products produced. Redesigning products allows for more sustainable input materials being used such as the increase in the percentage of recycled plastic materials. There is also huge potential in recycled plastic waste as they are used in innovative décor materials as well as in building materials such as bricks and vinyl floors.

The Government can work with businesses and also more closely with the Malaysian Plastics Manufacturers Association to encourage them to adopt new technologies that will advance local recycling markets and provide the necessary financial assistance [4]. Guaranteed supplies of recyclables, together with guarantees from local Governments or companies to purchase their recycled products can also be one of the strategies.

CONCLUSION

Recent trends in waste plastic management in Malaysia exhibit a substantial increase in the rate

of recovery and recycling of plastic waste. These trends are likely to continue, but some significant challenges still exist from both technological factors and economic or social behaviour issues relating to plastic waste recycling. Recycling of a wider range of post-consumer plastic packaging, together with plastic waste from consumer goods is an opportunity to enable improvement in the recovery rates of plastic waste and diversion from landfills. Best practices in plastic waste management will certainly support economic growth and societal well-being by enabling a cleaner, resilient, productive and sustainable environment. ■

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